Proceedings of the 3rd European Conference on Games Based Learning

FH JOANNEUM University of Applied Sciences, Graz, Austria
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Edited by
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Many thanks to the reviewers who helped ensure the quality of the full papers.

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Preface

These proceedings represent the work of researchers participating in the 3rd European Conference on Games-Based Learning, which is being hosted by The FH_JOANNEUM University in Graz, Austria. The Conference Chair is Maja Pivec from FH JOANNEUM and the Programme Chair is Thomas Connolly from The University of the West of Scotland, UK.

The conference will be opened with a keynote from Liz Boyle, University of the West of Scotland. The second day will be opened with a presentation from Maja Pivec on the topic of *ENGAGE Learning, Changing learning one game at a time*. There will also be a Panel Discussion led by Rob Davies, MDR Partners in the UK looking at *Increased mainstreaming of games in learning policies.*

The main purpose of the Conference is for individuals to present their research findings, work in progress and conceptual advances in many different branches of games-based learning as well as to come together to share knowledge with peers interested in the same area of study. The research included in these proceedings is clear evidence that the subject of Game-Based Learning continues to develop and mature.

A key aim of the conference is about sharing ideas and meeting the people who hold them. The range of papers will ensure an interesting two days.

With an initial submission of 82 abstracts, after the double blind, peer review processes there are 54 papers published in these Conference Proceedings. These papers represent research from Australia, Austria, Belgium, Bulgaria, Canada, China, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Russia, South Africa, Spain, Sweden, UK and the USA.

We hope that you have an enjoyable conference.

Prof Thomas Connolly
Programme Chair
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Biographies of Conference Chairs, Programme Chair and Keynote Speaker

Conference Chair

Maja Pivec, Ph.D, is professor of Game Based Learning and Learning with Multimedia at the University of Applied Sciences FH JOANNEUM in Graz, Austria. For her research achievements Maja Pivec received in the year 2001 Herta Firnberg Award (Austria) in the field of computer science. In the 2003 she was awarded by European Science Foundation in form of a grant for an interdisciplinary workshop organisation in the field of affective and emotional aspects of human-computer interaction, with emphasis on game-based learning and innovative learning approaches. She is co-ordinator, scientific leader or partner in several EU or national founded projects. She is editor and co-editor of two book publications in the area of innovative learning approaches. She is guest editor of British Journal of Educational Technology, Special issue on learning from games, May 2007. Her research work is published and presented at more than 70 international conferences and publications. She is international advisory board member of MJET – Malaysian Journal of Educational Technology. She is Program Committee member of GAMEON conferences and F.R.O.G. conference. She is reviewer for European Science Foundation and for British Journal of Educational Technology (BJET).

Programme Chair

Thomas Connolly is a Professor in the School of Computing at the University of the West of Scotland, having managed the Department of Computing and Information Systems for several years. Thomas worked for over 15 years in industry as a Manager and Technical Director in international software houses before entering academia. His specialisms are games-based learning, online learning and database systems. He has developed three fully online MSc programmes and developed and leads the undergraduate BSc Computer Games Technology programme. He is co-author of the highly successful academic textbooks Database Systems (now in its 4th edition) and Database Solutions (in its 2nd edition). He is a reviewer for several international journals and has been on the committee for various international conferences. He is a member of CPHC (Council of Professors and Heads of Computing) and member of the Higher Education Academy.

Keynote Speaker

Liz Boyle is a Lecturer in Psychology in the School of Social Sciences at the University of the West of Scotland. She has published papers on approaches to learning, learning styles and personality, motivation and games-based learning.

Biographies of contributing authors (in alphabetical order)

Matthew Bates is currently a PhD research student investigating design and modification tools to encourage knowledge distribution amongst children when interacting with new educational technologies. Member of The Interactive Systems Research Group at Nottingham Trent University and currently collaborating with Derbyshire Libraries and local secondary schools to create new serious-game content for children.

David Brown is Professor of Interactive Systems for Social inclusion and Director of the Interactive Systems Research Group (ISRG) at Nottingham Trent University. He is project coordinator for three EU projects developing serious games for people with disabilities on a range of static and mobile platforms, and combining these with location based services. Other current ISRG projects include the development of a rehabilitation glove using Wii technology and associated serious games for use in upper limb stroke rehabilitation.

Patrick Blum is a Managing Partner of the inside Business Group in Aachen, a leading company for e-Learning and Blended Learning in Germany working mainly for insurance and finance industries. He is a corporate learning expert and his work synthesizes concepts from the fields of computer science, instructional design, and cognitive psychology. Over the past twelve years, he has designed and developed e-Learning and Blended Learning scenarios, online assessments and certification programs, knowledge management systems and game-based as well as simulation-based learning applications. Dr. Blum believes in learner centred learning approaches and concepts of content-driven or goal-driven design. Dr. Blum is a regular speaker at international conferences and member of several committees of international conferences on e-Learning.

Shamim Bodhanya holds an engineering degree and an International MBA. He is currently completing his doctorate in Strategic Enactment. He worked in the corporate sector for nearly 14 years, where he served in a variety of capacities before joining academia. He is now actively involved in research, academic development, lecturing, and facilitation and consulting. His professional interests include large scale systemic change characterised by complexity.

Natasha Boskic works as an Educational Technology Manager at the University of British Columbia (UBC), Vancouver, Canada. She offers instructional and technical support to instructors and staff, and gives tutorials and workshops on online course development and delivery. She is working on her Ph.D. in Language and literacy education at UBC. The focus of her research is the intersection of games and narratives, with special interest in alternate reality games.

Thomas Bröker is a researcher at the chair of building physics, Bauhaus-Universität Weimar. He has helped to develop and implement eLearning Bauphysik, a further education programme and masters course in the field of building physics. He has a background in architecture and worked and lectured for several years on the conjunction of architecture and civil engineering. His research aims at the development of learning scenarios to mediate the complex scientific and planning coherences in civil engineering and ways to unitize their implementation.

Thibault Carron is an associate professor of computer science at the University of Savoie. He is a member of the Syscom laboratory. He obtained his PhD in computer science at the "Ecole Nationale Supérieure des Mines de Saint-Etienne" in 2001. His current research interests deal with the study of collaborative activity observation and with learning games (Projects : Learning Adventure, Learning Games Factory, Serious Lab for Innovation, Pegase).

Darryl Charles is a lecturer at the University of Ulster in Northern Ireland. His research specialism is in Computational Intelligence for computer games and is particularly interested in adaptive mechanisms and real time machine learning to enhance player entertainment. He also researches the use of these technologies in serious games contexts such as games for rehabilatation and games inspired e-learning systems.

Marco Antonio CHÁVEZ-AGUAYO is currently a Doctoral student in the Management of Culture and Heritage at the University of Barcelona, where he is professor and researcher. There he received a Masters in Cultural Management. He also holds a Masters in Comparative Studies in Art, Literature and Thought from the University Pompeu Fabra (Barcelona, Spain). His degree is in Psychology from the ITESO University in Mexico.

Celso Gonçalves is a PhD student on Technology Enhanced Learning at the University Joseph Fourrier in Grenoble, France. He has a degree in Psychology (Universidade Federal de Uberlândia, Uberlândia, Brazil - 2003), Master in Organizational Psychology (Université Lumières Lyon II, Lyon, France - 2007) and nowadays, member of the MeTAH team (Methods and Techniques for Human Learning - Laboratory of Informatics of Grenoble).

Thomas Hainey is studying for his doctorate at the University of the West of Scotland. His research is focused on the application of games-based learning to teach requirements collection and analysis in software engineering.

Klaus Hammermüller, MEcon Former IBM Digital Media and Metaverse Architect, 7 years of working experience in new media projects including Web, Streaming Media and 3D world technologies. Additional 10 years of working experience as University lecturer, IT Instructor and Coach. Initiator and now full time dedicated to the TALKADEMY project which started 2005.

Hanno Hildmann is currently a PhD student at the University of the West of Scotland (UWS) working on the formal design of serious games for mobile devices. His interests and background include Artificial Intelligence and Logic as well as Game Theory. He is hopfully going to graduate soon and is currently looking for a nice post doc position.

Jule Hildmann holds a Higher Degree in Special Education. She is an Outdoor Guide and Trainer in Experiential Education with various qualifications in outdoor sports. She is a Facilitator and Train-the-Trainer at the Centre for Experiential Education Volkersberg (Germany) as well as a Medic Aid, educational and systemic counselor. Her PhD Thesis is currently under review at the Ludwigs-Maximilians-University, Munich Germany.

José Ignacio Imaz Bengoechea holds a Doctorate in sociology. He is a lecturer at the University of the Basque Country in the Faculty of Philosophy and Education. In the last few years, his main research field has been the sociology of education.

Vincent Jonker is a Researcher in the area of mathematics education and games. He is involved in both the development of mini-games for www.thinklets.nl and research into the use of mini-games in schools and at home.

Pieter Joubert completed his Bachelors Information Technology at the University of Pretoria before working in industry as a test and programmer for an Electronics Warfare company for two years. He returned to academia and completed his Masters in Philosophy with a Speicalisation in Informatics. He is currently pursuing a PHB in Information Technology while teaching and researching at the University of Pretoria. His research fields include Virtual Worlds, Serious Games and Web 2.0.

Harri Ketamo, Ph.D., works as Principal Lecturer in Interactive Media at Satakunta University of Applied Sciences, Finland and as Adjunct Professor at Tampere University of Technology, Finland. His research focuses on conceptual learning, complex adaptive systems, machine learning, user modeling and game AI's. Ketamo's research results have also been applied in several commercial e-learning products.

Michael Kickmeier-Rust is a psychologist and software programmer. Since 2001 he is with the Department of Psychology at the University of Graz, Austria. His research and development activities are concentrating primarily on intelligent, adaptive educational systems. In particular, Michael is working on the evolution of psycho-pedagogical frameworks and models of adaptivity on the macro and micro levels. Since 2008 he has coordinated the FP7 ICT project 80Days which deals with game-based learning.

Kristian Kiili is a senior researcher at Tampere University of Technology and a Visiting Scholar in Stanford University. Kiili has studied computer assisted learning and design of game based learning environments and has taken part in several research and development projects on this area. Kiili has published over 30 international conference papers and journal articles on his research area.

Rolf Kretschmann studied Sport Science, Philosophy, and Media Pedagogy at the University of Dortmund in Germany. Currently, he is holding the position of an Assistant Professor for Sport Pedagogy and Media Pedagogy at the Department of Sport and Exercise Science at the University of Stuttgart in Germany. His research interests are in Sport Pedagogy and Didactics, Sport Philosophy and Ethics, and Media Pedagogy and Didactics.

Fiona Littleton is a tutor on the MSc in E-learning at the University of Edinburgh. She is the Virtual Worlds development adviser to the MSc, various schools in the University of Edinburgh and various other UK universities. Her research interests include virtual worlds, game-based learning and student learning.

Love Lönnroth has an MSc in Business Administration from Gothenburg University, Sweden. He is a project leader of the educational game Jirafa World for Jirafa AB. He has previously worked as a consultant with education and training for companies and government agencies, in classroom settings and with digital media.

Dennis Maciuszek holds German Dipl.-Inform. and a Swedish Lic. in Computer Science (minor: Psychology), as well as an M.A. degree in Media. He was previously employed as a researcher at Linköpings universitet, Sweden. Now he is a PhD student at the University of Rostock, Germany, working in the area of Game-based Learning.

Hamish Macleod is a member of the School of Education at the University of Edinburgh in Scotland. He has a background in psychology, and a longstanding interest in learning technology, particularly exploratory approaches to learning supported by information and communication technologies. He is presently Co-Director of the University's MSc in eLearning. http://www.education.ed.ac.uk/e-learning/

Christelle Mariais is a PhD student in Computer-Based Learning at the University of Grenoble (France), Laboratory of Informatics of Grenoble (LIG). She is also a consultant in the R&D department of the e-learning solutions company Symetrix. To be precise she is in charge of Learning Game projects for professional training. Her studies in pedagogy and multimedia training engineering and her interest in video games, naturally leads her to focus her work on Serious Games and Game-Based Learning.

Ben Meyer is currently an Assistant Professor in the Digital Design program at the University of Cincinnati's College of Design, Architecture, Art, and Planning. Prior to his appointment at Cincinnati, he has worked as a cg artist and animator for clients such as Hasbro, Warner Brothers, and South Peak Interactive. Ben has also developed interactive training material for corporate clients such as Motorola and for government programs such as the United States and British military.

Bente Meyer is an Associate Professor at the Department of Curriculum Studies, School of Educastion, University of Aarhus and a member of the research programme Media, ICT and learning. Her research interests are second and foreign language education, intercultural and citizenship education as well as computer assisted language learning (CALL). She has edited several books on media, ICT and Learning, including Digital Media and Educational Design (Digitale Medier og Didaktisk Design, The Danish University of Education Press).

June Moore is a Research Assistant in Computing at the Worcester Business School (University of Worcester, UK). Her expertise lies in computer game level design (especially using the 'Unreal Tournament' game engine as well as development of assets using 3D Studio Max). June's BSc. degree has combined elements of both education and computing. As a former professional musician and graphic designer, she is able to relate aspects of media creativity with educational theory and computer game principles. Her current goal is to research the fundamental principles of Educational Immersive Environments to establish both a theoretical basis and guidance for practitioners.

Alex Moseley is an Educational Designer at the University of Leicester, where he has had long experience as both practitioner and researcher of course design, development and subject teaching for higher education. He has particular interests in online and distance education, student engagement, and provision of effective research skills and student induction. He also researches online immersive games, and has suggested key features which can be transferred to higher education to ensure high engagement and community development; he was also part of the team behind the first charity ARG, Operation: Sleeper Cell.

Elias Pimenidis is a Senior Lecturer at the University of East London in the UK. He has been the programme leader for the BSc (Hons) Computer Games at UEL from 2003 to 2006 and over the past three years he has been increasingly involved with research in and development of games for educational purposes both in a Higher Education environment and for vocational training. Following the successful implementation of a library induction game for use at UEL, Elias and his team are currently working on educational games targeting to develop specific work based skills for H.E. students and professionals alike.

Gearóid Ó Súilleabháin is the elearning projects manager for the DEIS Department of Education Development in the Cork Institute of Technology where he also works as a lecturer in modules relating to the field of educational technology. He is currently undertaking a Phd on the topic, "Learning Transfer and Computer Game Environments".

Lucia Pannese, graduated in Applied Mathematics, is funding partner and CEO of the Serious Games development company imaginary s.r.l. based at the technical university Politecnico di Milano, and of Games2Growth Ltd based at the Serious Games Institute, Coventry University Technology Park. She has numerous Italian and international publications and presentations about Serious Games.

Paul Pivec has worked in Academia for 8 years and in computing for over 30 years in all aspects of the industry. He has consulted to both game development and publishing companies, and teaches game development at tertiary level. He has a Masters degree in Computer Technology with specific emphasis on digital games. His thesis showed that multitasking skills are enhanced from player immersive computer games. He also has a graduate diploma in higher education and is currently working on his PhD in Game-Based Learning at Deakin University in Melbourne, Australia. Paul and Maja founded Pivec Labs (www.piveclabs.com) where structured methodology is utilised to predict the success of both educational and recreational video games. He has been recently published in Becta and contracted to write for the ISFE. Paul's academic history can be seen at http://www.paupivec.com .

Bernd Remmele has gained his doctoral degree in sociology of knowledge. He is research associate at the WHL Graduate School of Business and Economics Lahr, where he directs a European project which develops an educational game fostering entrepreneurial attitudes. Currently he is interim professor at the University of Duisburg-Essen for the didactics of social sciences. Main research interests are the development of knowledged structures, particularly in economics, e-learning and game-based learning. Previously he has, e.g., been coordinating a project which used a MOO for teaching computer and law.

Sumarie Roodt completed her BCom: Informatics at the University of Pretoria before working in financial services for 6 years. During her time in the banking sector she performed a number of roles, including being a project manager, a strategic alliances portfolio manager and then a strategy consultant. Sumarie decided to pursue her MBA full-time at the University of Cape Town's Graduate School of Business and was then selected to attend the University of Chicago's Graduate School of Business for a semester. Sumarie is now a full-time lecturer at the University of Pretoria and is currently busy with her PhD in Informatics.

Olga Shabalina conducts research in the area of Digital Game-Based Learning since 2005. Currently she manages a research team on "Casual and Serious Games" project composed of 9 researchers. She was awarded a PhD in Management of Social and Economical Systems, Astrakhan State University in December 2005. She is also responsible for project management of several Tempus Joint European projects. She is currently a Lecturer in CAM Systems Design and Development at CAD department at Volgograd State Technical University.

Elsebeth Korsgaard Sorensen is a senior lecturer in ICT and Learning in the Institute of Information and Media Studies, University of Aarhus, Denmark. For many years she was head of the online Masters programme in ICT and Learning, offered collaboratively by five Danish Universities. Her international research focuses on collaborative dialogue and knowledge building online, pedagogical design and delivery of networked learning, and implementation of electronic portfolios as reflective tools in online learning processes. Elsebeth presents her research at international conferences, frequently as keynote speaker, and she has published extensively in international journals and books within the field. She serves on the editorial board of several international journals and on programme committees of international conferences within the field.

Penny Standen is Professor in Health Psychology and Learning Disabilities at the University of Nottingham. Her main area of research is developing and evaluating virtual environments and interactive software for people with intellectual disabilities She is currently collaborating with colleagues on the use of VR in stroke rehabilitation.

Tan Wee Hoe is a PhD candidate from Malaysia who is doing research on game-based learning (GBL) in the Warwick Institute of Education, UK. His research concerns with issues related to how subject matter experts and game experts can collaborate to design and develop GBL for use in formal education contexts. His research is funded by the Ministry of Higher Education and Sultan Idris University of Education, Malaysia.

Sevda Tsvetanova, Deputy Head of the Department of Foreign languages at the University of Rousse, is a senior lecturer in English who has initiated and coordinated several large scale EU - funded projects focused on the development of ICT- based teaching materials for a number of EU languages. She has written several FLT coursebooks and participated in a 147-nation survey on intercultural behaviour resulting in several publications in academic and professional journals. Her research interests are in e-learning and the use of ICT technologies in educational settings. She was the key note speaker at the Comenius Contact Seminar on Languages and new Technologies conducted by the Socrates National Agency of the HRDC-Bulgaria in 2005. Sevda Tsvetanova is also Head of the methodology panel of the Language Unit of the University Centre for Continuing Education.

Nikolina Tsvetkova has been a teacher trainer for English language teachers at Sofia University Department of Information and In-service Training of Teachers for more than 8 years. She works in the field of intercultural education, teaching English to young learners, applying ICT in ELT and material design. She has taken part in various locally and internationally initiated projects and has delivered papers at a number of conferences and educational events. Nina has co-authored and written several locally produced English language coursebooks and supplementary materials.

Anna Warren is a student on the MSc in E-learning (http://www.education.ed.ac.uk/e-learning/) at the University of Edinburgh. She has been a consultant to several European universities advising on the development of teaching materials for the online environment. Her research interests include game-based learning and using MUVEs and online games as teaching spaces.

Xueli Yu graduated from Computer Speciality in Tsinghua University and is a doctor tutor in Taiyuan University of Technology. She has been engaged in research and teaching project about Web-based intelligence information processing, software architecture and Web multimedia, and has published more than 70 articles in national and international key journals, among which, three has been indexed by SCI and 14 by EI.

Parameters for Video Games for the Treatment of Mental Illness in Children

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Abstract: Children from dysfunctional families often exhibit behavioural and emotional disorders which have long term consequences such as mental illness. As well as direct physical abuse children may experience neglect and such things as the use of television and computer games as child care substitutes. The games played by these children are often of an age rating far above their own. Adults from dysfunctional backgrounds and children from "normal" backgrounds have been shown to have been adversely affected by exposure to violent computer games. How much more damage can be done to these more vulnerable children? As repeated exposure to negative behaviour patterns through role playing computer games can have such a significantly bad effect on children with behaviour disorders, can role play games using good models of behaviour be designed to produce a positive effect on these children? Such games need to use existing principles of Cognitive Behavioural Therapy (CBT) or some other treatment method. Modelling is a common theme of CBT and social learning. Any intervention to treat conduct disorder must use social learning. In these approaches clients are presented with models of proper behaviour and appropriate communication between individuals and groups. Tools for this modelling commonly involve such things as work books, board games and discovery groups of many kinds. However, many of these methods do not easily motivate children. In particular they lack the motivation for homework based around these materials. A lot of work sheets need them to engage in activities they find boring or difficult (because of lack of literacy). Games offer the potential for engagement and motivation that many other methods now lack. This paper reports on progress in the design of a computer game based on CBT principles to treat mental illness in children. In addition to ethnographic study and experiments described previously analysis of the current content of standard CBT treatments has been used to derive the fundamental principles needed in the game. A wide range of current games and work books have been analysed. In addition to this other computer based tools (both for adults and children) have been studied to derive the principles needed for the game. The pilot of the game is being tested and evaluated by health professionals. The game is based around a set of narratives derived from everyday life. In the game images are used to convey the setting. In any narrative there is a central theme that defines the overall fundamental game play which revolves around the idea that thinking feeling, body signals and behaviour are linked and cannot be disconnected from each other. In addition secondary ideas derive from the main theme.

Keywords: Cogntive behavioural therapy, social learning theory, computer games, mental illness

1. Introduction

Recent press coverage of computer games in the UK has emphasised their possible negative effects on player's behaviour. Much of what has been written (Daily Telegraph 2009) has been sensationalised and does not reflect the true nature of the scientific enquiry it claims to be based on. However there have been serious studies that indicate negative effects of even short term exposure to some sorts of computer games (Anderson and Bushman 2001) and others that have shown serious results of addiction to certain games. However, the National Association for Health and Clinical Excellence (NICE) in the UK have recommended the use of computer based materials as therapeutic tools for adults with mental health problems. In addition a number of prominent workers for example (Stallard 2006) and (Brezinka, Hovestadt, 2007) have developed computer based "games" for use in the treatment of children with symptoms of mental illness. The question that the current study seeks to answer is "What are the design criteria for computer games that are intended for therapeutic use?" In particular we have concentrated on the treatment of children with behaviour disorders.

Children from dysfunctional families often exhibit behaviour problems. These are manifest in many different ways resulting from various serious contributory factors (Sadock, Kaplan and Sadock 2007). This problem is a significant one, one study in the USA showing one child in four in the age range 9 to 17 suffering from some form of conduct disorder. This is exhibited more commonly in boys than in girls and is also more frequent in urban than rural environments (U.S. Department of Health and Human Services 1999). The nature of the causes and their related symptoms and treatment methods are summarised in Table 1 below. These problems manifest themselves in many different ways, such as violent behaviour and Attention Deficit Hyperactivity Disorder (ADHD). In designing a computer based intervention for the treatment of these symptoms it is necessary to know about the target users, to understand their background, their ability, their skills, language and other details of their everyday life. For this purpose an ethnographic study and user experiment were conducted (Alshanqiti, Carr and Blanchfield 2008). The results of these studies were used to help inform the design of two separate computer games both of which explore the application of these ideas in different ways. This paper relates to further work done in designing one of these games.

Table 1: Summary of contributing factors for conduct disorder, resulting symptoms and list of resulting clinical approaches deemed suitable for the game design. [1] See for example (Sadock, Kaplan and Sadock 2007) and (Holmes, Slaughter, Kashani 2001)

Factors Contributing to the development of Conduct Disorder (CD)[1]	Symptoms of CD[1]	Clinical approaches used in the game design
Neuropsychology: Impairment in the frontal lobe – genetic basis Psychological factors: Hyperactivity Anxiety, depression, obsession, mood disorder Family: Divorce Parents who use physical and verbal aggression Parental psychopathology Family instability caused by severe marital disharmony Socio-cultural factors: Low socioeconomic status Social problems Dysfunctional environments	Symptoms gradually escalate and neglecting treatment could cause personality disorder. Symptoms: Children actively defy adults and rules Truancy, theft, vandalism, arson Physical aggression – towards people and animals Frequent bullying Improper sexual behaviour Initiating fights, often angry and resentful	Principles of Cognitive Behavioural Therapy (CBT) Psycho-education Modelling ABC Model The theory of social learning

2. Background to the design

The possibility of using computers in therapy has been investigated from as early as the work on ELIZA (Weizenbaum 1966) which was an attempt to implement a Rogerian approach. ELIZA selects key words from the user's responses and turns these into further questions, leading the patient to investigate their own thoughts and feelings. There have been a number of significant attempts to use computer games in therapeutic treatment, many of which were triggered by the growth in availability of general computer games with the advent of the personal computer in the early 80s (Wilkinson 2008). For example the "Adventure of Lost Loch" was designed to give therapy for impulse control (Clarke and Schoech 1984). In this game the player is taken on an adventure through a cave in search of a crown. The player has to make decisions and will either be rewarded or penalised based on the decisions they make. Some approaches to using therapy for children are given in (Jones 1996) for example she refers to "My Life in words and Pictures" in which the player is caused to reconstruct their life story. The main driver for this is that children in care often have complex life stories in which they have moved repeatedly from care homes to foster homes and need to establish for themselves who they are in order to deal with their own emotional states. Jones also highlights the use of "The bubble dialog" in which the player is encouraged to create the dialog between characters. In (Alshanqiti, Carr and Blanchfield 2008) we provided a short review of the games which we believe are most significant to the developments described here. In addition to the work of Clarke and Schoech we highlighted the work of (Resnick 1986) which was aimed at young people in care which was later finished by (Cowan 1994). Recent academic work of relevance includes that of (Matthews, Coyle et al 2004) which is an attempt to apply solution focused therapy to adolescents with personal problems. Similarly the work of (Brown, Shopleand et al 2007) introduced a game designed to engage adolescents with the aim of tackling their social exclusion problems. An interesting development in this area is the work of (Van Dijk, Hűnneman and Wildevuur 2008) which also seeks to engage adolescents and uses a virtual life environment in which therapists may take part as non player characters.

Our previous paper also outlined the experiments undertaken to inform the design of our game. It that paper it was established that there were some conflicting issues in creating games for the treatment of children with behaviour disorders. As outlined above, most children with serious behaviour disorders come from dysfunctional families. They often have high exposure to sophisticated computer games with player certification well above their own age range. On the other hand their general educational development lags their physical development. There was thus a need to meet with professionals in the treatment of mental illness who deal with children with conduct disorder to understand what methods are used to treat such children in addition to the ethnographic study and experimental study.

There is also a limited literature on the use of cognitive behavioural therapy for the treatment of children with conduct disorder. It was thus necessary to meet specifically with mental health professionals who use CBT in there sessions to understand how effective the use of CBT techniques might be for the target children. An important focus was the techniques CBT therapists used in their sessions; that is, the structure, time, language and so on. A background study of the literature on CBT treatment was made to ensure that the interviewer had a broad idea and a solid background to formulate questions that the interviewees (mental health professionals) could understand and respond to. The questions focused on understanding the current strategies and other modes of intervention that are used by CBT therapists for the treatment of conduct disorder children. CBT terminology was used in order to convey the information that is relevant to the field (Brace 2004). Literature review facilitated and helped choosing the words and the terminology that could be understood by the participants. The interviews produced a large amount of rich information and offered the opportunity to correct any misunderstanding of topics which need clarification or need to be observed to see how the tasks should be carried out. In particular interview questions were prepared to address the question of which way CBT techniques could be applicable as a basis for the design of a computer game.

3. Interviews

Between January and March 2009 a total of nine CBT therapists were interviewed in addition to the staff of the day unit at which the ethnographic study was carried out. Seven of the therapists worked exclusively with children. They would not diagnose the children as suffering from Conduct Disorder but call them “children with behavioural and emotional problems” because they are convinced they should not to label children below 13 years of age. Two others were consultants using CBT but working with adults but agreed that the same principals of CBT could apply to the treatment of children if used in an appropriate way. Most of the therapists felt that CBT could be used effectively with children aged 9 and above. The results of the interviews were analysed according to the following categories:

- How sessions were structured – in order to inform the structure of the game
- Patterns of treatment – to determine what content would be useful in the game
- The use of role play – to enable modelling, which is a big part of CBT, within the game
- Features of Characters when using role play – to inform the design of the central character for the game
- The use of story type and stories in the CBT sessions – to inform the narrative for the game
- The use of psycho-education within the session – to try to reflect relevant treatment patterns in the game
- Specific methods used with CD children – to make sure the game will help to limit escalation of the symptoms of the disorder
- Direct suggestions – of how the game should function.

There was general agreement on the way sessions were structured and the sort of content that was used in treatment. Mostly this confirmed the findings of the ethnographic study. However, sessions were adapted to the specific methodology of the therapist. They also said that they use other methods than purely CBT in their treatment; however most of the methods they use have their equivalent in CBT. There was disagreement on the likely effectiveness of CBT in the treatment of conduct disorder. However all respondents felt that role play would be very effective as the children being treated needed to identify with the situations they were working with. The general opinion was that this should be indirect involvement would be better than direct as there was a danger of too much identification could lead to distress in the children. This was not uniform as one respondent would deliberately use recordings of the child in role play situations which they would then review with the child as part of the session. Most interviewees noted that the children did not respond well with frustration and negative responses in games. This led to a conclusion that there should be no negative consequences to actions in the game. However, this contradicts the normal process in games where negative responses are meant to increase challenge and thus promote engagement. It will be necessary to add components that explore the consequences of negative reaction to frustration instead of it leading to negative game outcomes. This would be resolved by integrating the ideas vicious and virtuous circles within the game. There was general agreement that these should be explicitly used, however it is difficult to see how this can be developed as game type challenges. In the current design they are used as interjected sessions that the child would work through with their therapist (see section 4).

The therapists would generally use images of emotional behaviour when working with children. These would be from a variety of sources including magazines and video clips. They felt that cartoon like characters were more appealing to the children. Facial expressions were also used in parts of role play to help children learn how their facial expressions reflect their feelings.

The day unit workers would use “super hero” characters to enable them to express feelings that they cannot express easily in their ordinary life. This was confirmed by one of the CBT therapists.

All of those interviewed believed that the use of computer games in therapy could have an important side effect. Most of the children felt powerless in their daily lives; however they would generally be more happy and able in using computer games than their therapists, leading to a feeling of empowerment.

How the results of these interviews as well as those of the experiment and ethnographic study (reported earlier) have been used in the game design is further illustrated below.

4. Examples of the game storyboard and implementation

The results of the analysis of the interviews, ethnographic study and experiment with the children have led to the basis of the design. In line with the results the child should be exposed to events that would be expected in usual functioning life for a happy child before any disordered scenarios should be introduced. The first stage involves the child constructing their own character who they will direct in the game. The game continues with the player’s chosen character encountering a number of normal everyday events that would expect to make the child happy. In these “happy” tasks they will practice behaviour patterns. They will be introduced to problems and make choices that would exhibit normal positive responses to challenges. The first implementation of the idea has developed a level where a character is taken to a fair (Figure 1) The player has to take the character on rides but has to make decisions about how much time is spent on a given ride so that all rides can be visited within a certain time.

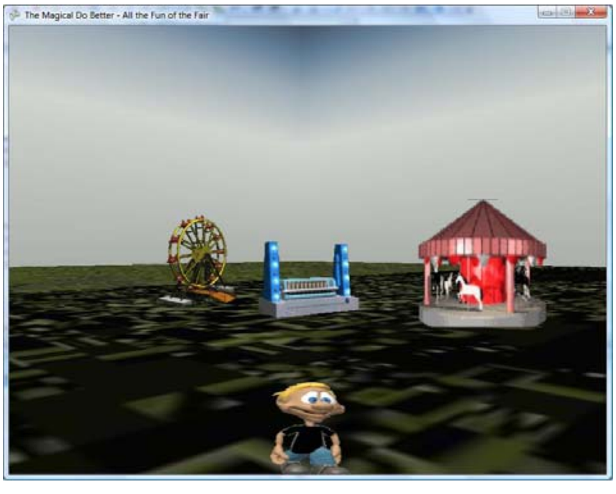

Figure 1: A player will visit a fair but must make decisions about how long to do a given activity

A second involves a driving game (Figure 2) which gives the player control over the character driving and encountering a number of obstacles. One issue that comes up immediately is how bad driving should be treated? This is in relation to the derived principles from the interviews. Negative results in the game – deduction of points for example – can lead to the player withdrawing from the game, but how can challenge be included without these negative responses?

Figure 2: Driving game gives rewards for safe driving – but how to react to bad driving?

In another example, shown in Figure 3 the player character is driving his box cart when it crashes. This generates a question that the player has to respond to. In a positive response the character will repair the cart. This introduces a subsidiary task which is the "level of happiness" symbolised by a ladder. The player chooses their own response on this ladder.

Figure 3: A game scenario from normal childhood

Other scenarios in this group include a barbeque, a picnic, a birthday party and a fishing game with a relative who has a positive relationship with the child. These scenarios have been suggested as a result of the expert interviews as being typical of the life experiences that a therapist will try to take a child through in a therapy session.

In the next part the child is introduced to the idea of emotions. Children in general and those with CD in particular have difficulty in labelling their emotions and finding the best way to relate these to facial expressions and other non verbal signals. These conclusions have been highlighted in the ethnographic study but also confirmed during interviews. So for example one part of the process is as shown in Figure 4

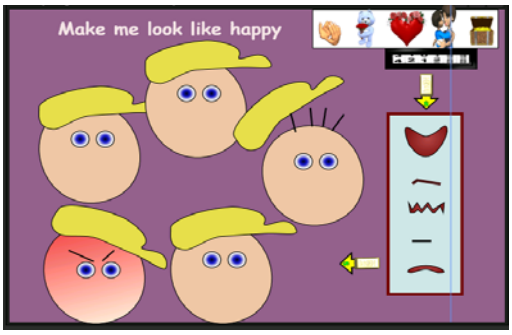

Figure 4: Emotion "construction" activity

In this part the child is given the task of constructing a face (using drag and drop) that will express the givn emotion. A correct response will increase their score and gain a reward. If the choice is inappropriate they will be given further attempts until they succeed. Frustration with this experience will be reduced by the inclusion of helps".

Subsequently children are asked to work through sets of scenarios, some problematic and some normal. This is to help them understand the classes of problem and specific examples of the problems they need to deal with.

One of the important stages in the game is the core of CBT – this is the cycle of "Thinking, Feeling and Doing". This is often known of as the "Vicious Circle" - incorrect thoughts can lead to different kinds of incorrect feelings which in turn result in problamatic behaviour. This is dealt with in the game as illustrated in Figure 5.

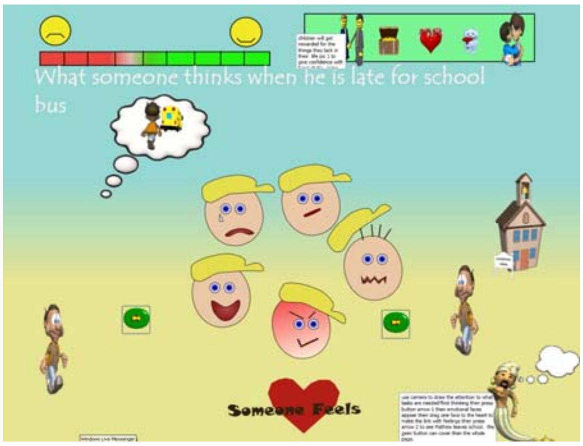

Figure 5: A "Viscious Circle" scenario

In the example shown in figure 3 the scenario is that the child is thinking about missing the bus. The child will choose the appropriate emotion face for their own response to the situation. That would lead to an outcome – perhaps the child does not go to school! The genie appears and gives advice to the child to explain alternative outcomes.

In other scenarios after the player has identified the problem there will be different ways to communicate with the problem. For example the child will choose the solutions to fix the problem. Consequences of the chosen solution will appear and the player has to choose the one they think is suitable to the problem presented in the beginning. The player will also be exposed through the game to different situations they have to challenge negative thoughts that are presented by an antagonist. Items of anger management will accompany the player to use whenever they need to control their feelings. The child will be given tasks to trigger the thoughts that cause the emotions that in turn cause the behaviour.

5. Discussion

A game to use CBT in the treatment of behaviour disorder in children has been designed. The design has been informed by discussion with CBT and other professionals involved in treatment of children and adults with relevant disorders. In general these interviews confirmed the findings of the ethnographic study and experiment which have been reported elsewhere.

Major issues that were identified were:

The need to include concepts of normal life and reactions before challenging children on their dysfunctional behaviour.

The need for children to identify with the game scenarios but from a "third person" view point so that the negative situations encountered were not too strongly personalised.

Opportunity to use "vicious circle" and "virtuous circle" concepts within the game.

Some of the findings are quite challenging for game design. Normally player frustration my produce negative reaction but this leads the player to further engagement in order to master the skills needed to make progress. This has to be limited to the point where the satisfaction with learning is greater than the frustration of failure. However, experts identified difficulties for the children under treatment in dealing with the frustration of failure and negative comments. Ways must be found in which the reaction to negative experiences can be challenged without the game alienating the players.

It has been possible to integrate both the needs of the children as determined by the previously reported experiment as well as tackling many of the issues brought up by the experts in the interviews. However some conflicts currently remain. The game is being developed in two and a half dimensions as this makes production of game components easier than with full 3 D (which would be preferred by the children). The game will be tested with the aid of therapy professionals and their clients. It is expected that the game will be used in both group and one to one sessions and the most effective method will be determined in collaboration with the therapists.

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Gaming and the Firewall: Exploring Learning Through Play via Game Design With Children

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Abstract: Respect from your peers is priceless in today's video-game culture. Gamers learn through play and share knowledge with others to form important social scaffolds. However, the potential of gaming as an emerging educational medium is often overlooked by schools and libraries which block access via firewall software and classify gaming as a threat! Could the ability for children to explore gaming in the classroom provide an important motivation for participation in group discussion and design? Knowledge transfer via collaborative activities can be readily observed in commercial Massively Multiplayer Online Games (MMOs) such as World of Warcraft. Some suggest it is a quest for greater social status within the gaming community that encourages players to gather and trade knowledge through exploration with others. Simple 'web-games' such as the MMO Poptropica are cultivating similar online communities through peripheral methods such as media rich blogs. Created by gamers as young as 12, these blogs often rival content created by official games developers. Current research within the Interactive Systems Research Group at Nottingham Trent University is investigating the pedagogies of these young gamers by collaborating with the Derbyshire Libraries group (consisting of over 40 individual libraries) and a design team of children aged 11-16. The group is observing how these young gamers convert their gaming knowledge into instructional theory when presented with key learning goals and a selection of physical and digital design tools. The design team has participated in a series of after school workshops at a local secondary school to design a new library based video-game. Workshop activities have included creating simple rule sets by modifying popular board games and building design prototypes using accessible games creation software. The team has used both Game Maker and Sims Carnival to create and modify a variety of simple game designs. A project blog for the investigation has been monitored to uncover if the social scaffolds created via large scale MMOs can also be experienced in educational activities of a much smaller scale. This paper discusses the conceptual design of this research including how video-games provide an important motivation for knowledge transfer via social activities. The initial results of the investigation are discussed including issues encountered with firewall software in secondary schools and libraries. The suitability of video footage, worksheets and electronic blogs as methods of data capture are assessed for use with children and important future work is highlighted.

Keywords: Games-design, modding, library, Poptropica, Game-Maker, MMOs

1. Introduction

> *"We need to engage with young people to think about these [gaming] worlds they inhabit as that might help us create more of a dialogue with them when they are running into difficulties." – BBC blog 2008.*

The BBC blog article *'Addicted to Warcraft?'* (Cellan-Jones 2008) documents the anticipated release of the 2008 update to World of Warcraft; the world's most popular Massively Multiplayer Online Game (MMO) (Woodcock 2008). The article allows both gamers and non-gamers an opportunity to debate the emerging trend of 'social' gaming and its impact on today's young gamers. Steinkuehler (2008) has found that MMOs allow gamers to express a 'collective intelligence' driven by a desire to learn the mechanics of play through exploration and competition with others. These gamers produce unofficial user manuals which supersede their official counterparts and include complex tutorials, mathematical models and in-game apprenticeship systems that act as social scaffolds for newcomers to a game. MMOs represent neutral 'third places' where gamers enter and leave without permission or invitation (Steinkuehler & Williams 2006). They allow young gamers in particular an opportunity to interact with professionals as equals, separated only by a game's fantasy context and user created avatars. These social scaffolds are expanding beyond their personal-computer centric role-playing roots and can now be found in multiplayer games on home video-console. Players of Mario Kart Wii, for example, can compete in weekly updated global challenges, compare racing times and exchange video evidence of their skills and achievements. The collective term 'video-game' is used in this paper to describe games played on computers, home video-consoles and over the Internet.

The field of 'serious' games represents new markets for non-entertainment based uses of gaming technology. Gee (2005) describes video-games as 'smart tools' which lead to a 'distributed knowledge' within a gaming community. The serious-game Poptropica (www.poptropica.com) has inspired knowledge distribution via online 'wiki' style knowledge bases, Youtube channels and media-rich blogs. These instructional materials often rival content created by the Poptropica game developers but are designed and maintained by children as young as 12 years. However, these 'smart tools' are rarely endorsed by modern schools. Steinkuehler (2008) comments that activities such as blogging, file sharing, media production and building social networks are more common outside of the classroom than within. Indeed, many schools and libraries block gaming websites and classify them as a distraction to children's studies. Steinkuehler suggests that we must look to contexts outside our current formal educational system to understand the potential of modern technologies for improving cognition in education. Steinkuehler suggests that video-games provide an excellent starting point.

Squire (2007) identifies that gaming is now participatory with digital authoring tools and distribution networks changing the ways in which we interact today. Squire suggests that teachers and researchers must now actively engage with gamers within these networks to investigate a broader adoption of games-based learning exercises in the classroom. As playing to learn will inevitably involve learning to play with educational technology (Bates et al 2007), the conversation and competition observed during this process will inform researchers how children assemble and distribute their gaming knowledge. Respect from your peers is priceless in today's gaming culture and so the ability to trade knowledge for power may provide a motivation for young gamers to engage in discussion and group work activities within schools. Exploring video-game design with young learners represents a new area of research within serious-games. The role-playing-game *Never-winter Nights* has been used to create landscapes, characters and dialogue as a form of interactive story authoring (Robertson & Howells 2008) while the intuitive authoring tools found in *Stage-cast Creator* have been used with 7-11 year olds to explore intrinsic games design via after school workshops (Habgood et al 2005). Intrinsic fantasy games are defined as those in which the learning content of a game is fundamentally related to that game's fantasy context. Habgood found that children do not naturally select intrinsic fantasies to deliver educational material and found that 26% of 7-11 year olds create extrinsic fantasy games where the learning content is arbitrary to the fantasy setting of that game. Whether this is the case for secondary school gamers (aged 11-16 years) requires further investigation.

2. Research

Current research within the Interactive Systems Research Group at Nottingham Trent University is investigating the pedagogies of young gamers by collaborating with the Derbyshire Libraries group (consisting of over 40 individual libraries) and a design team of children aged 11-16. The group is observing how these young gamers convert their gaming knowledge into instructional theory when presented with key learning objectives and a selection of physical and digital design tools. Derbyshire Libraries seek to promote modern libraries as both educational and social resources through working with children to construct a new serious-game. Both groups believe a peer designed product could provide a more attractive and relevant product than one designed by librarians or academics. Library staff, acting as customers, compiled a list of learning objectives that young users of a library game should achieve:

- Have a functional knowledge of how to access information and library services.
- Be aware that [a user] can find content that can enthuse and excite them.
- Have explored why [a user] would want to use a library and examined the alternatives.
- Have had the opportunity to engage creatively with the library.

To evaluate the wider research hypothesis that serious-games created by children can rival content created by their educators, an initial investigation was launched. This investigation aimed to evaluate if a focus group of children aged 11-16 years could design and create a new serious-game to achieve the above learning objectives. The investigation aimed to evaluate three main research questions:

- 1. Can children design serious-games?
- 2. How do children build and share gaming knowledge during a design process?
- 3. Which game authoring software is most suitable for use with children?

3. Methodology

A focus group of children aged 11-16 years was recruited via convenience sampling using responses generated from a recruitment campaign of poster advertisements and school assembly presentations. Based on methods of 'co-operative inquiry' (Druin 1999), the investigation used a multi-disciplinary design team of researchers and educators meeting monthly with children as equal members of that team at a south Derbyshire library. This investigation received zero attendance after four months (Bates et al 2008) and required modification. Following the successful recruitment of a second focus group of secondary school children in December 2008, a revised ten week investigation was undertaken between January and April 2009 at a local Nottingham secondary school. Figure 1 outlines the limitations of the initial 2008 investigation and how these were addressed in the revised 2009 investigation. The modern facilities at the school as shown in Figure 2 provided investigators with workspace for discussions and access to 30 networked computers.

Limitation	Revision to method
A focus group of children is reluctant to attend a 'serious' investigation in the summer.	Meetings branded as 'design workshops' to take place immediately after school using the library facilities. Investigation to run between January and April to avoid exams.
A focus group of children is reluctant to invest in long term design projects.	Weekly meetings to reduce duration of investigation to 10 weeks.
Library computers use extensive third-party firewall software and are unsuitable to run web-sites and video-games reliant on JavaScript or Flash.	Example media and prototyping tools must be suitable for operation on limited computer hardware.

Figure 1: Limitations of original investigation and revisions

Figure 2: Images of library computing suite and facilities

Workshops involved discussion and brainstorming exercises while recording ideas and notes on paper worksheets. This 'cognitive ethnography' approach to research requires investigators to actively participate within a gaming process whilst recording video-footage of game play, observation field notes and game-related conversation for analysis (Steinkuehler 2004). The MMO Poptropica was selected as a popular serious-game example for focus group to explore as it is a flash based Internet game requiring no installation. This would also allow investigators an opportunity to monitor how the group learn the rules and objectives of the game and how they share this knowledge with their peers. Physical design tools such as stationary and Lego were used by participants to design a basic board game and present this design the group. The group then used a choice of the following game authoring software to create interactive prototypes of their designs:

1. Game-Maker (www.yoyogames.com/make)

Developed by YoYo Games, Game-Maker offers a subscription free product allowing users to create characters, levels and game events via an intuitive drag and drop interface. Users can create custom sprites via the included bit-map graphic editor allowing for easy modification of existing games. Users can also publish their games as executable files allowing them to be freely distributed and run locally.

2. Sims Carnival (www.simscarnival.com/games):

Developed by EA games, Sims Carnival represents a subscription free suite of development tools. Once downloaded and installed, the drag and drop interface allows users to combine pre-defined objects with programming events via a drag and drop interface. Games can then be published to a central web-server for distribution via the Sims Carnival website. Participants initially worked in pairs with the goal being to converge their ideas into a single game design for the group. Video footage was used to provide both a transcript of conversation and visual evidence of physical exchanges between focus group participants during exploration of the above software. A project blog (derbyshirelibrarygame.blogspot.com) was created using free online software to record the electronic conversations of the focus group during the investigation. Each blog discussion topic was initiated by a Derbyshire Libraries investigator allowing focus group participants to post comments should they choose. Figure 3 summarises these data capture methods and the key outcome measures they satisfy.

Data-capture method	Outcome measures
Paper worksheets	Range of design ideas communicated by participants when asked to brainstorm game designs.
Internet blog	Extent participants use electronic media to communicate ideas and criticise the work of others.
Video-footage	Type of assistance offered by participants when learning new software and opinions on game authoring tools.

Figure 3: Data capture methods and outcome measurements

Game prototypes created in Sims Carnival could be embedded into the blog as shown in Figure 4. This allowed the focus group an opportunity to share and discuss their ideas electronically both in the workshops and at home. Figure 5 provides a weekly breakdown of workshop objectives and activities during the 10 week investigation and is based on methods of ‘participatory design’ (Druin 1999) delivered as an after school ‘design club’ (Habgood 2005).

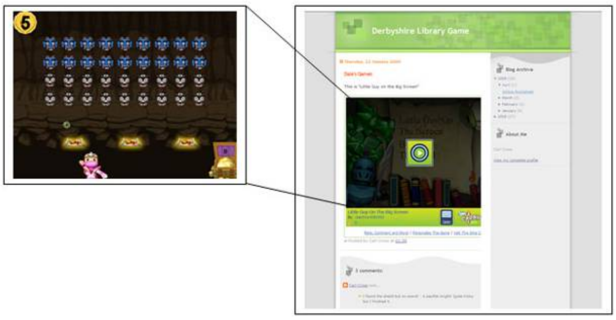

Figure 4: Example prototype embedded into project blog

Week	Objective	Methods
1	Introduction	- asked to design games to help players learn about library topic - introduced to blog and asked to create online accounts.
2	Learning goals	- told library learning objectives - provided with worksheets to structure the design process - asked to brainstorm game ideas and objectives.
3	Explore game example	- group presented with Poptropica as design model - opportunity to explore and discuss game as a group - group video-taped for analysis and ideas recorded on worksheet.
4	Explore game authoring software	- introduced to Game-Maker via online YoYo Games tutorial - group video-taped for analysis and ideas recorded on worksheet.
5	Create game designs	- work in pairs to design board game - asked to compile 10 rules for their game design - provided with Lego, pens, paper, glue, felt shapes and glitter.
6	Complete game designs	- complete Lego models and game designs following half-term - paper design worksheets collected for analysis.
7	Present game designs	- pairs present designs and models to group - group criticise and offer suggestions for each design - discussion video-taped and transcribed for analysis.
8	Create prototypes	- build prototypes using Game-Maker / Sims Carnival - reminders that games should teach library learning objectives.
9	Modify prototype	- discuss and modify prototypes to achieve learning goals - encouraged to complete designs in spare time.
10	Play prototypes	- play and comment on game prototypes - game prototypes collected for analysis.

Figure 5: Weekly breakdown of investigation objectives and methods.

4. Results

A positive result of the investigation is the high level of focus group attendance at the weekly workshops. An initial focus group of ten participants was reduced to a core group of seven over the ten week investigation including six males and one female of average age 14. The dips in attendance as highlighted in Figure 6 were due to illness, part-time jobs or school revision classes. However, many participants chose to attend the design workshops rather than other commitments demonstrating their enthusiasm for the project.

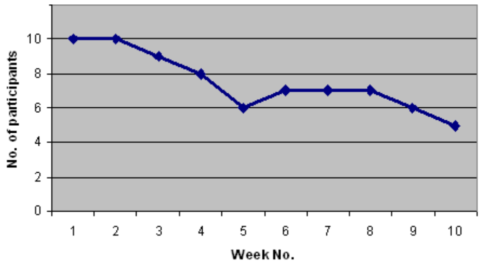

Figure 6: Focus group attendance

4.1 Can children design serious-games?

Game title	Pac-Man Alternative.	Lego Force	Halo Wars Alternative.	Station Trek	Space.	Collateral Damage
Goal of game	By getting to the end of the board.	Has to destroy / kill other opponents and enemies on the board.	By destroying enemy units and base.	When their space station is complete.	Use control panel first.	Blow up end console.
Main obstacles	Electric gates.	Other people, enemies on the board e.g. giant squids. Once an enemy is killed the player can have the enemy's advantages e.g. medi-kit.	Infantry and units of the opposition must be destroyed.	Asteroids, black-hole, super-nova.	Aliens of varying strength and race. Players can also attack each other.	Yes – enemy soldiers and maze like terrain.
Special items	Drug needles to make you go faster.	Players can pick up weapons to defend themselves or attack other players. For example you can pick up guns to give you an advantage and kill another player from 1 space away.	Outposts / air-strikes / special upgrades can be found.	Bonus Square (choose any part).	Extra weapons and provisions e.g. potions and gadgets. Extra armour. Quicker routes depending on which characters are left – like locked doors and blowing up walls.	Med-packs.
Special features	Because it's a new game that shows you what drugs do to you.	The setting of our game is in the future. It is a strategy game. There are a lot more features to our game unlike other games.	Must destroy enemy base and destroy infantry, enemies etc. It's different to others as it's the first board game to be created from an actual game.	You get to build thing[s] and play a game.	Filled with hundreds of extra weapons, armour and items making for endless possibilities.	Arrow keys to move, space to shoot.

Figure 7: Summary of game designs as presented on worksheets

The game designs presented by the focus group using Lego models lacked reference to either a library or the project learning objectives. After modifying these designs during prototyping, only one design was adjusted to incorporate a library as the final level of the game. The initial game design concepts as they appeared on participant's worksheets are presented in Figure 7.

The designs presented by the group support the argument that children design educational content using extrinsic fantasy and map instructional material into a pre-conceived fantasy context. Only one design was considered to use intrinsic fantasy. This design sought to dissuade children from taking drugs by controlling a Pac-Man character through a maze and collecting drugs to increase the character's speed. When pointed out to the participant that this idea was in fact promoting the use of drugs rather than dissuading it, he quickly changed the design to offer users a choice of drugs to take.

Several of the group's designs were heavily influenced by violent commercial video-games. To compare these designs with the group's gaming preferences, each paper worksheet asked participants to list their favourite video-games. European video-games are labelled with a minimum age rating governed by the Pan European Game Information (PEGI) system. If a game is deemed to be of major concern by the PEGI then it is referred to the British Board of Film Classification (BBFC) for approval in the UK. The genre and minimum age-rating of each game as listed by the group was collected using the search facilities of both the PEGI and BBFC websites. Of the six game designs submitted by the group, four were heavily influenced by violent commercial action / shooting games such as the Halo series, Gears of War and Call of Duty. The remaining two games were based on drug dissuasion and space station assembly. The following charts present the 52 commercial games named by the focus group based on their genre (Figure 8) and minimum age-rating (Figure 9).

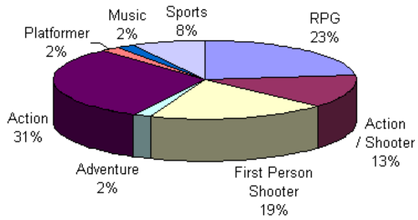

Figure 8: Favourite games based on genre

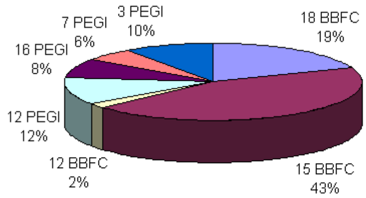

Figure 9: Favourite games based on minimum age-rating

Action and shooting games accounted for 63% of the group's favourite games and 62% had a minimum age rating of 15 classified by the BBFC for concerning content. The Game-Maker prototype for the game *'Collateral Damage'* was deemed unsuitable by the designer to be presented to the school head of IT due to the high level of shooting in the game. This observation is concerning and impacts the target audience of games designed by children.

4.2 How do children build and share gaming knowledge during a design process?

The use of Lego as a physical design tool motivated the focus group to convert basic paper design concepts into functional models to assist them presenting their work to their peers. An example of one complex model is shown in Figure 10. However, the use of Lego also proved a distraction to the male members of the group which was commented upon by the female member as unacceptable for taking '…*twenty five minutes just to go through two Lego games!'*

Worksheet responses revealed that children prefer to *'keep trying'* when presented with a video-game problem rather than ask for help. This was further observed during the exploration sessions with both

Poptropica and Game-Maker as very rarely were participants observed asking for help when stuck. Participants were asked where they seek help when confronted with a gaming problem at home with *'websites'* and *'friends'* being the most common responses. Participants agreed that the most important goal of a video-game was to *'have fun'* as opposed to actually completing the game or generating a high score. This was contradicted by the actions of some group members however as they continued to play Poptropica at home and presented their in-game achievements to their peers in the workshops.

Figure 10: Lego models as design tools

Electronic discussion via the blog was disregarded by the focus group as only three participants produced requested their games to be embedded on the blog. Further, only one of these games attracted user comments. In response to this, investigators suggested participants write a game review using the blog in with the best review receiving a £5 game voucher. This incentive attracted a further six posts over two weeks which included four game reviews. The remaining two posts argued over one participant plagiarising the work of another. This new competitive stimulus generated a further three posts creating eleven posts in total during the investigation. These observations suggest that children do not naturally use blogging software to share ideas and knowledge during a gaming process and is contrary to the observations in large scale MMOs. This requires further investigation into the types of electronic communication endorsed by children during a games-design process.

4.3 Which game authoring software is most suitable for use with children?

Firewall restrictions at the school would not allow participants to install the Sims Carnival software or access to the Sims Carnival website. However, the firewall software would allow the games developed in Sims Carnival to run when embedded on the project blog. Game-Maker allowed participants to publish prototypes as executable files allowing games to be run easily once installed on a library computer. However, distribution of these files was also restricted as the school firewall software restricted access to the .exe file format in email attachments. This is an understandable precaution and so investigators chose to distribute all Game-Maker prototypes using a memory stick. Out of five worksheet responses comparing Game-Maker and Sims-Carnival, four participants preferred Game-Maker commenting that is was *'Brilliant! Simple to use with great results.'* Some participants did express concern that the software interface '*Looks a bit hard to use.'* One participant preferred the Sims Carnival software commenting that '*As you are going along it tells you what to do next.'*

A post investigation presentation was held at the school allowing the group to summarise the design project for the school head of IT. This presentation was video-taped and transcribed for analysis. Figure 11 provides a sample transcript for the presentation. This transcript reveals that the focus group disregarded official tutorials on Game-Maker in favour of peer-led instruction and that Game-Maker could be an effective addition to the school IT curriculum.

The use of video-footage proved extremely useful when transcribing focus group discussions, presentations and exploration workshops. Although initially a distraction prompting male participants to misbehave, investigator use of a video-camera was disregarded by the focus group early in the investigation. However, a simple Dictaphone device could be used in revised investigations to observe if the behaviour of a focus group is markedly different when using video-equipment in workshops. The idea of repeating the investigation with a revised methodology is currently under discussion. This revision will proposed to observe a new focus group modifying the current game prototypes to integrate the project learning objectives. This new focus group will also be provided with a tour of a local library to inspire those unfamiliar with libraries of ways to achieve the project leaning objectives.


Head of IT: So how have you guys learned how to access this software? Have you gone through tutorials? Have you used [participant A] as a source?

J: There was a tutorial that [investigator] sent us which was some kind of clown game?

K: What I found was that there was too much writing.

J: Not as many pictures.

K: I'd rather the instructions were there and you were doing it at the same time.

J: I think that most of us grasped it after playing around with it. So we played around with it not really knowing what we were doing and then we sort of came to grasp how to add things onto the character, how to move.

A: Once you have worked out one thing all things are done in the same kind of way. You create an input using the events selector you say press keyboard press left for example, start moving left if you were playing a racing car game make it relative so you keep getting faster and faster. And basically once you have done that you can do it with hundreds of events which is why it is so versatile. You make your own sprites, you can make your own sounds as well.

Head of IT: Depending what we move onto, I don't want to steal your thunder, potentially it could be something we could bring in and put into the curriculum.

Criticisms of current instructional material
Benefits of peer-based instruction
Approval of Game Maker for use in curriculum

Figure 11: Transcript of presentation to school head of IT

5. Conclusion

Games, by their definition, seek to engage us in an activity for amusement and diversion from our daily lives. Serious-games therefore require extensive justification of their place in mainstream education and a fine balance must be found between learning through play and instruction. Learning through play can be a probabilistic strategy for educators as there is no guarantee that children will complete key learning objectives in an open ended explorative session. The results of this investigation support the theory that children design extrinsic fantasy games where instructional theory is arbitrary to the fantasy context of the game. However, the investigation has demonstrated that learning via video-game design allows secondary school children the opportunity to practice negotiating and group work key skills. Further, the ideas uncovered during the investigation have attracted interest from key staff at the school thereby promoting the use of game-based activities in lesson plans. To breach the firewall that exists between mainstream education and today's video-game culture, educators must embrace the positive impact that video-game based activities can have with children. Provisions should be made within teaching plans for use of such activities and time dedicated to explorative learning should not be considered wasteful.

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Computer Game to Teach Programming Constructs

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Abstract: While new students on MSc IT conversion courses and new undergraduates are generally very experienced with computers they often have little or no experience of programming. In particular most of the students have been regularly playing computer games from an early age. Conventional techniques for teaching programming to these students take simple tasks that gradually build into more complex programs that exercise the full range of the fundamental constructs of the language. However, many students find it difficult to grasp the purpose of these concepts, even though the examples may be quite practical. It is common for programming teachers to divide students up as "programmers" and "non-programmers" and accept the non-programmers as never going to become programmers. In the past attempts were made to introduce programming via more visual tools. In particular the "Logo" language, which used a "turtle" that followed paths derived from instruction sets, to draw pictures on a screen, were found useful in teaching these basic concepts to a wide audience. This paper outlines the results of experiments with a computer game designed to teach basic programming constructs to MSc IT conversion course students. In the game students build mazes from a set of tiles and then produce commands from a set of basic programming constructs which are used to direct a "player" character through the maze. This can be used to undertake challenge tasks (for example, find the shortest route through the maze or exhaustively explore the maze). The program has the potential to maintain the motivation and understanding of the "non-programmers" as they learn the basic programming constructs. They thus learn the purpose of the commands first and can then relate these directly to the program that is produced. The system makes use of common game characteristics so that the players are familiar with the environment and need little in the way of instruction to know what to do. The tasks can usually be completed in a number of ways but learning the value of the programming constructs enables a higher score to be obtained. Thus players are motivated to learn rather than use trial and error to succeed in the game. For example in the exhaustive search of a maze correct use of while loops reduces the number of steps required to complete the task and thus gains a higher score.

Keywords: Teaching programming, higher education, learning motivation

1. Problems encountered when teaching programming

Experienced teachers of programming find that those they teach break down into three groups. These appear to be, those for whom programming comes naturally, those for whom some trigger is needed but after that trigger is found making further is comparatively easy and those for whom that trigger never seems to arrive. For the most part the third group do not try to continue beyond the introductory level of programming. For some of this latter group however it may be necessary to continue to develop their understanding of programming even though understanding of the main process is not easily possible. What creates the trigger for the middle group will vary from student to student but observation has shown a number of fundamental problems these students have when learning to program. These include their not understanding how computers work (Illustrated by not understanding the need for variables) and not being able to turn an algorithm into a program. In turn the latter may be caused by, the abstract nature of programs and the fact that students do not intrinsically understand algorithms. Even some good mathematicians cannot understand programming and this may be partly because the most programming languages are not actually the language of mathematics. (Guzdial and Soloway 2002) contend that the current generation of students will need something more to motivate them than the traditional approaches. Their belief is that more concrete problems that relate directly to their lives will prove the motivator to learn. They have used "Squeak" and orient their programming tasks around developing multimedia. Rather than the traditional reasons for filling arrays and creating loops the students produce sound files that can be played as computer music. (Jenkins 2001) would agree that it is the source of the students' motivation that is the key to getting them to learn programming.

There are a number of examples of languages which have been specifically designed to make the process of learning to program easier. An example of such a language is Pascal. (Hoare and Wirth 1973) This made understanding the connection between the algorithm and the process easier. Two aspects of this language that make it easier to begin programming in are the lack of overhead needed to produce the earliest programs and more human understandable syntax – like using begin and end as the block definition statements. More recently (e.g. Becker 2002) practitioners have been prepared to argue that such languages are more suitable for teaching a first course in programming than the more commonly taught Object Oriented (OO) languages. The main argument against them is not their value as languages and tools for understanding the concept but their value as training for the world of work. This is a spurious notion because languages such as Java and C++ while being valuable on a student's CV may obscure the fundamental concepts and processes that are trying to be presented in relation to procedural programming during the early periods of an introductory course, inhibit the students' motivation to learn and lead to them being unable to program when they graduate.

The Logo and StarLogo languages were developed as parts of experiments to help people understand how to program and the connection between programming and abstract algorithms to complete tasks. In Logo for example the fundamental paradigm is that of seeing the consequences of your programming steps. This then makes it easier/more natural to understand how to concretise a given algorithm. There are a number of works of use for understanding this whole area. For examples of StarLogo in use see for (Resnick 1997) and (Wang et al 2006).

There are numerous other attempts to use programming to control "visual" objects as an introduction, particularly to OO programming concepts. (Bierre et al 2006) present one use of the IBM Robocode system in their teaching. A stated aim is to understand how their "system influences the students' perception regarding achievements and learning in the classroom." (Long 2007) presents results of a study in how use of IBM Robocode affected users understanding of how to program. One conclusion of their survey was that use of this system enhanced the understanding of algorithm development.

OO is not the only programming paradigm that students could be taught. However for pragmatic reasons it is the dominant approach. A good example of a different approach to programming – using the functional programming paradigm – has been reported in (Felleisen et al 2004). They observed fundamental difficulties in teaching introductory program and identified some of these causes of coming from attempting to introduce the subject through an industrial language. They claim to overcome this through developing their own system that seeks to lead the student to learn through teaching them "program design and problem solving in a systematic manner." They recognize the need for students to make a transition from this system to commercial languages and are reported as being currently focused on this.

Modern computer systems have not helped students to understand the need for programs. The current generation of students have been using technology since their earliest years. CBBC has a range of computer games aimed at preschool children. Young people spend their spare time playing computer games and by the time they have reached higher education students have a high level of familiarity with technology. However, programming teachers observe that their students often have little understanding of the way in which the computer translates their actions with a mouse (for example) into the response of the software system they are using. In the students' minds a mechanical link still exists between the mouse and the cursor!

The difficulty students have in learning to build programs out of algorithms or even building correct models for algorithms in the first place can be illustrated by many examples from experience. A strong example is trying to teach novice programmers how to make a computer sort a list of numbers. Examples are usually given by presenting a (usually quite small) list of integers in pseudo random order. The difficulty begins because students have not realised that computers will not "see" the full set of numbers as the students themselves as human observers can. They also do not realise that their natural sorting algorithm for these numbers will use quite advanced human pattern matching rather than systematic comparison. Human beings are very good at recognising patterns and we can easily detect the largest and smallest number in even quite a large array if we can see it all at one time. There are better ways of presenting the problem to students in the first place. A good way is to make sure that the students involved can never see more than two of the numbers at any one time. This can be done by distributing the process between the full student body, giving each student two cards which they have to sort and then getting the group of students successively to merge these cards until the full set has been sorted (assuming the merge sort algorithm is being illustrated). What has been done is to concretise the algorithm and to begin to introduce the need for variables.

One difficulty students' face is the need to understand the syntax of computer languages, which is generally less flexible than that of natural language or mathematics. One way to speed this process is through the use of a good integrated development environment. Some would claim that such environments are too complex and would not necessarily aid the process. To combat this, a number of teachers have developed their own "cut down" or tailored development environments for their students. The BlueJ system (Kölling et al 2003) is an example of this approach, which the authors claim changes the way in which programming can be taught.

A significant survey of the literature on teaching of introductory programming has been undertaken by (Pears et al. 2007). Their study presents a number of perspectives on the issue. An important comment from them illustrates the need for what they term "constructive alignment" – the need to understand "the relationship between expected learning outcomes, instructional design and assessment practices" – within the teaching of programming. However, their review does not directly answer the issue of how this can be addressed.

The question then this paper seeks to address is can a suitable computer game be designed that provides the trigger to enable those for whom programming does not come naturally to make the step into programming. The program developed so far has been tested on a group of novice programmers to establish the validity of the interface and further work will be undertaken to establish if it works as a learning aid for the intended group.

2. Design principles for a game to teach programming constructs

(Pears et al 2007) establish that the predominant languages used in introductory teaching are C and OO languages such as Java and C++. The main reason for this is their common use in industry and resulting pressure from students to be taught a language that will be immediately recognised as of value by potential employers (who may well put pressure on local colleges to use such languages). However they also recognise that these languages are syntactically richer than is needed for teaching introductory concepts, which leads to potential confusion for the new learner. Another problem they recognise is that the complexity of code that can easily be developed by novice programmers does not lead to an easy understanding by the students of the need for the programming constructs they are being taught. Our contention is that for a large proportion of novice programmers it would be good to establish the need for algorithms first without reference to a specific language. This should also be tackled through a more concrete interface such as a visual problem to be solved (see for example the work of (Bierre et al 2006) cited above.

Having recognised that the concretisation of algorithms and fundamental processes (for example the need to declare and give values to variables) the primary design goal for a game to teach programming must be the use of some concrete way of realising these concepts. One possible approach to this is the provision of some way of visualising what each step is doing using a computer graphic. The advantage of this is that students can "see" the result of their programming steps. This is fundamental to the Logo and Starlogo languages and many similar systems which have been successful in teaching some of these ideas. However, one advantage of a specifically designed computer game rather than just another teaching language is that students who have found understanding programming concepts difficult lack motivation to learn even with these languages. It is well documented that games can promote engagement because of their use of fun, play – leading to involvement, rules which give structure, goals which promote motivation and so on. (Prensky 2001)

Thus for the game to provide a better way for this group to learn programming it must also be a real game – that is include a number of these fundamental game concepts. The major component will be the game challenges. The user learns by completing a set of graduated tasks that introduce the programming concepts. Each task is completed by understanding the relationship between the task to be performed and the language constructs used to perform that task. The progressive nature of the challenges will mean that skills used in the earliest set of tasks are repeated throughout and thus reinforced but without this becoming boringly repetitive. A similar model could be found in the Lemmings game in which the skills needed to complete the complex later tasks are built up by completion of a sequence of tasks which gradually increase in difficulty. The skills acquired are repeated without the potential boredom introduced by this repetition because new skills are introduced at each level, thus maintaining interest. (Gee 2003)

3. Game design and function

As argued in part 1, novice programmers often lack a concrete understanding of what they are trying to perform. There is a need to engage them in the process of understanding how programming works and as explained in section 2 it is expected that they will do this by being able to see the concrete problem which they should be able to salve independent of what they would perceive as programming. The design thus centres on the idea of getting a player controlled character through a maze. The instructions will be things like, "at the first T junction turn right." Thus the problem solved becomes a concrete one rather than a somewhat more abstract one of say "if this variable is bigger than the other one then swap them." (This may seem reasonably concrete if you have worked out what a variable is but for many this is where their problem starts). The game that has been implemented sets a series of tasks for the player. The game screen consists of five parts, as shown in Figure 1. Each of these parts is used for different functions. The main area is used for displaying the maze.

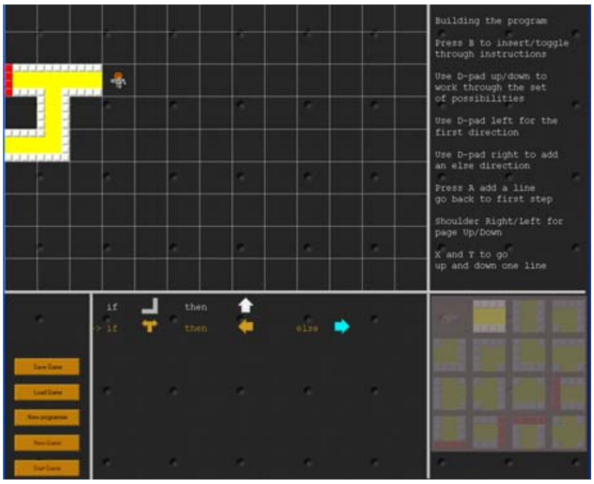

Figure 1: Showing the general layout of the game

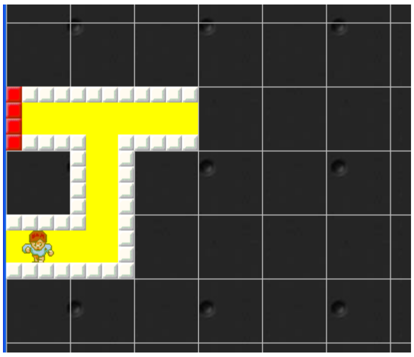

Figure 2: A maze from early in the game, the player is in the start position

Each maze is seen from above and a typical early level maze is shown in Figure 2. In this figure you can also see the player character at the beginning of the game. The program to solve the game is developed in a third window, as shown in Figure 3a).

Figure 3a): showing the program trace to the point reached as shown in figure 3 b)

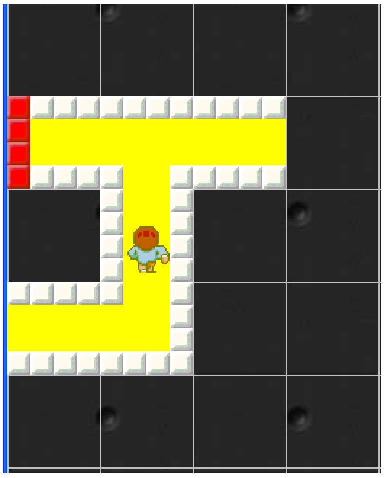

Figure 3b): The player character at the point in the program as shown in the trace in figure 3a)

The player has to write a program using a set of steps which combine a programming language like syntax with a set of objects to be manipulated. In the simplest level the maze consists of a set of turns (initially just one) then junctions, then cross roads. The player will make lines that are constructed as:

- If the obstacle reached is a left turn then turn left
- If the obstacle reached is a cross roads then turn left etc.

Instead of words the obstacles are represented by pictures (see Figure 3a) as are the actions.

A fourth window contains a set of buttons, with which activities can be chosen (load a game, save progress etc See the bottom left of Figure 1.). From this window the player would choose to start the game. When the program start option is chosen the player character is animated to walk through the maze according to the instructions in the program. The program is traced as it is run and this tracing is shown by highlighting the program line and instruction that is being run. The player can thus relate the program step directly to the result it is having. (The example program would be needed for an exhaustive search of the maze shown). In Figure 3a) the program trace is shown at the point the character has reached in Figure 3b). If the program is incorrect the player character will get trapped at some point in the maze and not be able to continue, at which point the program will be edited and rerun.

When some progress has been made in completing the fixed set of mazes, players can create their own maze by selecting maze pieces from a fifth area and placing them in the main area (shown in the bottom right of Figure 1).

As the game progresses further elements are added. The maze requirements and thus the algorithm needed are increased. An element is added that allows blockages of a maze to be turned on and off. A button element is added that will allow the path through the maze to be opened. This allows the requirement that the maze be exhaustively searched to be added naturally and without awkward description. Further programming constructs such as “while” loops and “switch” elements allow the algorithm to be more efficient in getting the player to search the maze. The game can thus monitor not only whether the player has escaped but how long process has taken.

As was stated above an important issue for novice programmers is to understand the need for variables. One problem for the game is how to implement this in a natural way. The decision was made that declaring variables would be a programming step but the assignment of values to variables would be done via maze elements. This allows extended functionality for the button pressing elements which now will only work if a variable has a given value. The extended algorithm thus needs to take the player character through the maze to the point where their variable can be assigned a value before taking it to the place where it will operate the button.

4. Evaluation of the usability of the game

As explained above so far the game has only been tested to see if it is viewed as a game and that it is enjoyable to play, challenging and therefore potentially motivating for the desired user group. A test group of 52 undergraduate students from an engineering course were asked to use the tool as a game. They were surveyed after use and responses were generally positive. All of the students found the software easy (76%) or fairly easy (24%) to use. The majority (67%) found it enjoyable. The remainder wanted more game like characteristics to be added. Most of the students (86%) found the game to be very challenging. They were also monitored for their level of mistakes and students learned how to use the program quickly.

The results of this survey are being used to improve the design of the game. Further game characteristics are being added, including extended levels of difficulty and reward. Formative and summative assessment recordings are being added. The ability to monitor and extract data on student performance is also being added.

Clearly the game was attractive and easy to use. None of the students had studied programming on their course at the point they were tested but all will be taking programming in the near future. Their responses and scores in the game will be a useful tool in predicting how quickly they should learn to program. The next stage is to use the game to evaluate which students are expected to have problems in learning to program and to track their progress through the course to evaluate whether the predictions are correct. Further work is being done on how to integrate the game into the teaching of programming on the course.

5. Conclusions

As shown in part 1 teaching of programming to novices can be difficult. Many students find initial hurdles to learning from the nature of the languages (again see Pears et al 2007). For example the complexity of language syntax and richness of functionality can often be a barrier to understanding. Many see the nature of the tasks they are asked to program – for example sorting arrays – difficult to relate to in their real world (Guzdial and Soloway 2002). A means of motivating the students to learn can be the key to getting them over the initial hurdles into becoming programmers (Jenkins 2001). Computer games are a potential method of allowing students to see what they are doing, engage with the problem and solve the problem algorithmically without their having first to learn the syntax of a complex language. This paper has presented a maze solving game designed to provide such a tool. The mazes are solved using a simple language where syntax does not have to be remembered; rather the focus is on understanding the problem to be solved and the algorithm that is needed to achieve the solution. So far the interface has been tested as a game. Users were enthusiastic for the game and could solve the algorithms even though they had not previously done programming. The next step is to test this game to establish whether it proves motivating to students in the learning of programming and if it achieves its major purpose of providing the spark of understanding to the target group.

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Using Educational Game Design to Teach Software Engineering

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Abstract: The area of computer games for education is now popular with technologists and educators. The main aim is utilise the inherent motivational nature of games and their ability to encourage engagement as a way to improve learners' time on task and their ability to repeat trial and practice tasks without the danger of student boredom. Many games have failed to either work as games or as education. The first problem occurs because they are not games but ideas taken from other educational tools and repeated as games by adding game elements as a wrapper but failing to integrate the educational aim into the game play. These games are usually led and developed by educators rather than technologists. At the other end are good games but this time are failed educational tools because they can be "won" without the player understanding the "lesson" behind the game mechanic. These games come from enthusiastic game designer or technologists who have failed to understand the educational process. Educational game design then is an intrinsically interesting area in which to attempt to learn the most difficult parts of the software engineering process. When teaching software engineering in a higher education setting one of the most challenging aspects is to identify a task that is a challenging practical problem that will demonstrate the value of good software engineering practice and at the same time is understandable as a task by the students themselves. Game design is valuable from both these perspectives. Students understand computer games. Most have been playing from an early age and have ideas of the needs of gaming. Games for educational purposes are also an obvious idea to them and most can outline how they have learned through some game in the past. This paper describes the use of the development of an educational game in the teaching of software engineering in an MSc course at the University of Nottingham. Valuable lessons have been learned in how to design a software engineering module. In addition practical experience of students in designing the games and going through the full set of software engineering stages are described. The exercise has now been run for three years and a number of useful and effective educational games have been produced.

Keywords Software engineering, higher education, module design, XNA, requirements and testing

1. Software development: engineering or art?

Software engineering is a core component of any degree in computer science or information systems. It is a fundamentally different subject from that of teaching programming as it involves all the stages of the design of a software package. The need for software engineering as a deliberate and differentiated part of any computer science course is well established. (See for example

e the ACM/IEEE guidelines on Computer Science course structure – ACM 2008). It is clearly different from but closely linked to software systems design, which in itself holds a lot of challenges not common to other forms of design. Other engineers often find it difficult to accept that it is an engineering discipline at all. In part that may be due to the lack of skills in the field that many programmers have developed while at university. Partly also it is an attitude of the practitioners themselves (eg. Bryant 2000) but the need for well trained software engineers has never been greater. Another issue is that there are many aspects of the software engineering process that are different from most other engineering tasks. The differences between these processes have been described by Stacey (2000) in relation to the degree of certainty in the required technology and agreement in the definition of the requirements. His assertion is that the degree of complexity of software design issues is such that it requires a different approach. Many methodologies for software development (such as the Waterfall Model – see van Vliet (2008) for example) treat the process as more structured and criticise more modern methodologies – see for example Ambler (2002) – for lacking rigorous requirements analysis before a development starts. The contention of the more agile development approaches is that the requirements cannot be known from the beginning and so a test driven approach to design is ultimately more productive.

2. Issues in teaching software engineering

Modern texts in software engineering (Shelly and Rosenblatt 2009), (Pilone and Miles 2008) stress the practical nature of the subject and try to introduce a project theme for their books. The issue raised by this is the difficulty students have in approaching these projects. As an introductory subject software engineering is often taught in the first or second year of degree programmes or on conversion masters programmes. The students generally have limited programming skill and even less experience. As a result many courses will try to develop their programmes around group based exercises. These exercises vary in size and scope though in general the idea is that most software development is done in groups and this is the major challenge to new engineers. However, choosing realistic tasks is often difficult. Many realistic tasks would require unrealistic levels of student time to complete. In particular the requirements gathering phase can be complex. Gathering requirements for a real information system would involve setting up contacts with actual customers and while this may be possible for a small number of groups, large numbers of groups could not easily be found such projects. It would also be likely that for a significant proportion of the groups would be unable to complete real tasks at a satisfactory level for real customers as the students are at an early stage of their learning. Instead of real world projects most courses offer limited versions of well tried projects with limited scope for their students. Immediately the process of requirements gathering has been reduced and the possibility for user testing and evaluation removed. For reasons outlined in section 3 the use of the design of educational computer games is seen as a possible strategy in enhancing the teaching of this subject.

3. Educational game design as a tool for teaching software engineering

Over the last five years the author has been responsible for a module in software engineering for the conversion course MSc in IT at the University of Nottingham. This is a compulsory module taught in the second semester. In the last two years the students from the MSc in Computer Science and Entrepreneurship have also had to take this module. The two groups are fundamentally different. The former group have had a minimum of a module in object oriented programming in their first semester and are concurrently studying a module which covers professional practice in program development but on the whole have very little other experience of programming and no exposure to software engineering. The latter group however are far more varied, generally having more extensive backgrounds in programming and some having real experience in the software development in industry – though generally only for a relatively short time. It is thus necessary to give these two groups of students the opportunity to extend their understanding of the software development process..

The School of Computer Science at the University of Nottingham has worked with local schools over a prolonged period and has good contacts at all levels and stages. Teachers have also been keen to work with us as they value the possibility of using games in their teaching but good educational games are not easily obtainable. Many games suffer from being good at requiring the student to gain knowledge about the subject but fail to be good games. Others can be good games but fail to integrate the educational requirements into the game play. In these the game is the ‘carrot’ and the educational work is interspersed – often in a way which may be better done on paper. Research in the University has shown that it is possible to integrate the education in a game (Habgood 2005). This means that the production of a computer game can be a significant exercise in software development. Access to local schools meant that real problems have been able to be tackled. The cooperation of local schools, teachers and students, has meant that the process of requirements gathering can be achieved for a large group of students and subsequently testing the software produced can also be carried out.

Games design has several intrinsic advantages for teaching software engineering. The purpose of the software as a game is naturally understood by the majority of students. As has been well stated elsewhere (e.g. Prensky 2001) this generation has grown up surrounded by and playing computer games. They have also all been through school and while mostly they have little understanding of pedagogic they at least have an idea of what needs to be taught at any stage. Giving them access to teachers and students has made them able to test their ideas and ultimately their designs, to ask questions and to understand how much (or little) their ideas have worked. It has only been possible to go through one complete iteration of the process but at least this has been a complete iteration.

In the last three years there has been a progression in the way in which this teaching has developed. Originally teaching of more formal development methods was given in parallel to the practical work. However, it was difficult for the students to see the relationship between some of the stages they were going through in their practical work and the methodological steps that that were being described. In the current year a specific agile model of the systems development process has been adhered to. Issues relating to other design methods have only been explained in contrast to the processes the students are undertaking. Use has also been made of those students who have been involved in industrial and business based software development projects to lead seminars of their peers. Students have thus been able to question how the process has worked in their case and how it is meant to work.

4. Methodology

The development has to be assessed and this forms part of the score the student is given for the module. The marks have been categorised in relation to the success of the project and the quality of the design. In addition marks are given for how the team performs – either in avoiding or resolving conflicts, group management, frequency and quality of meetings, how the work load has been divided etc. In particular success of the design has been assessed according to whether it meets the design criteria (including whether it fulfils the requirement that the teaching is integrated into the game play and the software functions as a game – it contains major elements of games such as 'fun', rules, goals, interactivity, the ability to win etc.) (Gee 2003) Assessment of the game (for at least a single iteration) by the users – students and teachers – has also been included in the marking.

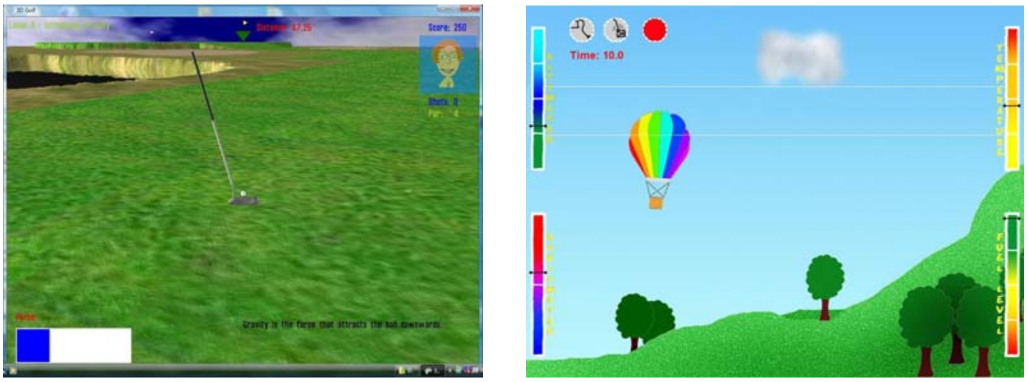
The first part of the process involved dividing the students into teams. They were chosen randomly from the group with some consideration for performance in preceding modules to ensure that each group had a relatively common level of programming experience. The process continued with a meeting with the customer (a local teacher with a teaching need) in which the problem was outlined. Students questioned the teacher and were able to produce a first draft of the requirements. They were then given two weeks to come up with a design brief which was presented to the customer (and module teacher and assistant). The students were given immediate feedback about their presentation and were given pointers by both the customer and the teaching staff on the degree to which the requirements seemed to be being addressed. The second iteration of this design was then tried on a representative sample of the school children of the appropriate age. After this meetings took place between the students and the customer on a weekly basis allowing slowly developing pilot versions of the software to be developed and tested on the customer. The University vacation period occurred during this process but students maintained contact through emails and in many cases by attending the University for meetings. This constituted a single iteration of the design process. At the end of the iteration the prototype games were tried on the school children and their assessment obtained. The major criteria for this assessment were: playability, engagement and whether the teaching aim was integrated into the game. A final meeting with the customer was also used to allow their assessment of the software from a teaching perspective to be included in the assessment.

5. Lessons learned

The project has been going for the last three years. Lessons learned each year have been fed back into the teaching and the experience is currently much more integrated than in the first year. The project has been facilitated by the development of the XNA game engine by Microsoft. This tool in its current implementation is integrated into the Visual Studio 2008 Integrated Development Environment. It allows both 2D and 3D games to be developed by people with little background experience in games programming but with the value of allowing their own developments to be in a fully functioning and professionally credible language (C#) as well as using a modern development tool. In previous years students were encouraged to look at producing 3D games as the level of sophistication possible would allow these games to be attractive to young people as games. However, such games are more complex to produce and place rather too much value on the students obtaining 3D game assets (most of the students were not capable of developing their own models and animating them suitably). This year the students were encouraged to produce a 2D game and this has led to generally more complete levels of games having been implemented.

6. Examples of games

Two examples of educational outcome that were used were a game to teach aspects of physics for the UK National Curriculum Key Stage 3 and the development of a game to teach Spanish to children in Key Stage 1 and 2 in UK (specifically England). Figure 1 shows screen shots from two of the physics games. Seven physics games were produced in total. All were designed to teach Newton's laws. Most integrated the physics into their game design. For example the golf game (Figure 1a) used different levels in which these concepts were introduced incrementally. They were all judged by the users to be enjoyable games but most failed in integrating the teaching element in the game play. While the golf game used the physical laws and progress could be made better if they were taken into account progress could also be made with practice at the game skills. It was thus possible to win without having to understand the physics. The balloon flying game (Figure 1b) succeeded better at requiring the player to learn to balance the forces on the balloon but the skill needed to achieve this was quite high and detracted from the players recognising this relationship.



a) the golf game b) the Balloon Flying Game

Figure 1: Game to teach Key Stage 3 physics

The lessons learned from last year have been of great value for this year's students. As stated above in previous years the value of using 3D in the games was emphasised as this helps to make them have greater impact with the audience but the difficulty in developing 3D models and implementing their animation makes the development process longer and more difficult. Some students last year chose to do higher quality 2D games and these proved to be more impressive than most of the 3D games as they were more "complete" by the time user trials were carried out (see Figure 1b for example).

7. Testing and results

The test of any teaching method must involve the response of the students and whether they learn from the method. The assessment of this is quite difficult as any two sets of students – especially on a conversion course at Masters level - will be different from each other. The level of experience and the background of the students will vary from year to year. I have experience of teaching this subject at this level for five years and have naturally evolved the way I teach it over the years and have the subjective result of my interaction with the students. However at the end of each year the students complete a survey regarding their evaluation of the module. In addition they also take an exam. Originally I taught the subject from a completely theoretical perspective – working from text book descriptions and trying to align these with my own experience in the industry. In the first year the response of the students in their evaluation surveys was that they had not understood the relationship between the theory and the practice and that a more specific focus for the module would be valuable – with all examples in the theoretical part of the module being derived from the same practical problem. As a result of this I decided to introduce the design of a computer game as the practical task in the next year. However, I limited this to a design and the result was probably predictable. Students came up with very advanced ideas – none of which were practical. Demonstrating this to the students was difficult and the outcome was a large number of students obtaining low results in the exam. During the last three years I have refined this idea. During the third year I acted as the client, limited the aims of the project to a family game and introduced the requirement that the game actually be produced. The groups were split into teams based on their semester one results so that teams had roughly equal levels of past experience and programming ability. Groups of friends were also split up. In the first weeks they were introduced to the idea of rapid development methodology and the development tools – Microsoft XNA had just been officially released. In terms of the software produced the result of the exercise was good. All groups produced a working game. The student evaluation of the module showed a measure of improvement in recognising the point of the module – however there was still a lack of experience in the areas of domain analysis and user testing. This gap in their understanding also showed up in the average exam response.

During the last two years the activity has been changed to the development of an educational computer game. This expanded the need for domain analysis and allowed the introduction of user testing. As explained above local schools actively participated in the user testing at the end of the development. This year a teacher at a local school initiated the project and was thus also able to act as a customer. As well as being able to interview the teacher the students had access to the school and were able to do more extensive domain analysis. The result of this has been software that not only works as games but also that has been demonstrated to be engaging to the target audience and be a potential learning vehicle. As a consequence of this two of the projects are being extended to complete learning/teaching aids.

The final analysis of the value of this method is based on student responses in the form of a survey and the quality of student answers in the exams.

In the survey a range of questions were asked. Of particular significance to whether the students learned from the module were the questions “The module has given me a good understanding of the subject” and “The module helped me to think critically”, both of which are viewed as intentions of the module.

Students were asked to respond with “Strongly Agree”, “Agree”, “Neutral”, “Disagree”, “Strongly Disagree” or “Not Applicable”

The current class consisted of 32 students 17 of whom responded to the survey. As stated above the level of experience of the students was quite broad though most were relatively new to software engineering concepts. The overall modal response to the survey questions was “Agree”. “Strongly Agree” was more common than “Strongly Disagree” but less than “Neutral”. The surveys were anonymous and thus it was not possible to know whether those who were less content with the module were the less experienced or more experienced students. The questions relating to the main objectives of the module received modal “Agree” responses. Only two questions had modal responses of “Disagree” and these related to the workload of the module. The same survey method was used in previous years and the same survey questions asked. The numbers of students responding was roughly equal over the five years and a gradual improvement in mean response has been achieved with the largest improvement being in the previous year. Students were also given the opportunity to give open ended responses asking their opinion on the module and how it could be improved. The positive comments all related to the engagement in the activity – the students could see the purpose of the subject and why they were learning it. Most negative comments related to the organisation of the module. The whole process took less than fourteen weeks including a four week term break and the students found this stressful (as evidenced by the response to the workload question).

A possibly more valuable measure of the effectiveness of the technique can be found from the result of the exams. The exam responses improved with the introduction of the game based teaching but this year the overall mark improved significantly with only two of the students obtaining less than the 50% pass mark and no student gaining less than 40% (a significantly smaller proportion than in previous years). As stated above no overall conclusion can be drawn from this as student groups vary from year to year but the nature of the responses are encouraging and imply that students have actually learned more from the experience than in previous years. This was particularly noticeable in questions relating to requirements gathering and user testing.

8. Conclusions

The success of the use of educational games design for the teaching of software engineering is observed from the success of the classes in engaging the students and from the level of their responses in the exams. Previously it had proven difficult to get student answers which did not rely largely on regurgitation of notes in the exam. With the current method the student responses have improved greatly and students are able to demonstrate that they have understood the concepts in a more personal and practical way. At the end of each year the students were surveyed to evaluate their response to the course. Students’ responses showed that they had understood the purpose of the course better than in previous years when less concrete tasks were used for their course work. Students also evaluate their peers and in general are very satisfied with this process. They are assured that the marks achieved are in line with the effort made in any group. By introducing this development students are aware of practical aspects of a complete software development process. There are some common aspects of software development in general which cannot as easily be integrated into this course work. The need to develop data storage solutions, which are common problems in many software systems developments, cannot be developed fully. There would be ways of integrating such work into the projects – for example by adding student performance monitoring and central data gathering for this but the length of the projects and the levels of success might be reduced.

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A Concept for the Integration of Online Business Games Into Blended Learning Scenarios Based on Kolbs Experiential Learning Theory

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Abstract: Business games have a long tradition in corporate learning and are experiencing a comeback these days because of their unique capability to provide learning through experience. Based on the extended model of learning through experience by David Kolb, it is possible to integrate online business games into blended learning scenarios in corporate learning using its main advantages such as mastering complexity, the achievement of higher cognitive objectives, learning from mistakes without risk through trial and error, learning from operating experience through time-lapse and particularly strong learner motivation. The German insurance industries are using business simulations to teach learners how to act in environments with complex business and economic inter-relationship networks. Using the example of the closed, stochastic and single player online business game "SiVa – a simulation of an insurance agency" – a concept of a blended learning scenario and its theoretical background are presented.

Keywords: Online business games, e-learning, blended learning, simulation, experiential learning

1. Introduction

Business games have a long tradition in corporate learning for example as board-games or as computer based games. In the 1990s business games lost their acceptance in the executive suites of the companies. In times of shareholder-value "learning by gaming" wasn't en vogue anymore and business games disappeared from the agenda of corporate learning. These days business games are experiencing a kind of comeback. In times of turbulent markets where cost and risk reduction is very important the pressure on companies to learn and change fast is very high. For this reason the companies recall the biggest advantage of business games: learning by experience without any risk. In the German insurance industries basic education of sales personnel is regulated by law to guarantee a secure customer oriented sales process. Standard training mainly targets insurance-knowledge, -law, -conditions and the sales process. It often does not sufficiently prepare the attendees for their future working life as self-employed worker in an insurance agency. Most of the critical topics for the management of an insurance agency like time management, self-management, business planning and leadership are not part of the guidelines of the legislative administration or if additionally provided by the insurance company it is treated only in theory.

2. Business games and working life

Online business games as a form of gaming simulation offer an excellent opportunity to shed considerable light on the network of business and economic inter-relationships in complex systems of reality, such as in an insurance agency. Decisions will be taken on the course of action but the consequences thereof will only be simulated, which means that an action can be tested without any risk. In the workplace this is rarely possible.

A further advantage of a business game is that the time between consequences and decisions can be shortened to whatever degree may be required simply by using time lapse and thus makes it possible for a participant to "learn from experience". In the real working life, however, errors and mistakes are frequently difficult to discover and the consequences mostly become apparent only a long time after they have been made. Business games thus make it possible to investigate systems that would be too slow, too expensive, too difficult or too risky to analyze in the real world.

With their main advantages such as mastering complexity, the achievement of higher cognitive objectives, learning from mistakes without risk through trial and error, learning from operating experience through time-lapse and particularly the strong learner motivation, business games can help mastering the future working life as a self-employed worker.

3. SiVa[1] – an insurance agency simulation

An insurance agency is a complex system and has a considerable and multi-faceted interrelationship network of actions, events and consequences. In order to prepare learners in the insurance industry for their later working life as self-employed agents the online business game SiVa has been developed. SiVa is a simulation game that provides different scenarios of an insurance agency with distinct stories, objectives and challenges. In SiVa the learner runs an agency in simulation without any risks so he is able to learn from experience by means of trial and error.

3.1 The principle of Siva

In the closed, stochastic and single player online business game SiVa the player assumes the role of an independent agent and manager of an exclusively bound insurance agency.

The situation within the agency is observed over a simulated time period of 18 months that commences in April. A month in reality is equivalent to one game period. The parameters that apply to the game are the working hours of the manager of the agency. They can be distributed in each round across a number of predetermined activities to be dealt with. Planning is completed for a week at a time, whereby the values are extrapolated to the month to calculate the performance of the agency (Figure 1). Each number of hours that can be invested is derived from the minimum number of working hours, i.e. 40 hours a week: but, just as in real life, these hours can be varied freely.

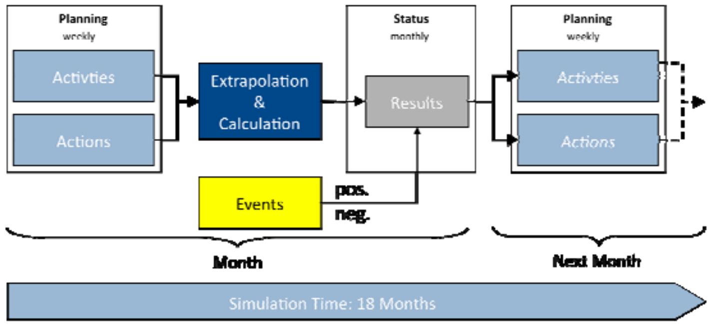

Figure 1: Simplified flowchart of the online business game SiVa

3.2 Factors and activities, actions and events

The status of the insurance agency can be observed directly on the basis of so called factors defined for the agency and then be evaluated. The factors are the key figures used in the insurance business that present a clear picture of the success and the performance of the agency. A clear difference is made between quantitative (hard) factors and qualitative (soft) factors.

The quantitative key figures of the insurance agency describe directly the economically measurable performance of the agency using numerical values and certain units e.g. Euro, pieces, percent etc. Primarily the economic success is represented through the production, i.e. in the total of commissions that have been paid. Other very important indicators for the economic success are the amount of cancellations and the number of clients, since these are indicative of the chances of success for the agency over the long term (Figure 2, lower right table). To describe the economic status of the insurance agency the following quantitative factors are used:

Quantitative Factors:

- New business The production that has been generated by the activities within the framework of the acquisition of new clients.
- Business in force The production that has been generated by the activities within the framework of doing business with clients the agency already has.
- Size of the portfolio The number of policies in the agency's portfolio.
- Volume of the portfolio The current volume in units of the policies in the agency's portfolio.

[1] SiVa: German abbreviation for Insurance Agency Simulation

- Increase of the portfolio The increase of the volume of the portfolio derived from total production of the business in force minus cancellation in a year with reference to the average production of the business in force.
- Applications cancelled The cancellation proportion of production of the new business within the liability period in which a certain proportion of the commission has to be paid back.
- Policies cancelled The cancellation proportion of the production of the business in force within a year with reference to average production of the business in force.

The soft facts held by the insurance agency describe its qualitative status using certain termed categorical values e.g. very bad, bad, balanced, good and very good. Qualitative factors like the motivation or the qualification of the agency manager play a crucial role in the economic success of the agency. There is, for example, motivation as an indicator of one’s own satisfaction. This factor has an effect on the willingness to perform and will over the long term influence the performance of the insurance agency. On the other hand a good or a bad performance of the agency influences the motivation of the agency manager (Figure 2, upper right table). This means that qualitative factors can influence quantitative factors and vice versa.
Qualitative Factors:

- Agency Manager - Motivation The readiness of the manager of the agency to participate actively in the daily work of the agency
- Agency Manager - QualificationThe qualification of the agency manager with reference to sales and expert knowledge of insurance
- Quality Follow-up Visits: The key figure indicating the quality with which visits are reworked.

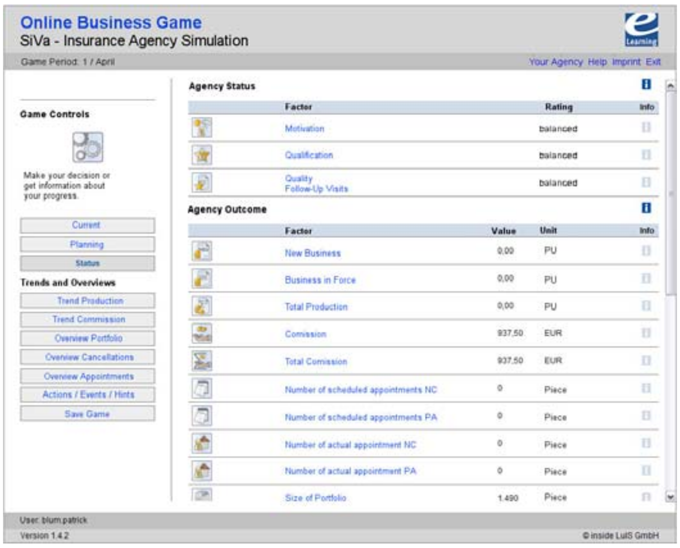

Figure 2: Screenshot of the user interface of the business game SiVa: agency status

The simulated insurance agency can be controlled on the basis of activity groups. Each activity group represents a resource that can be used for predetermined activities e.g. the working hours of the insurance manager or the number of contacts used by the manager for acquiring new clients. The working hours of the manager can be distributed to the following activities:

Activities

- Agency Meetings The time expended for conferences with the company, reporting, marketing and the planning of strategies, dealing with formal minutes, etc.
- Office Organisation The time required for activities that are not directly connected with planning or preparation for customer calls: such activities might be the evaluation of written communications, telephone calls, weekly, monthly and annual planning, controlling, etc.
- Scheduling The time spent on planning appointments of all types, customer calls included. These might imply, above all, the checking of recommendations for possible future business.
- Preparation for Meetings The time spent for all the activities associated with preparing for customer calls. Such activities might include research, completion of a draft policy, etc.

- Preparation of draft policies and their evaluation The time spent on activities associated with the completion and evaluation of draft policies. Such activities might include the selection of information, setting out a sales strategy or a needs analysis.
- Promotion The time spent on activities associated with presenting oneself, the agency or the insurance company with the aim of projecting and maintaining a positive public image.
- Further training The time that the agency manager devotes to personal professional development. This might include utilization of e-learning opportunities, attendance at seminars, obtaining further qualifications by examination, private measures to develop one's knowledge, reading specialist publications, etc.
- Time for acquiring new clients The time devoted to client support and sales in the case of new clients. This might include aggressive business recommendations, clients recommend other possible clients, financial analysis, telephone client acquisition, etc.
- Number of addresses used
- Number of scheduled appointments on the basis of the addresses
- Number of scheduled visits on the basis of the addresses
- Number of recommendations used
- Number of scheduled appointments on the basis of recommendations
- Number of scheduled visits on the basis of recommendations
- Time for policy acquisition and retention The time devoted to client support, advice and sales in the case of existing clients. This might include service visits, sales meetings, following up recommendations, financial analysis, revitalising policies in danger of cancellation, etc.
- Number of contacts used
- Number of scheduled appointments
- Number of scheduled visits

Further possibilities for the player to influence the simulation process in order to maximize the economic success of the insurance agency are specific actions. During the entire simulation a number of different actions are available to the agency manager, for example:

- Seasonal Actions,
- Advertising,
- Attendance at a sales training,
- Attendance at a special insurance training,
- Employment of an assistant
- Informative presentations,
- Holidays, etc.

The costs that will be spent by the agency for such actions will vary from action to action and these will have to be covered by the income generated up to the moment when such an action is initiated. In addition the agency manager may have to devote more time to a specific action and this time must also be taken into account. If the time for a specific action is the correct one and if it is a success, it will have an effect on a number of different factors such as new business or business in force, either in a restrictive way or in a beneficial way.

In the course of the game and in dependency of the chosen scenario a number of events will randomly occur, making the game more realistic and more challenging. These include:

- Insolvency of one of the largest employers in the agency's region,
- Changes to the law relating to insurance,
- Adjustment of premiums by the insurance company,
- Reorganization of policies already issued,
- Sickness,
- Natural phenomena etc.

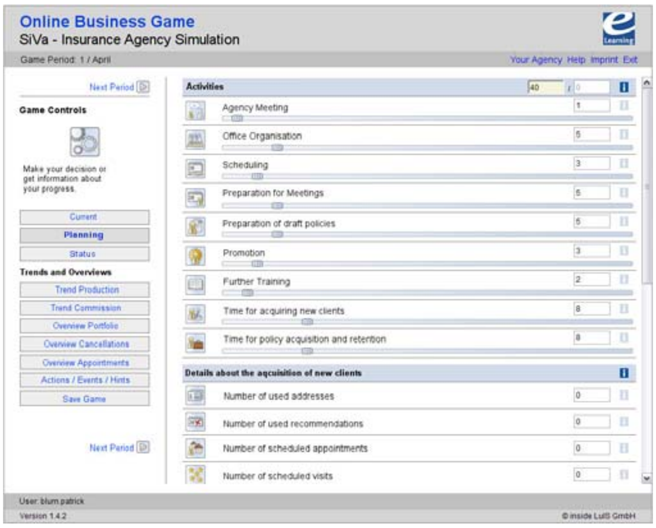

Figure 3: Screenshot of the user interface of the business game SiVa: activity groups

The events influence the current status of the insurance agency by changing factors, e.g. new business, business in force, the portfolio or the cancellations. The learner must counteract the negative effects on the economic health of the agency by carefully altering company strategy or by taking certain actions.

3.3 Scoring and feedback

At the end of the business game SiVa a score is calculated. This score represents how well the learner has performed during the 18 periods. Its purpose is to provide an index for a personal ranking or a group ranking if SiVa is played in a competition (see 4.2.1 - 4.2.3: SiVa competition). The score is calculated in two steps. In step one the basic score is computed on the basis of several different quantitative factors e.g. the total of commissions that have been paid overall during the game. In the second step the basic score is decreased by penalty points and increased by bonus points.

If the value of a factor representing an attribute of the insurance agency with a positive meaning (e.g. the size of the portfolio) has fallen below its initial value at the end of the game the basic score is reduced by a certain amount of penalty points or it is increased by a certain amount of bonus points if the factor has exceeded its initial value. The basic score is also reduced by a certain amount of penalty points if the value of a qualitative factor representing an attribute of the insurance agency with a negative meaning (e.g. the cancellation proportions of the new business) exceeds its initial value at the end of the game. If it has fallen under its initial value the basic score is increased by a certain amount of basic points.

The score is adequate for a ranking at the end of the game but it is not sufficient for a learner to improve his skills to manage an insurance agency. For this purpose SiVa provides additional feedback. The feedback includes ratings and the calculation of the ratio of certain activities e.g. time for scheduling per client, time for preparation per client or time for policy acquisition per client. This kind of feedback shows the coherence of activities and sensitize for personal timing. The feedback also includes ratings of the accomplished respectively not accomplished goals in the given scenario e.g. production goals. This kind of feedback shows if the learner is able to concentrate on certain goals in addition to the overall goals of the insurance agency. There is also feedback on the evolution of qualitative factors meaning the ascending, descending or alternation of the factor. This kind of feedback gives the learner information about the soundness of his strategy.

The score gives the player an orientation on his overall performance and the feedback supports the better understanding of the business and economic interrelationship network of the learner. It also allows the learner to improve his management strategy.

4. Online business games and blended learning

One of the main principles of business games is learning by doing based on authentic and complex business problems. They put the learner into the position to learn by trial and error – to experiment in realistic business scenarios. Thereby the knowledge is the outcome of a self-organized, entertaining, motivating constructivist learning process and not the result of a simple cognitive acquisition of information. By immerging into a simulated reality learning takes place by acting “within” the learning topic and not only by dealing with a learning topic like conventional learning does. Online Business games allow learning by experience without any risks.

4.1 Learning by experience

How does it work, learning by experience? In 1984 David Kolb developed a model for experiential learning. The central principle of this model is a four-staged “cycle of learning” describing a full experiential learning process of experiencing, reflecting, thinking, and acting:

- Concrete Experience,
- Reflective Observation,
- Abstract Conceptualization,
- Active Experimentation.

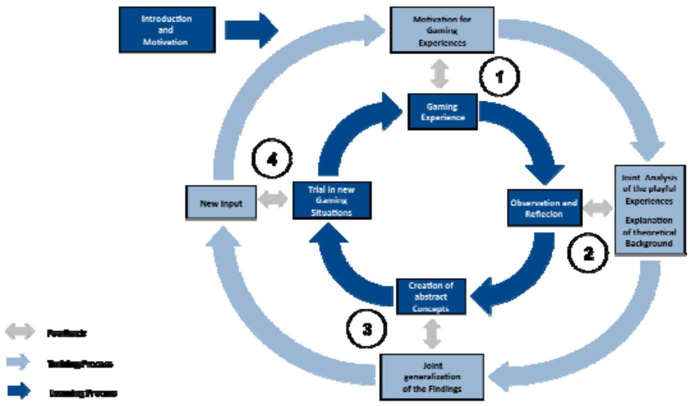

Figure 4: Model for business game based experiential learning based on Kolb’s experiential learning theory

Based on Kolb’s theory an extended model for experiential learning with business games can be developed. With blended learning in mind Kolb’s cycle of learning is expanded by an outer “cycle of training” with well-defined couplings to the inner cycle (Figure 4). Both cycles define the extended model for game based experiential learning in blended learning scenarios. In the stage of reflection, the experiences of each learner will be amended by the experiences of other learners, expert opinions and supplemental knowledge by the trainer. On the basis of the results of the observation, trainer and learners together derive general conclusions and build abstract concepts to prepare their modified game strategies. New game scenarios and quests initialized by the trainer are the source for new gaming experiences. Running through the described model multiple times creates a continuous learning and training process that makes a sustainable learning success for the learner most likely. This learning and training process establishes the scaffolding for the adoption of business games in blended learning scenarios.

4.2 SiVa and blended learning – an example

In order to prepare learners in the insurance industry for their later working life as self-employed agents of an insurance company a training concept based on blended learning is used. The attending learners have successfully absolved a nine-monthly basic education as an insurance agent with a certification at the chamber of commerce. But most of the critical topics for the management of an insurance agency like time management, self-management, business planning and leadership are not part of the education or treated only in theory. The theoretical knowledge that is gained within the education does not suffice to recognize the interrelationship between decisions and actions and the effects they have on the daily work in an agency. The focus of the subsequently presented blended learning scenario is to close the gap between theory and practice and to provide simulated experience in the management of an insurance agency.

Based on the business game SiVa the above presented learning and training process for business games in blended learning scenarios can be demonstrated very easily. The basic blended learning scenario for SiVa consists of three parts: kickoff, e-Learning-phase und debriefing (Figure 5).

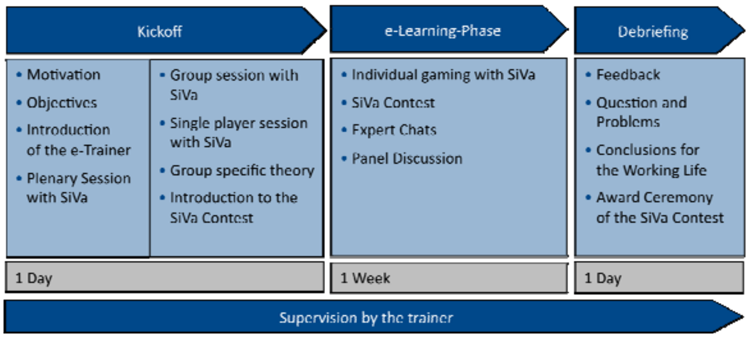

Figure 5: Basic blended learning scenario for SiVa

4.2.1 Kickoff

The one-day opening session starts with an accommodation sequence and the introduction of the trainer and the learners. After the introduction of the business game, its objectives and its primary scenario, the learners enter the simulated reality of an insurance agency by playing SiVa all together, lead by the trainer. During the simulation the learners get into a first discussion about how to run an insurance agency. This discussion provides plenty of information for the trainer about the learners: theoretical background about an insurance agency, self and time management, planning capabilities etc. Based on this information the trainer is able to individually adapt the agenda of the opening session to fit the needs of the learners. After approximately 3 rounds based on his observations the trainer should reflect the gaming experiences with the learners. The first half of the opening session ends with a feedback and a summery from the trainer.

The second half of the opening session starts with the formation of small groups (2 – 3 learners in each group). The learners make their first autonomous gaming experience. They learn how to operate the game and they get more ideas about how to manage an insurance agency (Figure 4: stage 1). Playing with activities and actions, followed by the reflective observation of the outcomes, the learner groups derive their first knowledge on the economic dependencies within an insurance agency. The role of the trainer is to observe and to coach the learner groups. According to the groups need the trainer gives intensive care or lets the learners act on their own as far as possible. On the basis of his observations the trainer formulates questions focusing on the management of an insurance agency for discussion and reflection (Figure 4: stage 2). To compensate common deficits of the groups e.g. in theoretical knowledge about managing an insurance agency or self and time-management the trainer performs knowledge building exercises after the group session. On the basis of the reflection, the new acquired knowledge and with guidance from the trainer, the learners subsequently create their first general concepts on the management of an insurance agency (Figure 4: stage 3).

After that a single player session follows to verify and to improve the new derived general concepts. For this purpose a concrete task is assigned to the learners: “Manage your insurance agency for 6 month and file a business report for the management of your insurance company” (Figure 4: stage 4). Consequently another reflection takes place after the single player session.

To provide a greater challenge a SiVa competition is introduced to the learners at the end of the kickoff. During the e-Learning-phase the learners compete for two awards: “Best Single Player” and “Best Group”.

4.2.2 e-Learning-phase

During the week-long e-Learning-phase the online business game is made available to the learners on the job using a LMS (Learning Management System) ideally based on the SCORM standard (Sharable Content Object Reference Model). A SCORM-compliant LMS allows the trainer to easily monitor the learner’s progress and to use standard content for further knowledge building.

In this phase the learners play SiVa alone to make their own individual gaming experience without any third party influence. The difference to the kickoff is that for the first time SiVa is played completely: all 18 periods that means 18 simulated months. The learners have to develop their own business strategy to meet the goals of the given scenario. Based on the analysis of the course of action the learners improve and complete their abstract concepts of an insurance agency and its business and economic inter-relationship network. For documentation a blog is available for each learner. To support reflection and further abstract conceptualization online discussions with the trainer and insurance agency experts are provided using the capabilities of the LMS. The role of the trainer is to motivate and coach each learner, to start discussions in the forums and to keep them going as well as to provide knowledge building content if needed. Especially in this phase it is very important that the trainer actively supports the process of reflecting, thinking and acting.

4.2.3 Debriefing

After finishing the e-Learning-phase a debriefing takes place. At the beginning the learners report on their experiences with SiVi during the e-Learning-phase. Afterwards the trainer summarizes the results of the online discussions and expert chats. Collectively the learners and the trainer develop a final understanding of the general concepts of an insurance agency. The result of this process is a checklist with dos and don'ts for later working life. At this time the trainer has to discuss the differences between the simulation and reality. He has to elaborate on the business policy and strategy as well as the terms and conditions of the insurance company the learners work for. In an exercise each learner has to develop his personal business strategy for the first 6 month of his working life as a self-employed insurance agent. Ideally this business strategy should be deliberated after 6 month as well. The debriefing closes with the award ceremony of the best single player and the best group. Each winner gets a certificate and each learner gets a certificate of attendance.

5. Conclusion

Online business games are a useful extension of blended learning in corporate learning for trainings scenarios concerning the understanding of business and economic system. They offer an excellent opportunity to shed considerable light on systems with a complex network of business and economic interrelationships. They allow decision making by observing the consequences without any risk which is rarely possible in real working life. Online business games uniquely provide “learning by experience” an ability that no other e-learning-method can offer.

On the basis of the extension of Kolb's cycle of learning in his model for experiential learning by an external cycle of training it is possible to easily integrate an online business game into blended learning scenarios with at least two training phases at the beginning and the end and one e-learning phase in between. Through the continuous trainer-guided cycling of the four steps experience, analysis, generalization and experimentation in the first training phase a good comprehension of complex business and economic systems can be achieved. This comprehension can be deepened and enriched through personal experiences in the e-learning phase. Supervised by the trainer the conclusions for working life can be elaborated and finalized in the training phase at the end of the blended learning scenario. Using online business games in blended learning scenarios requires trainers with profound knowledge in experiential learning, high capabilities in systemic thinking and system analysis as well as in the usage of e-learning tools. The knowledge achieved through playing business games in blended learning scenarios is the outcome of a trainer-guided but self-organized, entertaining, motivating and reflective constructivist learning process directly applicable in working life.

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Exploring the use of Simulation as a Tool of Change Management

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Abstract: The ability of an organisation to change and adapt is critical in a world of constant upheaval and turbulence. The process of change however tends to be more challenging than originally conceived, and organisations frequently rush into change initiatives without considering the wider systemic effects of the change on employees and their skill base, leading to unintended and often undesirable consequences that undermine the change effort itself. Relevant stakeholders are often not included and there remains much contention around critical issues of communication and participation. As a result many change efforts fail. Current theories and models of change are criticised for being over-simplistic, and the change process generally tends to be a negative experience. A proactive and holistic approach to change encourages participants to understand the need for change in the context of the whole system in which the change is embedded, to explore their own problems, and to work collaboratively in finding solutions towards implementation of the change. Simulations have proven beneficial in enabling participants from various backgrounds to meaningfully engage in "learning from experience". The safety of the environment enables participants to explore ideas and strategies, with the aim of developing abstract thinking by observing and reflecting on their experiences. This is an effective form of double-loop learning which is imperative for change to be enduring. This paper draws on multiple strands of literature, namely, simulation and gaming, systems thinking, complexity theory and change management to explore how game-based learning may contribute to effective organisational change processes, in the context of social complexity. One of the contributions of the paper is a set of design principles for simulations and other forms of game based learning, to contribute to effective change management. It is envisaged that the findings generated from this study will add value to the theoretical base on change and simulations, as well as prove to be a key resource for organisations contemplating or already grappling with change efforts.

Keywords: Change management, simulations, organisational learning, systems thinking and complexity theory

1. Introduction

Change management has often been viewed in a linear manner that involves proceeding through certain steps to achieve organisational effectiveness. Such processes essentially involve moving from a current state to a desired future state, and theories of planned change outline the required steps to make changes to strategies, structures, and processes with the intention of enhancing organisational effectiveness (Cummings and Worley 2001).

The above-mentioned approach does however have its limitations. Elving (2005) reported that many change management efforts failed, despite the wide-spread literature. This in part, is due to the literature often oversimplifying the change process and being incapable of capturing the rate of change (Bamford and Forrester 2003). Managers interviewed by Andrews, Cameron and Harris (2008) raised concerns about the significant gap between theory and practice, and valued theory that viewed change in a non-linear manner.

An often neglected, yet critical consideration is that of acknowledging the lack of stability in organisations. There is a tendency, as Ferdig (2007) explains, for people to look towards leaders to take control, give answers, and focus on linear models of managed change, regardless of the fact that we find ourselves in a world of uncertainty.

An alternative way of approaching change that acknowledges the perpetual turbulence in organisations is therefore proposed. The complexity perspective essentially challenges change as being a one-dimensional sequence of activities and challenges traditional change models, by rather perceiving change as created from the interaction of various interconnected causes and effects (Styhre 2002). Beeson and Davis (2000) draw attention to change occurring through the complex interaction between people, and argue that the systems perspective remains critical in attempting to grasp complex patterns of relations, through the holism of understanding structure and actions in the entire system. The systems approach incorporates both negative and positive feedback, resulting in unexpected and unintended consequences (Van Tonder 2004).

Small inputs or variations can produce significant or variant outcomes, and these processes cannot be entirely controlled or planned (Beeson and Davis 2000). It is therefore critical to note that conventional management theory does not align well with managing complex and adaptive organisations (Ashmos, Duchon and McDaniel 2000). Emphasis should rather shift to control in the system as opposed to management, with the result that organisational capabilities to solve intricate difficulties effectively, is enhanced (Lichtenstein 2000). If managers encourage a culture of experimentation and risk, then workers can recognise and implement change, and also change for suitability (Bamford and Forrester 2003).

Change is thus a continuous activity filled with experimentation and adaptation in order to align the organisation's capabilities with environmental needs (Bamford and Forrester 2003). This approach to change will be adopted throughout the paper. Organisational learning then becomes an imperative. This is the development of the collective ability to perform more effectively by allowing members to diagnose the situation of the organisation as well as assess their past behaviours, and then merge this understanding to adapt the rules that steer decision-making and action (Hayes 2002). The change process thus has opportunities for creativity, and for the enhancement of the skills and abilities of employees and management to deal with inherent uncertainty (Callan, Latemore and Paulsen 2004).

It has been shown that 'yesterday's models and methodologies with their constrained conceptions of change will not reveal the true character of change in organisations in the future' (Van Tonder, 2004: 227). This article therefore sets out to investigate the use of simulation as a tool of change management, capable of incorporating critical areas of systems thinking, complexity theory and organisational learning, considered by Montouri (2000) to be vital to organisational longevity.

The following sections will focus on the suitability of simulations for use in organisations, complexity, problem-solving and continuous learning, the development of strategies and skills, and facilitating communication and participation. This will be followed by a set of design principles for simulations and other forms of game based learning to assist with change management.

2. Simulations and change management

2.1 Simulations for organisational use

Thiagarajan (2003: 235) defines a simulation as 'the representation of the objects, characteristics, behaviours, and relationships of one system through the use of another system', which contains play objects, goals, rules, and roles. The emphasis is on the abstraction of a depicted operational model, representative of a much larger system (Enciso 2001).

The use of simulation in management research specifically, is encouraged due to its 'legitimate, disciplined, and powerful approach to scientific investigation' (Harrison et al., 2007: 37). This could prove to be a useful method to change management.

Simulations are powerful tools of teaching (Jackson 2004). A whole or partial organisation can be modelled such that participants are able to see the connections, and are therefore ideal for adult employees in organisations (Pivec, Dziabenko and Schinnerl 2003).

Simulations are ideal for use in change processes where participants can see connections between activities in the simulation and the real world. This ability to step outside of the usual work surroundings to make observations, perhaps otherwise not possible is essential to continuous learning and improvement.

Participants in a simulation can actively utilise and not just acquire the knowledge of facts and ideas (Jackson 2004). This is important in understanding why isolated training programmes for change management with the presentation of pre-determined facts and ideas to employees may be unsuccessful.

2.2 Simulations for complexity

Change processes are filled with much uncertainty. This can be approached using a powerful combination of methods capable of handling complex, uncertain, and unique issues (Klabbers 1996).

Enciso (2001) also mentions the integration of cognition and emotion in a simulation that results in active learning to facilitate with dynamic and complex situations, as critical to individuals and organisations.

Self-organisation in a simulation occurs when behaviour emerges from the actions of various entities, which no one controls; the emergent behaviour has its own rules and laws (Dooley 2002). Enciso (2001) mentions that self-organised groups must be afforded the opportunity to comprehend and adapt. This could also increase organisational effectiveness by producing accountability in individuals.

Conflict and other seemingly negative situations are often viewed in a pessimistic manner by most organisations, resulting in lost opportunities for creativity and idea-generation. Ashmos et al. (2000) encourage managers to embrace difficulties, conflict and ambiguity, by employing processes of sense-making and collaboration to interpret information and use opportunities for growth. The power of conflict and collective exploration in the change process by way of the generated tension has the ability to lead to new thinking and discoveries (Ferdig 2007). Simulations are therefore suitable for use in change processes with inherent complexity, which should be acknowledged and addressed, rather than stifled.

2.3 Simulations for problem-solving and continuous learning

Organisations should engage in problem-solving to produce ideas and aid in continuous learning, but such that this is truly meaningful. Superficial problem-solving is viewed as single-loop learning. Argyris and Schon (in Hayes 2002) define single-loop learning as the identification and fixing of errors, resulting in members adapting their current mental models to do things better. This could become an obstacle to organisational learning, with the consequence that there will be less motivation to engage in eliminating root causes (Tucker, Edmondson and Spear 2002). First-order problem-solving is cemented by organisations shaping the work context to focus on independence and quick fixes, and the job structure to not include time and means of solving problems (Tucker et al. 2002). This sort of thinking can result in many negative outcomes for organisations.

Problem-solving although important, on its own, is insufficient if people do not critically reflect on their actions by asking how they may have created problems and then change their behaviours (Argyris 1999). Other attempts will probably be futile, unless people take responsibility by exploring and deducing. It is thus suggested that organisations aim for double-loop learning to eradicate root causes by way of simulations.

Double-loop learning, as explained by Argyris and Schon (in Hayes 2002) is a deeper process, which leads to current thinking being challenged. This then generates a novel understanding, which sees a change in the behaviour of members, which ultimately ends up in things being done otherwise or new things being tried. Simulations allow for double-loop learning and for the development of strategies, which encourage the achievement of a common goal through the exploration of mental models (Serrano et al. 2006).

Simulations enable organisations to continuously learn and adapt to change, rather than try to predict the future (Wenzler and Chartier 1999). This coincides with the view of organisational change as being less concerned with managing processes but rather for employees, managers and other stakeholders to be given opportunities to strive for learning and constant improvement. Furthermore, a constant focus on learning and improvement can prevent situations where crisis management must be employed. Simulations can also assist managers to translate their personal experiences into an experiential learning cycle, thereby impacting future change theory (Andrews et al. 2008). Simulations are appropriate due to the “learning from experience”, and can be viewed as a valuable opportunity to build theory.

Lane (1995) draws on Kolb’s model of experiential learning to argue for the “learning from experience” approach inherent in simulations. This comprises of participants having concrete experiences, which leads them to observe and reflect on the experience, thereby promoting the development of abstract concepts that should then be applied and tested. This profoundness offered by participation in a simulation will have long-term benefits for members, as they may become more cognisant in their future actions.

Simulations are capable of illustrating 'the totality of a model and the dynamics of a system' and prove critical in gaining a holistic view of a problem presented by multiple stakeholders (Geurts, Duke and Vermeulen, 2007: 544). This is an effective way to deal with problems that can simultaneously shed light into concerns in other work areas. Simulations allow participants to be introduced to the situation and problem, and they are encouraged to work towards solving it; thus, content is self-discovered (Lane 1995).

New features to the problem can be uncovered in a simulation and ideas that are produced, can be considered by other participants (Geurts et al. 2007). This also encourages respect among members when they work together towards a common goal. Jackson (2004) describes how learners in a simulation deeply engage with ideas and principles. Pivec et al. (2003) also point to a community of learning, gathered from the simulation experience which occurs through participants communicating their ideas, problems and solutions to each other. Participants in a simulation may unknowingly release their fears and gather courage through collective exploration. One simulation could replace a long drawn-out series of meetings called to address various issues. This could save time and money.

Attention is also drawn to organisations that rely too heavily on plans and forecasts during change processes and which ignore covert processes. Employees may through their own sense-making process alter management plans, despite structures or systems designed to ensure conformity (Balogun 2006). Change is therefore about working towards a shared understanding of the intricacy of the various issues and consideration of the alternatives, and not about outlined plans and forecasts (Bamford and Forrester 2003).

There must be a transformation in the joint assumptions and beliefs held concerning how things occur, and the ways in which people respond (Balogun 2006). Wedge (2006) contends that existing assumptions and obstacles can be challenged by contributions from various persons. Individual assumptions and beliefs from all stakeholders should be identified to uncover how members operate.

According to Keys, Fulmer and Stumpf (1996) simulations are valuable in that the views and behaviours of those involved can be changed. Simulations facilitate learning by challenging existing ways of thinking how we go about things (Enciso 2001). This can contribute to improvement through the detection of subtle behaviours that may have contributed to problems.

Simulations thus unveil how people naturally go about doing things. This ability of simulations to bring together various stakeholders to uncover and consequently question usual routines is powerful, and impacts organisational effectiveness. Simulations also present a valuable occasion for participants to make mistakes, and consequently reflect and learn.

2.4 Simulations for addressing strategies and skills

Many organisations rush into change initiatives without consideration for unintended consequences that may occur. Oakland and Tanner (2007) found that less than half of the organisations interviewed in their research, conducted a pilot implementation or feasibility testing prior to the initiation of change processes, with the result that implementation is rushed into without consideration of possible alternatives before making the decision.

Simulations provide a proactive view when participants explore strategies before implementation, and direct future situations that may cause problems (Geurts et al. 2007). Simulations are particularly advantageous when an organisation is confronted with significant change requirements, in that strategy and implementation can be practised in a risk-free environment (Keys et al. 1996). Simulations can prevent unnecessary and lost investments in change processes.

It is necessary to gather insight into the holistic view of each action being connected to every other action and grasping the long-term effects of our choices (Ferdig 2007). Simulations can expose common misperceptions that there are single cause-and-effect relations, and that an occurrence in one area will not have consequences in other areas.

Change processes should centre on learning and skills for employees, as well as management who can assist employees during the process (Van Tonder 2004). Change processes will have effects on the current skill base of employees and managers; this can be dealt with in the safety of the simulation.

Simulations can aid in the comprehension and incorporation of complex systems, thereby allowing for the acquisition of systemic skills (Enciso 2001). Thus, having participants look for information and strategies can develop critical skills such as decision-making and negotiation (Pivec et al. 2003). Organisations often highlight the need for employees to develop their higher-level skills. Simulations enable employees to actually practice these skills and conclude the importance thereof for themselves and their work, rather than just be passively informed of the importance of attaining these skills.

2.5 Simulations for facilitating communication and participation

Communication and participation in change management are particularly contentious issues. Many organisations communicate with employees by sending out formal communication briefs. It is important to note that formal language through management briefs and newsletters are not sufficient, as they overlook the complexity of organisational change (Bamford and Forrester 2003). Van Tonder (2004) thus warns that an over-reliance on the formal diffusion of information can cause change efforts to fail.

There is also a tendency to overlook the emotions of people. People often get authoritarian management during periods of change, rather than empathy, information, ideas, milestones and feedback (Carnall 2003). There will be consequences deriving from the manner in which organisations choose to deal with their employees.

Methodologies that are genuine and truly participative can decrease resistance levels during change efforts (Van Tonder 2004). The use of various communication modes, especially face-to-face communication is urged (Callan et al. 2004). This is considered crucial for effective communication to occur.

Change is a ‘two-way process of sharing and negotiating interpretations through many communication genre… through gossip, discussion, negotiations, observed actions and behaviours as individuals go about their daily work’ (Balogun, 2006: 43). This sort of interaction can be obtained through participation in a simulation where various individuals are present, and where negotiations, observations and scenarios resembling the actual work situation occur.

Simulations offer rich experiences, due to the complex types of knowledge and the mixture of human reactions, emotions and interactions (Lane 1995). This is pertinent in change processes where there are many legitimate concerns raised by various stakeholders, all of which must be attended to in an effective manner.

Participation by senior management in the simulation also sends a very strong message. Coherence in the deeds, words and behaviour of top management, as well as their active participation in the change process will ensure the prevention of counteracting outcomes (Balogun 2006). Therefore, participation by senior management in a simulation is an occasion to “walk the talk” and cultivate trust. The involvement of top management in a simulation also disputes the traditional view of the leader being the one with all the answers, which Ferdig (2007) argues, has created a state of learned helplessness. Simulations allow for the participation of individuals from various organisational levels and backgrounds, including top management, thereby ensuring organisational learning (Keys et al. 1996). As Barreteau, Le Page and Perez (2007) explain, simulations permit for legitimate and candid articulation from all stakeholders.

Simulations provide the platform for diverse groups to express their opinions and ideas, with implications for group relations. Geurts et al. (2007) point to the usefulness of simulations in assisting with communication in complex situations with various groups, to facilitate in discussing ideas and closing communication gaps.

This is verified by Barreteau et al. (2007) in mentioning how simulations promote communication, positive dialogue, clarity and training in a complex system, and essentially strengthen ties between those dealing with common resources and also ensure future exchange among participants. It must be noted though that the point is to achieve genuine, meaningful communication processes, which could consequently assist in uniting individuals during change processes.

Simulations can be considered to be the answer to Argyris's (1999) call for a change program that incorporates education at all levels, and which leaves a system for use in upcoming changes and one that contributes to organisational learning.

2.6 Design principles

The following represent a set of design principles for simulations intended to contribute to effective organisational change processes. They are drawn from the multiple strands of literature, namely, simulation and gaming, systems thinking, complexity theory and change management, already referred to in this paper.

- **Simulation as a system.** Given that a simulation is a model of reality, it may be considered as an abstract or conceptual system that has a relationship to a real world referent. The implications for designers are to explicitly consider how the simulation is a system by applying diagramming techniques from system thinking. This would include, for example, consideration of the system and its boundary, the various sub-systems as well as some of the dynamic inter-relationships between components.

- **Parsimony.** Rules of interaction are important architectural components of simulations. Complexity theory indicates that simple rules give rise to complex behaviour (Eisenhardt and Sull 2001). Designers should strive for a minimalist set of rules that is consistent with the model of reality to be embedded in the simulation.

- **Design for emergence**. Complex systems exhibit emergent properties (Anderson 1999). Participants should similarly be able to experience complexity through emergent outcomes as a result of interactions in the simulation. In design terms, this favours loose-coupling in design and free-form as opposed to rigid design. Facilitator guides should in turn be designed for relatively non-interventionist approaches of facilitation, yielding more ownership of outcomes to participants.

- **Facilitator-led, but participant-centred debriefing.** Despite the desired learning outcomes from a simulation, modelling the complexity of a real world organisation implies that the actual learning outcomes for participants may be radically different from what was intended (Leigh 2007). This calls for a more open design, favourable to explore such alternate learning outcomes. Attention has to be paid to this in the design of the debriefing materials, with a concomitant flexibility and skill of the facilitator in the actual use of the simulation.

- **Double-loop learning.** For enduring organisational change, it has been shown that participation in simulations must contribute to double-loop learning. Fundamental to this is challenging the assumptions underpinning the prevailing mental models of participants. This requires a deep appreciation of the shared mental models of the client organisation, and incorporation of mechanisms into the simulation design that will challenge these fundamental assumptions. Causal loop diagrams may assist in this regard.

- **Multiple conceptions of time.** In order to achieve higher levels of verisimilitude, simulations need to acknowledge multiple and richer conceptions of time. Simulation design therefore needs to be explicit on the role of time in the simulation. Consideration needs to be given to whether time is explicit or implicit in the simulation, whether the focus is on linear or cyclic time, and whether actions are monochronic or polychronic. For example, when simulations are played in rounds representing the passage of time, the outcomes of decisions may not necessarily be conveyed to all teams (stakeholder groups) simultaneously as is conventionally done in many business games. These multiple conceptions of time will assist participants in better appreciating the ambiguity and uncertainty prevalent in organisations that are ripe for change interventions.

- **Dynamic complexity.** If the conventional, linear stages model of change is inappropriate, then change management simulations need to assist participants in understanding and working with dynamic complexity (Sterman 2001). From a design point of view, this may be achieved by incorporating common systems archetypes, such as "Growth and Under-development" and "Tragedy of the Commons" as vehicles for debriefing. Systems archetypes explicate important causal linkages and reveal non-linear relationships that give rise to the dynamic complexity inherent in a wide variety of real world systems and contexts (Senge 2006). Another benefit of this approach to the design of the debriefing phase is that the same simulation may be run for the same group of participants more than once, using different system archetypes, thereby providing a richer experience of the social complexity of the given organisational context.

3. Conclusion

This contribution has illustrated the suitability of simulations for use in change management. This may also provide insight into the occurrence of resistance to organisational change, which is derived from neglect of a systemic perspective and lack of acknowledging inherent complexity. The use of simulation embraces the complexity and uncertainty associated with change processes, and is a valid method for addressing concerns about current change models and inadequate literature. The interactive nature of simulations is ideal for adult learners in organisational settings, and sets the scene for addressing a multitude of complex situations. Simulations permit for problems to be dealt with in a genuine manner to unravel the intricacies involved, as opposed to employing quick fixes that may fail or result in the re-manifestation of the problem. Through experiential learning, participants explore a problem and experience for themselves the outcomes of choices that they made. Benefits of using this method include the opportunity for the exploration of mental models in order to acknowledge stakeholders' varying perspectives. This powerful approach encourages sincere communication and participation between all involved, and is considered vital in facilitating meaningful interaction during change processes. Participants can also test strategies and explore their skill base in the simulation, rather than experience the consequences of their inadequacies in the real world. A set of design principles has been presented for simulations intended to contribute to effective change processes. The use of simulation is critical to organisational learning, which is considered an imperative when viewing change as an opportunity to strive towards continuous improvement.

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Complexity and Dynamics of Gameworlds: Autopoiesis of Possibilities

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Abstract: Studying the precise nature of the complexity of games enables a deeper understanding of the play phenomenon. Complexity theory offers a distinct approach to examining the world of games. The key segments in Salen and Zimmerman's (2004) definitions of play and games are theorized through complexity thinking. They are taken as a starting point and provide a framework for theoretical discussion about play elements and their functions. The paper explores how imposed constraints, that is, game rules, influence the freedom of movement of players. It looks at the importance of predictability and its impact on players' motivation and engagement. Open possibilities and the unexpected, especially in Massively Multiplayer Online Role Playing Games (MMORPGs), enable connectedness of components, which, as a result create new quality. Emergence of new properties leads to creation of new conditions, which again open new opportunities, developing an autopoietic loop. The paper also examines the notion of simultaneity of complexity theory and conceptualization of the disappearance of opposed dualities such as real and unreal. Games were for long considered as mere entertainment with no connection to serious activity or work. The explosion of video and computer games in quantity and in the level of skills and competences required from their players, have induced educators to reassess their pedagogic potential. While the future direction of development of games is uncertain, it is clear that play has significant implications for the way we think and work, as individuals and in the collective.

Keywords: Complexity, games, emergence, autopoiesis, predictability, constraints

1. Introduction: mastering complexity through ages

Human mind has been historically viewed by scholars, scientists and philosophers through different lenses. To varying extents, these perspectives have been based on understandings of human origins, development, civilization, and contemporary context. They were all shaped by their historic moment.

Technology has played its part in this conceptualization from the early recorded period. (Gee, 2007). Plato, for example, who believed that the mind was a separate entity from the body, saw writing as a dangerous invention. He expressed his concern in *Phaedrus* where Socrates relates Thamus's response to Theuth, who discovered the use of letters:

> *… for this discovery of yours will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves.*

In 17th and 18th century John Locke, David Hume, and Francis Bacon, the early empiricists, viewed the mind as a blank slate. They believed that whatever was experienced through our senses became engraved onto the slate, just as, Guttenberg's invention of movable type two centuries earlier, had enabled letters to be pressed onto paper, contributing to the spread of literacy and knowledge.

Ideas of stability and progress dominant before World Wars I & II gave way to confusion, and uncertainty, raising questions around human nature and mental awareness, and also about possibilities of technologies. While Vannevar Bush (1945) was writing in "As We May Think" about a new electromechanical device, *memex*, that would help a large research library to be read by following associative trails of links, James Joyce and Virginia Woolf were showing through their fiction a network of human mind, *a stream of consciousness*.

The complexity of human consciousness was reflected in the complexity of the outer world. New ideas about human thought, its multilayered nature, its dynamics and ability to cross boundaries of time and space found resonance in new technological inventions, such as the microwave, the pacemaker, the credit card, optic fibres, the computer, the laser, the videocassette, the cell phone and much else.

Each of these technologies in turn poses more questions about the way we learn, cope with everyday reality and live together. As Gee (2007) argues, the perceptions of modern cognitive scientists, being influenced by the way computers work, have changed over time from seeing the human mind as a logic-like rule system to understanding it as a complex adaptive network. Janet H. Murray (2003) says that “all creativity can be understood as taking in the world as a problem” (p. 4) and she calls for “more powerful methods of mastering complexity” (p. 4).

2. Approaches to the study of play and games

The study of games was for years focused on the history of games. Theorists perceived them as children’s pastimes, with attention given to equipment or types of games (Caillois, 1961). Less attention had been given to the nature of play and its effects.

A significant step forward was made in 1938 by Huizinga who has been considered the founder of Dutch cultural history. Huizinga was the first to claim that play was a cultural phenomenon. “Games can provide proof of the constancy of human nature on certain levels” (Caillois, 1961, p. 82) (Avedon & Sutton-Smith, 1979). Through games we can learn about customs and beliefs and the evolution of a particular culture (Avedon & Sutton-Smith, 1979; Carter, 1992). Games and play cannot help us reconstruct history, but rather understand human nature, what we as “meaning-seeking creatures” (Armstrong, 2006, p. 3) strive to do. Hans (1981) even argues that understanding achieved through play may be more valuable than understanding achieved in other ways. Play and games often demand that players go beyond what they think they are capable of. Thomas and Brown (2007) claim that we cannot separate learning from play.

A study of these complex systems created for new digital spaces, requires expertise of, or at least openness to, more than one discipline and approach. Murray (2003) sees computer technology as a medium that has brought engineers and social humanity workers together. Sutton-Smith (1997) looks at diverse forms of play and examines the implicit ideological rhetorics of various disciplines that are marginal to play. Interdisciplinary method, he believes, is the best way to investigate the ambiguities of play. Alongside Sutton-Smith’s (1997) approach to studying games, Murray (2003) believes in the necessity of a multidisciplinary perspective, claiming that “new *multimedia* games became intentionally interdisciplinary” (p. 10).

Ubiquitous technologies change not only the way we do things, but also the way we think (Turkle, 2004). Davis and Sumara (2006) point out that the diversity in interest is best described as transdisciplinary rather than inter- or multidisciplinary. This particular perspective stresses an approach to study of a phenomenon not only from different disciplinary backgrounds but also across time and space. In addition, it bears conscious awareness of the world as a dynamic and adaptive space, in permanent change. Thorburn and Jenkins (2003) draw attention to the benefits of media change and the introduction of new technologies. They invite us to re-examine the new forms and discover those unique qualities and potentials that emerge.

3. Salen and Zimmerman’s definitions and complexity theory

Many theorists have tried to define play, but no single, clear definition has been or is possible (Crapo, 1993; Sutton-Smith, 1997). Each author’s definition has its own focus. The question that arises today in the digital era is how significant are developments in gameworlds. Salen and Zimmerman (2004) argue that there is no difference in the qualities that define a game from one medium to another. However, there are some properties that are unique to digital games, and which need to be identified and their value acknowledged.

Salen and Zimmerman (2004), primarily interested in game design, point out that we need to define the relationships between games and play before we offer a definition of one or the other. On one hand, they state, we can see games as a subset of play. On the other, play can be seen as an element of game. They represent this visually as two circles, a smaller circle inside a bigger one (cf. Salen & Zimmerman, 2004). In one case play is a more general term, defining a sociocultural phenomenon, where games are situated inside that system, as a subset of organized activities. In the other case, play is what is happening inside the rule-governed system of games.

Both Juul (2005) and Salen and Zimmerman (2004) go through a number of various definitions of game, and create categories for comparison based on different criteria. Sometimes the difference is in the way things are expressed, that is, more linguistic than essential. This paper looks at Salen and Zimmerman’s definitions and limits its discussion on the elements that are informing our knowledge about complex systems. According to Salen and Zimmerman:

> ***Play*** *is a free movement within a more rigid structure (2004, p. 304).*
>
> ***A game*** *is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome. (2004, p. 80)*

3.1 Rules and constraints

Let us first examine the terms "rigid structure" of play, and games "defined by rules."

For many theorists (Avedon & Sutton-Smith, 1979; Caillois, 1961; Crawford, 1996; Huizinga, 1970; Salen & Zimmerman, 2004) rules are pivotal a part of their game definitions. Rules must be obeyed by the players, or the game does not function. Caillois (1961) argues that not all games have fixed or rigid rules, referring to playing with dolls or soldiers and similar. Although not explicit as in other games, rules still exist, remaining in the sphere of imagination. If someone from 'outer world' enters and puts the dolls, or soldiers back in the toy box, the game is spoiled. It may well be that the whole play is improvisation, but the rules are not non-existent. Instead they are invented as the game proceeds.

John Holland (1998), a computational scientist, explains in his book *Emergence: From chaos to order*, how only a few simple rules can make games extraordinarily complex. He says that

> *Even in traditional 3-by-3 tic-tac-toe, the number of distinct legal configurations exceeds 50,000 and the ways of winning are not immediately obvious. The play of 4-by-4-by-4, three-dimensional tic-tac-toe, offers surprises enough to challenge an adult. (1998, p. 23)*

Juarrero (1999) claims that complex systems are possible only when there are context-sensitive constraints, in this case the rules that govern play. They limit the alternatives, imposing limitations on players. At the same time limitations create possibilities. Galloway (2006) argues that rules prevent players from doing whatever they want. Instead they make the gamers find out how to predict the consequences and adapt. When rules are learned well, players are free to manipulate and use them in their favour. As a result, new relationships are established and new solutions found. The system as a whole changes (Salen & Zimmerman, 2004).

A character in a video game, as for example a Healer in the *World of Warcraft*, may be limited by his character traits, not equipped to fight the monsters. But because of his skills, he can heal the wounds of a Warrior, who will as a consequence become his friend and protector, and fight the monsters for both of them. The components, as Juarrero (1999) explains, become context dependent, as the Healer and the Warrior in this case, thus enabling a complex dynamical system to emerge. Due to this new correlation, the components are able to face different challenges and move in less predictable directions.

This ability of increased likelihood that new connections will be made, Juarrero (1999) calls the first-order contextual constraints. Johnson (2004) and Salen and Zimmerman (2004) describe this as bottom-up behaviour. The rules constrain the possibilities, but at the same time enable new ones. This process is inexhaustible (Holland, 1998). Both characters in the World of Warcraft now have different goals and different limitations. They have new properties and greater degree of freedom. In turn, as Juarrero claims, "the higher levels impose second-order constraints on the lower ones" (1999, p. 143). These top down constraints imposed by the whole now make other players less likely to kill either the Healer, who will be protected by the Warrior, or the Warrior, whose wounds be constantly healed and who therefore cannot be killed. This will require other components/players to find new strategies to defeat the Healer or the Warrior.

Constraints that exist in a game could be imposed by the environment, by the prescribed rules, or by interrelationships among the players (Ellis, 1972). The complexity of games may be expressed through occurring social interactions, a variety of strategic options, developed narrative, or cognitive challenges.

3.2 Free movements and possibilities

"A game is defined by rules," as Salen and Zimmerman state above, but "play is a free movement within a more rigid structure" (2004, p.80/304). Their definition concurs with Gadamer's (1982) view on play as a possibility of movement. He claims that "one enjoys a freedom of decision, which at the same time is endangered and irrevocable limited" (1982, p. 95). Gadamer explains a player's choice of movement which is not completely limitless, but is contained in the area that is "specially marked out and reserved for the movement of the game" (1982, p. 96).

Galloway (2006) claims that "the game, like all other digital objects, is but a vast clustering of variables, ready to be altered and modified" (p. 112). The attractiveness of a game lies in the player's experience and expectation. The openness to different possibilities and the risk of choice is one of the top motivators to play and stay in the game (Gadamer, 1982; Maietti, 2008). Maietti argues that "the pleasure of the user does not derive from the fruition of the actual, but from the fruition of the potential, or better, from the transition between the two" (2008, p. 104). Gadamer points out that the purpose of the game is not its solution, but in the "ordering and shaping of the movement of the game itself" (1982, p. 97). Play and imagination bring freedom, although not freedom in chaos, but freedom through willing submission to the constraints of a complex system of rules that enable emergence.

The possibilities in video and computer games enable players to make connections with other players or game components, and they collectively create conditions for new possibilities. This could be seen as autopoietic loop of gameworlds. Francisco Varela and, Humbert Maturana used the word *autopoiesis* for the first time in 1974 to describe living systems as self-producing machines. This term has since been adopted in areas other than biology, such as sociology, psychotherapy, management, anthropology, and many others. Autopoietic systems are simultaneously producers and products.

3.3 Outcomes and predictability

Salen and Zimmerman (2004) speak of "a quantifiable outcome" as meaning the final score in a game, the notion of winning and losing. In this way they exclude "less formal play activities" (2004, p. 80) for which outcomes cannot be quantified. There are other formal games, however, which do not have easily measurable outcomes, unless we consider successful social connections as winning, and lack of participation as losing, as for example in a new genre of games, Alternative Reality Games (ARG).

Regardless of whether the outcome is quantifiable, predictability is an aspect of games which is interesting for complexity theory. What does 'predictability' become when we are dealing with emergent phenomena? To answer this question, we may go back to Katherine Hayles's (1991) discussion on chaos theory. She claims that a characteristic of complex systems is not "randomness, but the orderly disorder" (1991, p.1). Nevertheless, she continues, they are unpredictable. The issue with predictability is that one needs to know all the initial conditions and the factors that can influence them in order to initiate or prevent them. Small fluctuation can lead to enormous changes (Hayles, 1991; Holland, 1998; Salen & Zimmerman, 2004; Watts, 2003). Watts (2003) calls this a cascading failure or a domino effect. Hayles (1991) states that

> *Cascading effects from initially small causes could, and have, been observed at any time. But whereas in earlier epochs they tended to be seen as anomalous or unusual, now they are recognized as paradigmatic of complex behavior. (1991, p. 15)*

In a game, and especially in Massively Multiplayer Online Role Playing Games (MMORPGs,) every move leads to unexpected twists and turns (Holland, 1998). One player cannot in any way predict all possible moves of the other player. Holland (1998) claims that predictability depends on a level of detail. He takes a weather forecast as an example where meteorologists do not know the values of all the relevant variables, but the prediction is still satisfactory for our everyday purpose. The same may be said for a game in which the right level of detail can be sufficient for the player's progress and takes him/her to another level, or where the wrong level of detail results in his/her virtual death.

The player is not the only one who cannot predict the results produced by everyone's action. It is impossible even for a system designer (Aarseth, 1997; Salen & Zimmerman, 2004). Salen and Zimmerman find this exciting. They say that:

> *One of the great pleasures of being a game designer is seeing your game played in ways that you never anticipated, seeing players explore nooks and crannies of the space of possibility that you never knew existed. (2004, p. 168)*

Exploring a game is not just a journey. Every game poses a challenge. It means managing resources, testing skills and competences, solving problems. The attractiveness of a well-designed game is its ability to produce never-ending and increasing challenges (Castronova, 2005).

3.4 Emergence

It is exactly because of uncertainty about the outcome of the game that the players are so engaged. Many theorists have tried to explain this phenomenon.

Huizinga (1970) sees the element of tension as a very important part of play. Tension for him means uncertainty, chance, striving to achieve and end the game, “absorbing the player intensely and utterly” (1970, p. 13). The later theorists of games call this engagement arousal-seeking (Ellis, 1972), flow (Csikszentmihalyi, 1990), immersion (Murray, 1998; Turkle, 2005), or interactivity (Salen & Zimmerman, 2006).

Personal enjoyment in play, art or any other activity is one of the main preoccupations of Csikszentmihalyi’s (1990) theoretical work. He seeks to account for people’s motivation and explains it with his celebrated theory of flow, a state of full immersion and focus, in which people are intrinsically motivated to do what they are doing. Play is seen as an intrinsically pleasurable experience (Crapo, 1993). Even though playing a game can have a goal (material or symbolic interest), people engage in play because they enjoy it and therefore, they are ready to practice and repeat.

In addition, because of the unpredictability of all variables, every game is different. Sometimes “the play of the game is an end in itself” (Salen & Zimmerman, 2004). The careful design of participant’s experience is critical to his/her engagement. The quality of interaction depends on the relationship between the player’s choices and the system’s response (Salen & Zimmerman, 2004). The more possibilities there are for the player, the higher is the uncertainty of the outcome, and thus, the bigger tension. Variety of possibilities does not mean arbitrary play, however. Salen and Zimmerman (2004) consider a good design to be a game with a simple set of rules, and a limited set of objects, but leading to unpredictable results. Caillois (1961) believes that if an outcome is known in advance, there will be no game. It is against the nature of play.

3.5 Harmony

Finally, let us examine Salen and Zimmerman’s definition term “artificial conflict.” (2004, p. 80). Cyberspace, according to Robins (1999), has lost touch with the world’s reality. Users can present themselves as someone else, using a pseudonym or avatar (Page, 2008). This representation could be real, or completely imaginative, even gender switching. The players of online role-playing games in virtual worlds create their realities. Reality is produced by collective imagination (Lévy, 2005).

Salen and Zimmerman (2004) believe that the gamespace maintains its clear border, setting itself apart from reality. Therefore the conflict inside it is “artificial.” Other theorists question the thickness and stability of the membrane that separates real from unreal (Castonova, 2005; Haraway, 2003; Turkle, 2004). Castronova finds it “actually quite porous” (2005, p. 147). The dualities such as real and unreal, serious and non-serious, order and disorder do not qualify as such any more. They exist simultaneously and in harmony, complementing each other rather than opposing.

Figure 1: In virtual world

According to Castronova (2005), typical users spend about 20-30 hours per week inside a virtual world (Fig. 1). Some of them reported feeling that Earth was just a place to sleep and eat, but that ‘real life’ was happening in their fantasy spaces.

ARGs, and "documentary digital games" (Bogost & Poremba, 2008) are games that are escaping from the fantasy world of computers, consoles and arcades into the real world. These games require real people to reconstruct a historical moment or to place themselves in the possibilities of the future. Lieberman (2007) calls Alternate Reality Games off-the-screen games where "people interact with each other and the drama unfolds in the real world." Hans (1981) argues that play may create a false illusion of simplicity, but complexity is always there, even in the simple. The more complex the demands are for playing a game, however, the more human growth and adaptation are increased (Sutton-Smith, 1997).

4. Conclusion

Complexity theory offers another approach to study the world of games. The key elements in Salen and Zimmerman's (2004) definitions of play and games are theorized through complexity thinking. Thus, rules are perceived in terms or system's constraints and components' freedom of movement, game outcomes through predictability and emergence, and a binary real/unreal through simultaneity and interrelatedness of "opposing" phenomena.

It is important to realize that gathering a number of elements into a system produces something different than their individual characteristics, i.e. results in new properties, new entities and new behaviour (Holland, 1998; Morowitz, 2002; Watts, 2003). Salen and Zimmerman (2004) talk about emergence of a new quality during play, terming it "transformative play" (p. 305). As the play is never completely predictable, its results could be surprising and may force the structure of play to change. Complexity gives rise to emergence, which is perceived by Salen and Zimmerman (2004) as an important element of play. They say that "understanding how emergence works and creating a design that encourages emergence is one way your games can bring you this pleasure" (2004, p. 168).

In the process of emergence of a new property, the structuring components have a history and prior experiences embedded in them (Morowitz, 2002; Juarrero, 1999). These histories "carried on their backs" (Juarrero, 1999, p. 140) influence the interrelation with other components of the system, and consequently the final result of the interaction. The "embedded history" in gameworlds could be a part of the design, where all previous experiences of a play are automatically remembered by the system and have impact on current and future actions.

Well-designed computer and video games have inherent principles of learning built into them. Gee (2007) wonders why these principles have not been applied in schools and learning environments. The majority of them possess the possibility for creating new opportunities. Games are complex systems, which through the realization of their autopoiesis, keep the players perpetually engaged. As Aarseth says "a typical adventure game is not mastered by being 'read' once but by being played over and over, as the way we reread a great and complex novel" (1997, p. 114).

Children and adults play because they feel drawn into a game, and because it is fun. Games were for long considered as mere entertainment with no connection to serious activity or work. Although games have always been used for learning, this capacity has not previously been seen as a dominant teaching approach. The explosion of video and computer games in quantity and in the level of skills and competences required from their players, have induced educators to reassess their pedagogic potential. While the future direction of development of games is uncertain, it is clear that play has significant implications for the way we think and work, as individuals and in the collective.

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Digital Mind Games: Experience-Based Reflections on Design and Interface Features Supporting the Development of Reasoning Skills

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Abstract: This paper addresses the area of games based learning; it refers to digital mind games and explores what design and interface features best serve the educational purpose of enhancing reasoning skills, which are actually "key abilities", transversal to any kind of learning. The considerations at the core of the paper draw on a small-scale, long-term pilot research project aimed at fostering primary school students' strategic and reasoning skills by introducing the systematic use of a number of computer-based mainstream mind games in classroom activities.Taking for granted that the effectiveness of any educational intervention is primarily related to the soundness of the underpinning pedagogical design, in the framework of the above mentioned field study it was also demonstrated that the effectiveness of digital mind games to develop reasoning and problem solving skills is closely related to the game format and to some specific design and interface features (indeed, it was shown that different computer implementations of the same game have different degrees of educational effectiveness and impact).This paper presents concrete examples as a means to discuss which characteristics of mind games favor the development and the enhancement of reasoning skills. In particular those features that can support or, conversely, hinder students' cognitive effort are considered, since, during the field experience, the cognitive load required to perform the task appeared to be a crucial point: those mind games that provided a variety of functionalities and stimuli able to sustain and orient cognitive activities, appeared to be better suited to the intended educational purpose, while it also emerged that cognitive overload represents a significant obstacle to learning.While exploring the use of mind games to support the development of reasoning skills, in this paper emphasis is given to those considerations that can have a general validity for their selection and pedagogical use as well as for their design and implementation, in case they are to be used for educational purposes.

Keywords: Games based learning, mind games, reasoning skills, software interface, software design, primary education.

1. Introduction

Recently a growing number of teachers, researchers, and educators have shown keen interest in the use of digital games for education. On one hand, this research field appears to be promising: many authors acknowledge that such games have great potential to foster learning (de Freitas, 2006; Kirriemuir & McFarlane, 2004; Mitchell & Savill-Smith, 2004). On the other hand, the assumption that games can have a potential for educational aims, taken as such, is very generalized and the effective impact of games on learning is questioned (Hays, 2005).

The point is that many different types of digital games exist and, what is more, they can be employed for a variety of specific educational purposes (Pivec, 2007). In this respect, it appears necessary first of all to distinguish between entertainment games and instructional games. The former are designed and implemented without a specific educational aim, while instructional games (Garris, Ahlers & Driskell, 2002) are explicitly designed for training or to promote learning (Dondi & Moretti 2007), and adopt some of the characteristics of entertainment games to create engaging and immersive learning experiences aimed at reaching specified learning goals (de Freitas, 2006).

This paper focuses on entertainment games, in particular on mainstream mind games when used in formal educational settings with the aim of supporting the development of problem solving and reasoning abilities. Mind games, which are also called puzzles or brainteasers (Prensky, 2005; Schiffler, 2006), are not frequently studied from the point of view of learning outcomes (Facer, Ulicsak & Sandford, 2007) even though it is suggested that they can be used in schools to foster learning (Griffiths, 1996). On the other hand, while there is general acknowledgement that logical and reasoning skills can be developed by playing games (Kiili, 2007; McFarlane, Sparrowhawk & Heald, 2002), few research studies have focused on the use of mind games to this end.

The main aim of this work is to make a contribution to a research field which, to date, has not been fully addressed, namely that of the use of mind games to foster the development of reasoning and problem solving abilities in primary school students. In particular, in the following what features make mind games more or less suitable for this purpose is discussed. The reported considerations draw on a small-scale, long-term pilot research project aimed at fostering primary school students' strategic and reasoning abilities by introducing the systematic use of a number of computer-based mainstream mind games in classroom activities (Bottino, Ferlino, Ott and Tavella, 2007).

2. The research project

The above mentioned research project was carried out over a three-year period and involved around forty children aged from eight to eleven years; the research group comprised educational technologists, psychologists from the Local Health Authority and primary school teachers from the school where the experiment took place. The project was aimed both at shedding light on the cognitive abilities involved in the use of a selection of digital mind games and at identifying which design and interface characteristics make them more or less fruitful for the target educational purposes. This latter aspect is the one examined in this paper, while the analysis of the cognitive abilities involved in the use of mind games has been discussed elsewhere (Bottino and Ott, 2006).

2.1 Target population

During the project, a group of around 40 children belonging to two classes of the same age level was followed for three years while using digital mind games in computer sessions carried out during normal school hours. The student group, which remained almost the same during this period apart from a few new arrivals and withdrawals per year, was involved in the project from the third grade (age 8-9) up to the fifth grade (age 10-11).

2.2 Tools used

More than one hundred mainstream mind games (freeware, shareware and open source products) such as MasterMind, Minefield, Battleship, Domino, Labyrinths, etc… were analysed for the project and about thirty of these were actually used by the children during the experimental work during the three years. The adopted games can be ascribed to the category that Prensky (2005) calls "mini-games", that is "games that take less than an hour to complete (often far less), and whose content is simple and one-noted". These characteristics are important when the use of games is planned during school hours: other types of games can, in fact, require a substantial and prolonged time investment which stretches play well beyond the span of a typical single-class unit (Becker, 2007).Although belonging to the same category, the games used involved children in a wide range of different activities, and differed greatly with respect to the type of user interface, the modalities of interaction and the type and level of cognitive abilities required in order to reach the solution.

2.3 Experimental setting

The experiment lasted three years and took place over six months per school year. The students of each class were divided into groups of 5 or 6, with each group taking it in turns to attend a computer session of approximately one hour per week in the school computer lab, where each child had at his/her disposal a computer. Each child had the opportunity to play a number of different games and each game was used by the same child for more than one session and at different levels of difficulty. The children were engaged in repetitive play over time, thus tackling each game according to a multi-trial and multi-level approach. This allowed the involving of students in a game cycle in which the recurring judgment-behaviour-feedback loops can lead to better acquisition of target skills (Garris et al., 2002).

3. Methodology

During the work, each student was followed individually by a member of the research team, who had the task of observing the activity and intervening when necessary. For each student, and for each game session, quantitative data on individual performance were recorded by means of an observation sheet containing the observer's appraisal of: 1) student performance (score obtained, errors committed, etc.); 2) working approach adopted; and 3) perceived student attitude towards the exercise. The resulting data were basically rated on the basis of a Likert scale but the sheets also included free content and free style notes to be filled in by the observers. In particular, a specific section of the sheet contained specific indications about the perceived (from the observers' viewpoint) positive and negative elements of each game's features. The evaluation techniques adopted to analyse the experiment results basically follow the paradigm of "mixed research methodology" (Burke et al., 2007), they made, in fact, a combined use of quantitative and qualitative approaches and both quantitative and qualitative data coming from direct observation were considered.

4. Results

Each year, quantitative data on student performance and qualitative considerations of the observers were analysed both to inform the work of the following year and to obtain information on individual students' abilities and emerging problems. Bottino, Ferlino, Ott and Tavella (2007) report on the quantitative analysis of the results obtained. In this paper the results of the qualitative analysis of both structured notes and free-style considerations carried out by the observers are reported with the aim of shedding light on which characteristics make the games more or less suited for the learning purpose of supporting and improving the students' reasoning skills. The analysis of the compiled observation sheets showed that, from the point of view of the learning outcomes, the amount of cognitive effort required of students to perform the task (that is the amount of cognitive resources allocated) is a crucial point: it, in fact, largely affects students' motivation, attention, concentration and ultimately even their performance (Ott and Tavella, 2009). During the project, evidence was also gathered that a number of specific characteristics of the games can support or, conversely, hinder students' cognitive effort; in the following, those features that were judged to have both a general validity and a higher impact are reported.

4.1 Possibility of graduating the required cognitive effort

When a game is used to support reasoning and problem solving abilities, it is very important that the levels of difficulty correspond to the progressive deployment of such abilities.

During the project, one of the most frequently recurring remarks in the observation sheets was that greater educational effectiveness could be achieved if the software supported the learner to gradually develop those problem solving and logical abilities at the core of the playing activity. As an example, one of the observers wrote the following comparison: "let us imagine a student trying to climb a hill: proceeding straight to the top is much more arduous than following a zigzag of hairpin bends, where the slope from one step to another is very gradual".

Many mind games feature multiple levels of difficulty so that when one level is mastered, the player can move up to another that poses a greater challenge and therefore an incentive to continue playing. However, in some cases, the shift up might be too steep, calling for a considerably augmented cognitive effort.

Let us consider an example. The figures below show the screenshots of two different computer-based versions of the well-known game MasterMind. The first (Figure 1a) is taken from GMC MasterMind (Moerth, 2002), the actual version of the game that was used during the project, while the second (Figure 1b) comes from GnomerMind (Rizzo, 2000), an open source version of the same game that the research team customised following the suggestions that emerged from the experimental work.

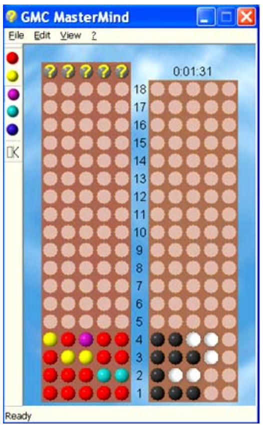

Figure 1a: GMC MasterMind

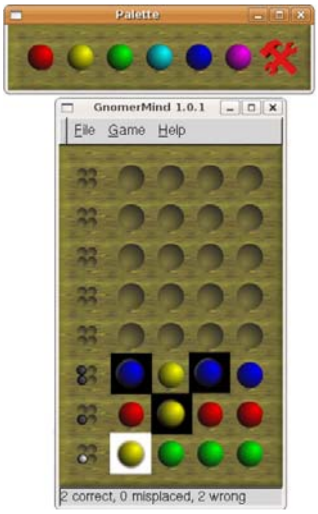

Figure 1b: Modified version of GnomerMind

The goal of MasterMind is to guess a sequence of coloured pegs that the computer has selected at random. The players start making guesses by filling the holes in the bottom row of the left-hand column (Figure1a) with coloured pegs chosen from the range available in the top-left corner. Each time a row is completed, the program gives feedback on the attempt in the right-hand column: a black peg means that the player has correctly positioned a peg of the right colour, while a white one means that a peg of the right colour has been chosen but it is not in the right place. Since the feedback provided by the program in Figure 1a does not reveal which individual peg colours/positions are correct within each attempt, the players have to figure this out for themselves. So, at each attempt, the players need to process all the feedback received up to a given point in the game in order to decide what to do next. GMC MasterMind can be played at different levels of difficulty by adjusting two different parameters: the number of different colours that can make up the sequence (in the example in Figure 1a, the five colours shown top left) and the number of columns (in the example, five). Observation revealed that there are other ways of providing more graduated support to users' cognitive activity, for instance by changing the type of feedback. With this objective in mind, our team produced a customised implementation of GnomerMind, an open source version of the game (shown in Figure 1b). In this modified version of the game, players have the option of having the program automatically display, after each attempt, exactly which one of the individual choices made are correct (correct position + colour = black box, correct colour only = white box). Correct pegs are also automatically placed in the next row before the player makes another attempt, a feature which has been suggested to sustain working memory. Furthermore, after each guess, additional feedback is provided both graphically (the small pegs on the left) and in written form (in the status bar at the bottom), and this also favours better understanding. .

In this new version of the game, the possibility of determining the type of feedback available represents a major opportunity for finer control of the cognitive effort required; during the experience, in fact, it clearly emerged that students, in particular those with specific difficulties, could benefit greatly from the possibility of adjusting the level of cognitive difficulty: this increased their willingness to be involved in the experiment and also led to better outcomes (Ott and Tavella, 2009).

4.2 Availability of hints supporting cognitive effort

While hints are often available in mind games, they do not necessarily provide any effective support or guidance for cognitive activity. Some games provide hints that simply take the game forward a step without making the user aware of the rationale behind the move. For example, in certain computer-based versions of Sudoku, the hint provided consists in a correct number being placed on the board. This may help players proceed, but, in general, it does not help them to improve the strategy applied.
The difference in hint value is clearly illustrated by two games that were used in the project, Tree Tent (Yoogi Pvt Ltd, 2003) and Hexip (Yoogi Logic Games, 2003-2004). Despite broad similarities between the two (shown respectively in Figure 2a and Figure 2b), they provide different hints that give a different level of support for cognitive activity.

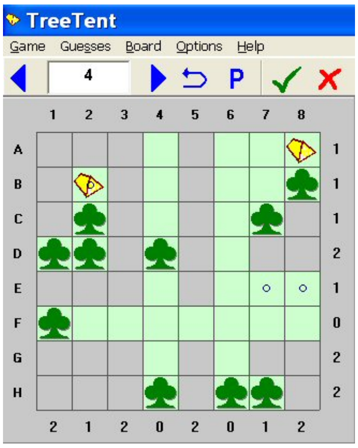

Figure 2a: Screenshot of TreeTent

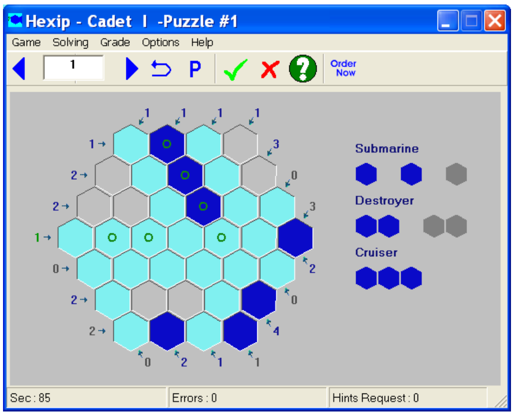

Figure 2b: Screenshot of Hexip

Both games require the user to place objects (tents for TreeTent and ship segments for Hexip) in a grid by using available information (numbers outside the grid, corresponding to the number of objects contained in each row). The respective help functions differ greatly: Tree Tent only provides information about the game and general advice about possible solving techniques, while Hexip provides well focused explanations that refer to the game situation at hand, as described hereinafter.
Hexip is a battleship-type game whose goal is to find the position of ships hidden on a hexagon-shaped board (Figure 2b). The game provides information on the number of boxes occupied by ships along both the horizontal and diagonal rows of the board (numbers outside the hexagon). The player can make inferences on the content of each box by filling it either with a light colour (no ship) or with a dark colour (ship-segment); when doing so a small pellet appears in the box. Clicking on the tick in the toolbar validates the player's inference. If the inference is correct, the pellet disappears, otherwise the system provides an error warning. Figure 2b shows a game situation in which the player has already correctly positioned four ships using the information available on both the horizontal and the diagonal rows. This is a crucial point because placing other ship-segments in the right position is not easy with the available information. The player may well get stuck and so decide to ask for help.
When the question mark button is pressed, Hexip provides a suggestion as shown in Figure 3.

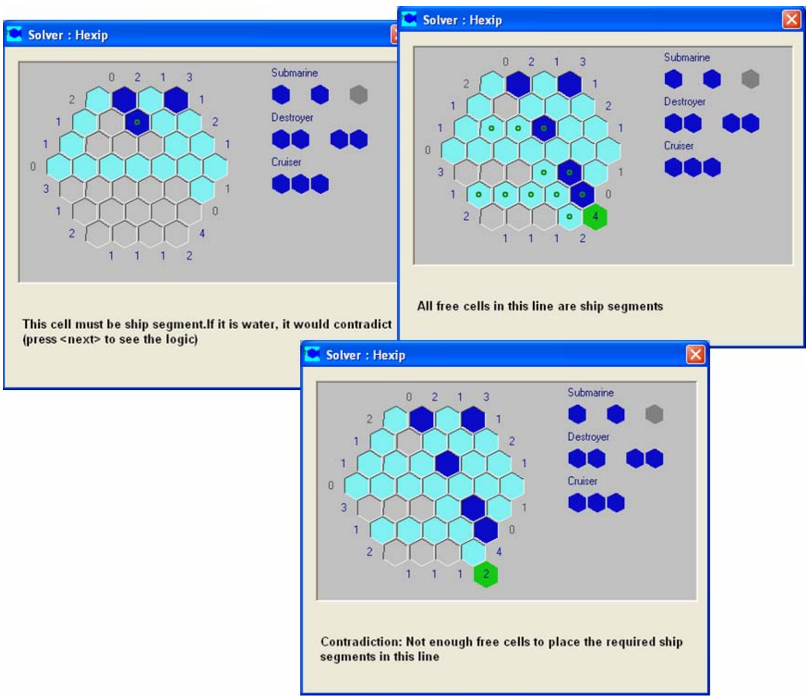

Figure 3: Screenshots of the game Hexip showing the help function

The program calls this hint function "Solver" but, as well as providing a step toward solution, it also explains the logic behind the move. Thus, it steers players, step by step, to the solution by supporting them in the development of more complex reasoning strategies; during the experience this game feature (that was basically used under the supervision of the teacher) was considered particularly valuable and useful to better direct students' efforts.

4.3 Availability of interface features supporting cognitive effort

In order to favor the development of reasoning skills, the game interface needs to have features supporting the reasoning process entailed in performing the task. This means, for example, that the interface should help the player to remember the rules and/or constraints of the game. This is true in the case of the Hexip game, where the fleet to be placed on the board is shown on the right of the screen, with ships already correctly placed displayed in grey (Figure 2b). Thus the interface helps the user to concentrate on the task, providing, at any moment, a clear picture of the current situation.
Conversely, it is equally important that the interface does not needlessly increase the cognitive effort required to solve the task (Mayer and Moreno, 2003). TetraVex (a game that was originally available in Windows Entertainment Pack 3 and that is now also available as an open source game on the GNOME desktop) is a case at point. This domino-like game is played with tiles that are divided into four triangles each marked with a number from 0 to 9 (Figs. 4a and 4b). The goal is to drag the tiles in the right-hand board into the left-hand board and position them so that any two adjacent tile numbers are the same.

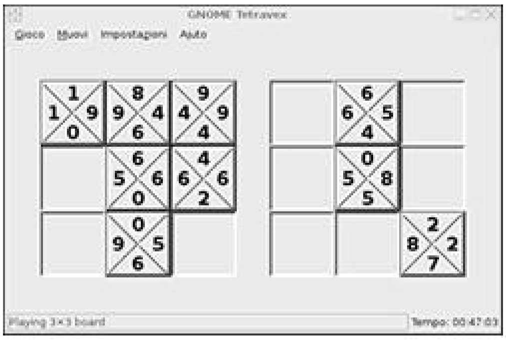

Figure 4a: Screenshot of Tetravex

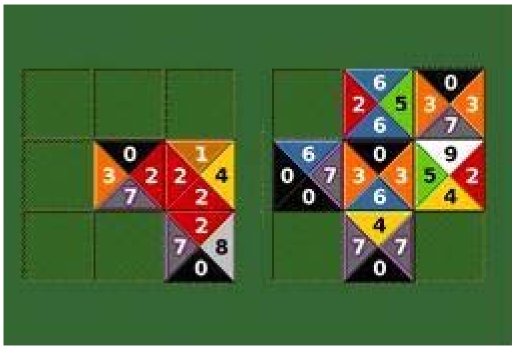

Figure 4b: Screenshot of the coloured version of Tetravex

Tetravex has difficulty levels that range from the easy (two-by-two boards) up to the very difficult (six-by-six boards). At the easy levels, the game can be solved through a trial and error strategy but as the difficulty increases with a higher number of tiles to be placed, this approach appears inadequate; it becomes necessary to conceive a solution strategy and apply it correctly, even though this might be quite demanding in terms of attention and effort. One of the possible solving strategies is to consider all the numbers in the upper triangle of each tile and comparing these with those in the bottom triangles. If the numbers in the upper triangles do not match any of the numbers in the bottom triangles, this means that the corresponding tiles have to be located in the topmost row of the left board. The same reasoning can be repeated for the numbers in the left- and right-hand triangles of each tile in order to establish the right position of each tile in the row, and so on. Once some border tiles have been positioned, the task becomes easier because it is possible to position subsequent tiles simply by matching the numbers.

Figure 4a presents a screenshot of the original black and white version of the game that was used during the project. Since students were observed to experience significant perceptual difficulty during the game, a new coloured version was found (Rydlinge, 2007) that provided better perceptual support to enact an effective solution strategy (Figure 4b). The cognitive task and the reasoning behind the solution is exactly the same in the two versions of this game but the coloured interface diminishes the perceptual effort, thus allowing the user to concentrate on the reasoning process to be enacted.

4.4 Presence of facilities steering cognitive effort towards verification activities

One of the crucial activities in problem solving tasks is verification of what has already been performed, that is, looking back and reviewing the work done. During the project it emerged that this approach was not commonly adopted by students who seemed not to be accustomed to verifying the accuracy of already accomplished steps or of the given final solution (Pugalee, 2004; Schoenfeld, 1985). In the great majority of cases, they are not aware of the importance of verification and need help in finding the proper mechanisms to evaluate what they have already done. According to Lee and Hollebrands (2006) "these mechanisms may be influenced by the features made available in technology tools".

As pointed out in some observation sheets, it is important that the game interface makes specific resources available to foster reflection that can result in control activities.Games of different types induce and support the verification process in different manners. For example, in games like MasterMind or Hexip it is supported by the fact that, thanks to the interface design, each move has to be confirmed before being accepted by the program (thus also generating feedback). For example, observers pointed out that the need to press the validation tick in Hexip (Figure 2b) inserted a gap between moves and feedback, thus encouraging students to look back on what they had done. In GMC MasterMind the "OK" button (a non-standard feature of the game which needs to be set before starting) performed the same function.

An example of game design oriented to support verification can be found in the well-known game Mine-Sweeper (Ivanche Company, 2006), where mines can be positioned tentatively by using the symbol "?" (Figure 5) and subsequently confirmed after mentally checking the appropriateness of the guess.

Figure 5: Screenshot of the game Minesweeper

During the field experience it was shown that developing a specific attitude toward verification (in particular "in itinere verification") concretely guides students to decompose the task at hand into simpler sub-tasks, thus also helping him/her to better focusing cognitive activities and, quite often, to reaching the game solution more easily.

4.5 Customization facilities to avoid interferences with the main cognitive task

During the project there was general agreement among the observers on the need for students to focus on the main game task without distraction from other events, information, constraints, etc. (even if such features could be interesting and amusing for them). For example, the need to perform a task within a strict time limit could represent a major difficulty, particularly at the age level under consideration, thus hindering the reasoning process. The Pathological game (Gignac, 2003) is a case in point. This is a puzzle game consisting of marbles and wheels. The marbles are of different colours and roll along paths. Each wheel has four slots which are to be filled with marbles of the same colour: to do so, the user clicks on the wheel to rotate it. When the wheel is completed, the marbles vanish and the wheel turns dark. Pathological is organized in progressive difficulty levels that correspond to different schemas. The aim of each level is to complete all the wheels in the schema (see two of these in Figure 6) within a fixed time. In the standard version of this game, the time constraints (shown in the blue bar on the left) play a major role and could be a serious obstacle in properly performing the reasoning behind task solution. Accordingly, an attempt was made during the project to overcome this problem by adjusting some game parameters related to time constraints. This was not directly possible through the interface, but required modifications to the open source code.

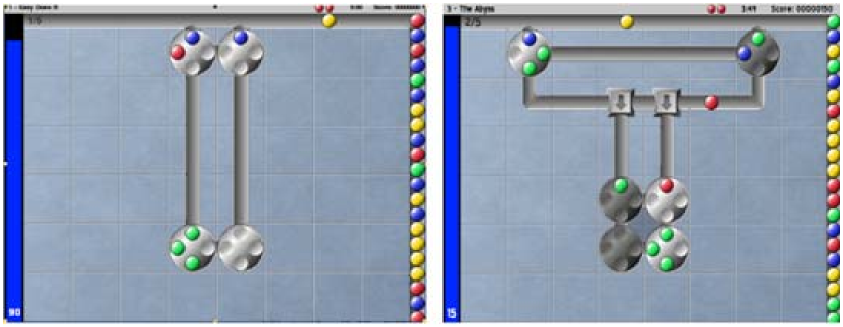

Figure 6: Two Screenshots of the game Pathological

The possibility of code modification also allowed a high degree of customization of the game difficulty levels: the order of the schemas presented was changed following the idea, explained above, of properly graduating the level of difficulty, also by repeating, when necessary, some schemas. When this customized version of the game was used by the students in the project, the observers found that the changes made had significantly improved the game usability and increased its effectiveness on students' reasoning abilities.

5. Conclusions

Drawing on a long-term experimental project, this paper has proposed and discussed some characteristics of mind games that make them better suited for fulfilling the educational aim of fostering reasoning skills. Future specific investigations will, hopefully, explore whether there are grounds to consider that the research results obtained can be considered as having a more general validity in the field of games-based learning. Nevertheless, even in the specific field of mind games and reasoning abilities, the positive features that have been briefly sketched out above do not claim to be exhaustive; a number of other relevant aspects should be taken into account before deciding to employ games for educational purposes. Comprehensibility and ease of use are also two key aspects: games should, in fact, be appropriate for the age level under consideration and clearly understandable (especially for new players), they should, then, be governed by a set of rules that are both well defined, simple to understand and easy to put in practice.

The presence of performance measures (namely both measures of player's performance at the end of each playing session and on-going recordings of performances), which is, no doubt, relevant for teachers in that it provides the proof of what students have done (Becker, 2007) also plays an important role for students: it supports their metacognitive attitudes by stimulating self-evaluation, contributes to the awareness of the soundness of the reasoning adopted and also, to some extent, increases motivation. Last but not least, the game should really offer the possibility of taking advantage of one of the most evident aspects of computer game play, that is the fact that they lead to increased interest, enjoyment and involvement (Garris et al, 2002). It should, then, offer a reasonable degree of challenge (Ang, Zaphirisand Mahmood, 2006), it being understood that users should not perceive the role of luck as predominating over their own effort (Dondi & Moretti, 2007).

The considerations outlined in the paper may prove useful to those with the task of designing and implementing educational games, but should primarily be seen as a contribution to support teachers and educators (including parents) interested in making an effective choice among the wide variety of existing mind games.

The educational effectiveness of games, of course, is not simply a matter of choosing the right product; it is also strictly linked to the way it is used, and to the underpinning educational / pedagogical design. The teacher's role is crucial at these ends: the classroom game use, indeed, needs to be backed by other activities that are also to be orchestrated by the teacher (students' verbalisation of the solution processes enacted, classroom discussion of the difficulties encountered, comparison of the different strategies adopted by the students, etc). In particular, the teacher has to define the specific aim, context and modalities of game use, also including, if needed, specific customizations (e.g. setting difficulty levels, deciding on help available to students, configuring interface constraints), which also goes in the direction of building individualized itineraries better suited to each student's specific needs.

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Purposeful Problem Generation in Simulation Games - an Approach to Extend the Target Group of Complex Simulation Games in Engineering Education

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Abstract: Understanding and overseeing complex, interdisciplinary planning correlations in engineering is a difficult task; mastering them is an essential key to successful engineering. Nevertheless discussion of didactic approaches to mediate the necessary skills is quite new to engineering education. While there are implementations of alternative learning methods here and there, a media-compatible integration within the scope of e-learning has been developed only partially. Existing educational software and application of conventional software cover always only parts of the demands on alternative learning scenarios. Contemporary computer games seem to overcome these limitations offering situated learning in authentic contexts. In the course of a literature research today's demands on engineering skills, as well as didactic approaches to achieve them, have been determined. An important aspect here is the differentiation into targeted learning of scientific engineering fundamentals and the complex interrelations in advanced engineering. To transfer these approaches to e-learning, contemporary software and its suitability have been examined and compared to the educational aspects of computer games. While computer games combine the advantages and compensate the disadvantages of existing software, they mean an enormous effort of development facing specialised and rather small target groups. This paper outlines an approach to focus certain problems within the simulation core of a computer game. Making them accessible for targeted learning of engineering fundamentals. Using knowledge structure maps, activity of the underlying interactive structure can be guided to the generation of purposeful problems. This way complex simulation games cannot only be applied in graduate but also in undergraduate engineering courses.

Keywords: Educational use of simulation games, Engineering Education, Engineering Skills, situated learning, Ill-structured problem solving

1. Demands on engineering skills and didactic proposals to achieve them

During the last decades the demands on engineers have evolved heavily. The rapidly advancing technology had initially led to an increasing number of specialist areas, fragmenting the different disciplines in engineering. Today's demands have reverted to an integrated view of engineering. Engineers are not only supposed to deliver their special knowledge but to integrate it within interdisciplinary collaboration processes. This requires the ability of systemic thinking and makes the design of complex systems the core of all engineering activity (Hedberg 2001). A deep understanding of these systems (Bréchet 2001) as well as a broad scientific and mathematical knowledge are the keys to cope with the ill-structured problems emerging during the design and implementation process and to develop creative and advanced solutions (Redish & Smith 2008; Mills & Treagust 2003; Reuber & Klocke 2001). Furthermore soft skills like communication, collaboration, management, etc. are needed to accomplish this in distributed, interdisciplinary environments.

Despite these comprehensive changes on the demands of engineering skills, engineering education has not changed notably for more then six decades. Instructional classes with abstract concepts and problems, detached from real world settings still predominate (Lang et al. 1999; Rugarcia et al. 2000; Felder 2002). Compared to medical education where more student-centred learning methods have been developed and evaluated since the 1950's (Skelin et al. 2008) and influenced almost all medical curricula around the world (Aretz 2003), the discussion and implementation of alternative learning methods is quite new to engineering education. Only in the end of the last century educators started to propose changes from common instructional teaching to more student-centred methods. These can be condensed under the concept of situated learning. While situated learning is more a learning aspiration than a method, it demands didactics of self-activity and self-determination (Reich 2006) and implicates the use of authentic contexts to present knowledge in an environment of social interaction and collaboration (Lave & Wenger 1991). Several empirical research studies have shown the effectiveness of these methods to achieve the desired results in engineering education (Rugarcia et al. 2000). Phenomenological observations (Redish & Smith 2008; Hedberg 2001) as well as constructionist science support this point of view (Gerstenmaier & Mandl 1995) and stress the importance of authentic learning environments to attain knowledge (Baumgartner & Payr 1999).

But in contrast to the approved implementations of these methods in medical education, educators demand adapted approaches for the different steps in engineering education. They distinguish between scientific fundamentals during basic and relational knowledge in advanced studies. Fundamental scientific knowledge is considered as a primarily hierarchical structure, that is: Concepts depend on each other and missing or misunderstanding one might prevent the understanding of following concepts; Mediation happens in a targeted way. Methods used in this stage of engineering educations should give enough guidance to prevent gaps and misunderstandings but they should give authentic contexts to apply this knowledge to and to understand its relevance. Graduate students also need authentic learning environments but in a more immersive way and offering a high degree of freedom. The primary goal is to grasp the interrelations of scientific concepts and their relevance in design and planning processes. They need to get accustomed to the ill-structured composition of problems and the high variance of possible solution processes. An appropriate solution proposed to implement these ideas is the use of project-based learning methods. They are supposed to reflect the collaborative and interdisciplinary processes of engineering work (Mills & Treagust 2003; Felder 2002).

The biggest obstacle to implement such authentic situations for both undergraduate as well as graduate studies is developing appropriate problems. It means a much higher effort to design a problem and oversee its learning outcome and the cost to get there, instead of lecturing theoretical concepts and training the concerning equations (White 1995; Reich 2006).

2. Today's software solutions – chances and limits

While implementations of student-centred methods have been successfully approved in conventional learning environments, the implementation in the field of e-learning is rudimentary. Educators can draw on different solutions to implement aspects of situated learning in e-learning scenarios, but despite their advantages they all have limits; limits that seem to originate from the still predominating instructional approach of implementing education in e-learning environments. This becomes obvious in the numerous developments of tailored e-learning tools in engineering education: Simple and sophisticated animations to visualize dynamic interrelations and partially interactive and small programs for calculation and simulation to allow a delimited application of theoretical knowledge (Clemens et al. 2000; Mehra & Sedlbauer 2004; Gorges et al. 2007). They are suited to complement instructional courses, either in classroom courses or similarly structured e-learning courses to enrich common explanations or exercises. Without this external stimulus they are of little use as a motivating environment for self-regulated learning.

Within the evolution of problem-based learning in medical education authoring tools have been developed that aim at this problem. They use so-called branching stories to embed exercises into a rich, interactive context that allows different courses of action. Depending on the software, these contexts can be set up using multimedia descriptions of situations (e.g. Soon Trainer (Dannenberg & Seitz 2008)) or sophisticated 3D environments (e.g. Thinking Worlds (Brannigan 2009)). But every possible solution, every wrong track and every blind alley has to be prepared in advance. The user can only interact within this prefab structure and at designated stations. That is, interactivity is confined to rather simple conditional branches. The wide range of scientific solutions applicable to a physical model cannot be depicted.

Simulations are the usual tools in engineering to examine the wide range of possible problem solutions but scarcely as training simulations (Freitas 2006). Developed as planning tools to predict or analyse the behaviour of physical systems they are also used during graduate studies. Using highly developed simulation cores they allow calculation of virtually random variants to approach the best solution. In turn this *best solution* usually is a compromise, depending on technical and non-technical circumstances in a wider context. Something a simulation cannot provide. Moreover it requires an endeavour of initial training to master the practical use of the software itself and extensive supervision to develop and maintain an appropriate problem with its context.

A combination of both approaches seems to be the synthesis to accomplish the didactic demands for situated learning scenarios: problem-based learning software to deliver the context and simulations as planning tools within these scenarios to allow dynamic calculation of physical models. But apart from adjusting and synchronizing both parts they are lacking appropriate functions for communication and collaboration; An essential requirement for distributed teams in distance education.

3. Simulation games and obstacles of implementation

Software that already integrates both approaches are actually many computer games. Aside from incorporating many of "fundamentally sound learning principles" every good computer game offers an authentic and motivating context (Gee 2003). Lots of them, especially simulation games, use complex dynamic calculation cores to allow a high degree of interactive freedom. They create a simplified but consistent microworld. The player interacts with and within this world: Through action and reaction he explores the underlying rules and interrelations of this system, developing a deep understanding of it (Aldrich 2004). This correlation of a dynamic model and user interaction provides the basis for creating different variations of a problem and variable solution processes; Problems do not have to be developed 'externally', they develop out of context, given goals and/or the individual aim of the player. All this is forming an immersive environment and generating intrinsic motivation. Such a game actually combines the necessary elements to model complex, ill-structured situations, necessary for training the demanded engineering skills. The multiplayer aspects of massively multiplayer online games (MMOG) and their functions for communication and collaboration even show ways to integrate social aspects of learning.

During the last years there has been an increasing development of and research on educational games; In the area of engineering for example *Mobility (Kraus et al. 2001)*, *DeinTown* (Harder 2005) or *Supercharged!* (Squire et al. 2004) have been developed. They deal successfully with the simulation and mediation of scientific contexts. A problem they are all facing is the limited target group and financial funding of such projects. Commercial educational games aim at the broadest educational target group that are usually K-12 students. Functionally specialised projects depend on public funding and sponsoring, as they cannot be refinanced out of later sales. This, the low significance of teaching and educational research in engineering (Rugarcia et al. 2000) and the difficulty to oversee such a development process prevents a broader development of educational games and moreover games to teach advanced skills in this discipline. The problem of an initial funding cannot be solved but the ratio of effort and benefit can be improved. One way of doing that is to find ways to widen the target group. This can be achieved because of the fact that an immersive educational game would actually contain all basic aspects of discipline. It just connects them, depicting their correlations and embedding interdisciplinary connections, to create an authentic context. All basic aspects are embedded within such a complex interactive structure. The problem is to focus and isolate the single aspects for use in undergraduate studies.

4. Focussing situations within simulation cores

The isolation of single problem cases can be achieved by reprogramming the calculation core of the simulation game. By delimiting the relevant equations and parameters, problems can be generated purposefully and they can be isolated from the simulated system. *Mobility*, a traffic simulation game with a scientific base, makes use of this technique. After its development it turned out to be too complex and time-consuming to make use of it in the classroom. While it offers an authentic context and intrinsic motivation to explore the rules of traffic planning, it cannot be utilized to accompany classes. From these experiences *DeinTown* was developed, building upon the simulation core of *Mobility*. It offers a collection of prefab cases that concentrate on certain aspects of traffic planning. They are computed with the simulation core but it is delimited to the corresponding problem.

This kind of hard programmed perimeter of a simulation implies that teachers have to adapt their lessons to the existing scenarios as they can only draw on those prefab scenarios. To implement individual scenarios, adjusted to the ideas and methods of the teacher, there is always the need of a programmer. For a broad application of this functionality in education, a solution has to be developed to lower this technical threshold. The interactive structure controlling the simulation game needs to be made accessible in a user-friendly way. Focussing upon individual cases needs to be possible for the particular expert of a discipline without having to work on programming level. This requires a transformation of the respective technical terminology the expert works with to the information-technical implementation of the simulation core. Hereafter, an approach is outlined that offers an intuitive approach for the purposeful problem generation within simulation games.

5. Approach for purposeful problem generation in simulation games

Within a simulation's complex interactive structure a case study is modelled as a choice of initial values that fluctuate under certain constraints and scientific rules within a specific range. Parameters that are linking to other areas and considered to be irrelevant for that case are muted. That means results of those links are not cared about and do not affect the result. The definition of the actual problem develops from one or multiple values that exceed or fall below a defined target area. To control these values and direct them to the target area the user has to influence the relevant parameters. So within the simulation's structure specific, detailed settings have to be undertaken to create useful problem cases.

Within the knowledge structure of engineering, parameters and equations are simply the lowest and most detailed level. They are virtually attached to certain key concepts that are again linked to a superordinate level. With this in mind the root concept of a discipline contains all equations and parameters of the system (Figure 1). Advancing through the structure, from general to more specific concepts, means a more specific limitation of this system. Every conceptual specification narrows the amount of depending equations and parameters (Figure 2).

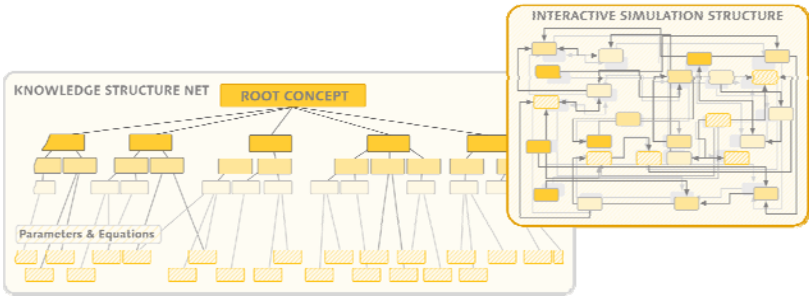

Figure 1: The root concept of a discipline contains all concepts and parameters of a system concerning the simulation core it means to activate its complete interactive structure

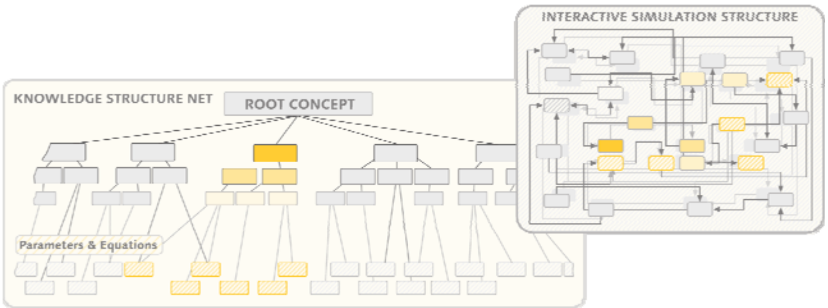

Figure 2: Selecting a specific branch within the knowledge structure activates only the depending parameters and equivalent regions within the interactive structure

As these parameters and their interrelations also form the complex interactive structure of the simulation – its core – both sides can be virtually attached to each other (Figure 1+2). Advancing through the knowledge structure would mean then to confine the activity of the simulation core. Equations apart from the selected branch remain intact but are muted. Concerning the construction of a case study the value of the corresponding parameters stay within their target area. Parameters within the selected branch are triggered either through the superordinate concepts or a detailed selection that permits fluctuations of their range. That means the knowledge structure map of a discipline is a first approach to a user interface for isolating problem cases

The activation and deactivation of equations and parameters within the simulation's interactive structure does not yet result in problem cases. They remain abstract without an object and context for application. To create a context the parameters have to be located and linked with a defined model of the system. This allows to draw on appropriate constraints. For example the equation to calculate the heat transmission of a building component remains abstract until it is applied to a specific component and necessary constraints, as for example inside and outside temperature. As an applied science, engineering needs a combined approach to design relevant case studies. On the one hand the conceptual knowledge structure of a discipline, on the other hand a practical model to apply these concepts and underlying equations to. This practical model is of concern on various levels and delivers the context for the equations' application. These different points of view follow the usual levels to design a complex system within the appropriate discipline in an approach of wide and narrow planning processes. In the area of building physics such levels could be: The building as a whole, zones of the building, single rooms, building components or materials, etc.

The combined use of the scientific knowledge structure and a paradigmatic model allows generation of random but useful problem cases. As the equations, chosen through the scientific concepts, are applied on a model, they can be embedded into a context. Linking the elements of both interfaces could already activate or deactivate relevant or irrelevant areas after choosing specific parts.

With this approach case studies are not torn out of their context. Even though calculable links to other equations are muted, the correlations can at least be indicated. The knowledge structure map in combination with a paradigmatic model allows teachers to isolate problem cases in their own terminology. In contrast to programming solutions this allows a more intuitive and timesaving method to construct case studies, utilizing the existing authentic context of a complex simulation game. Then such a game cannot only be used for advanced students but offers the chance to be used from the beginning of engineering studies.

6. Conclusion

Simulation games include the technical and didactic basis to train the skills demanded from engineers: They provide an authentic context and the dynamic calculation structure to depict and train typical ill-structured situations in engineering. Making use of communication and collaboration functions they could even embed distributed interdisciplinary teamwork, integrating the social aspects of learning. They bring along an immersive learning environment that facilitates intrinsic and self-regulated learning.

To foster a broader development of educational computer games in engineering, the obstacle of high and difficultly manageable development expenditures has to be lowered; the ratio of costs and benefit has to be improved. Strengths developing isolated, single aspects have to be joined and combined results made accessible to the widest possible target group.

Focussing problem within the complex interactive structure of a simulation game is only one side to achieve this goal. An extensible framework can lower efforts in development. Aspects of a discipline could be implemented in manageable steps. Modular simulation software in engineering shows successful ways to improve and extend this basis over decades. Transferring these conceptions to computer games would allow to develop all aspects of a discipline in manageable steps.

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Designing Serious Games Using Nintendo's Wii Mote Controller for Upper Limb Stroke Rehabilitation

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Abstract: Given the fact that most current stroke rehabilitation systems employ relatively sophisticated or expensive hardware and software, one question of paramount clinical importance is whether the benefits obtained from these systems can be obtained with less sophisticated affordable systems. What now needs to be explored is the rehabilitation potential of commonly available computer games. Although commercially available platforms lack specificity in terms of software, hardware and performance metrics they often provide other equally important advantages such as mass acceptability, easily perceived feedback and most importantly affordability for unrestricted home use. Our solution is the development of a low cost rehabilitation glove using the capacity of the Infrared Receiver on Nintendo's Wiimote to pick up the signal from four diodes placed at the patient's fingertips. This compensates for the inability of previous low cost solutions to track fine motor skills. Four diodes per glove are used as it is only possible to track that number of separate Infrared Signals per Wiimote. Six initial games have been developed which elicit a range of rehabilitation movements from patients wearing these data gloves. Each movement is typical of those required in stroke rehabilitation and the receiver reads these signals and maps these movements onto game responses. This rehabilitation system will be tested using a randomized control trial with intervention and matched control groups compared on changes from baseline to post intervention. Sixty patients will be tested who range between 18 and 85 years, who have had a stroke, and are no longer receiving any other therapy. This rehabilitation system is designed to work with games that elicit the real rehabilitation movements that stroke patients have to perform many times. It is hoped that the patients in our study find these games engaging so that these repetitive exercises are more enjoyable to perform and that the system has a measurable clinical effect.

Keywords: Wii mote controller, upper limb stroke rehabilitation

1. Introduction

Stroke is the third most common cause of mortality and the leading cause of long-term disability worldwide (Mackay & Mensah, 2004). Of those who survive, approximately 75% regain their ability to walk again, however a considerable proportion ranging from 55% to 75% fail to regain functional use of their impaired upper limb (Feys et al., 1998). Upper limb motor impairment limits the individual's functional autonomy and activities of daily living. In the UK the National Clinical Guidelines for Stroke recommend rehabilitation which focuses on "participation" and includes planned withdrawal of medical and rehabilitation services and substitution with leisure and social activities that encourage independence and reintegration to normal life (RCP, 2004). However, access to further rehabilitation is often difficult to achieve after hospital discharge, due to cost, distance and availability of rehabilitative services (Reinkensmeyer et al., 2002).

One approach to maximise the intensity and convenience of task specific rehabilitation training is the use of Virtual Reality (VR) rehabilitation (Dobkin, 2004). This could provide the early intensive (Kwakkel et al., 2004) task specific (van Peppen et al., 2004) practice for a sufficiently prolonged period of time (van der Lee et al., 2001) to facilitate motor recovery. It could also incorporate various forms of augmented feedback which have been considered to be particularly effective in enhancing the acquisition of motor skills following stroke (Van Dijk et al., 2005).

Preliminary research in the use of VR in stroke rehabilitation focused primarily on examining the feasibility of complex VR systems that provide the participants with different types of augmented feedback and different VR rehabilitation protocols for acute, sub-acute and chronic stroke patients (e.g., Merians et al., 2002). Although this work mainly involved small sample sizes it suggested promising trends, triggered the active exploration of telerehabilitation applications (e.g. Broeren et al.,

2004) and has been followed up by studies involving bigger sample sizes (Holden et al., 2007) and small controlled clinical trials (e.g., Piron et al., 2006, Crosbie et al, 2008). This later work established the feasibility, health and safety of VR stroke rehabilitation systems and indicated that previously obtained positive outcomes were not attributed to spontaneous recovery (Holden et al., 2007). Neuroimaging studies also demonstrated that VR training can induce cortical reorganization following stroke (Takahashi et al., 2008).

Most of the systems used in these studies employ relatively sophisticated or expensive hardware and software which requires expert technical support and that the patients attend the laboratory or clinic. These drawbacks may be avoided through the use of commonly available VR platforms and games. Although some of these platforms and games lack specificity, they can offer other advantages such as mass acceptability, easily perceived feedback and affordability for unrestricted home use. In addition some of these platforms and games share similar characteristics to their higher cost predecessors. For example, they take an egocentric perspective combined with a virtual representation of the hand and this further enhances the potential to facilitate improvement through activation of relevant motor areas of the brain (August et al., 2006).

2. Wiimote rehabilitation glove

Our solution is the development of a low cost rehabilitation glove using the capacity of the Infrared Receiver on Nintendo's Wiimote to pick up the signal from four diodes placed at the patient's fingertips (Battersby, 2008; Barker, 2009). This device will be used to track patients' movements interacting with serious games, and it will be these games which elicit accurate rehabilitation movements required after stroke.

The decision to use 4 diodes per glove is based on the capacity of the Infrared Receiver used to pick up the signal from the diodes (the Wiimote).

2.1 Multiple Wiimote implementation

With the use of 2 Wiimotes, it is possible to triangulate the position of a single Infrared source and produce a set of 3D coordinates. As the Wiimote has no memory of the LEDs it sees and lacks any indexing of Infrared sources or synchronisation between multiple devices, it is critical to tackle these factors.

Iocchi (Iocchi, 1998) outlines calculations to triangulate a position with either parallel cameras, or non parallel cameras. The parallel camera technique has been adopted for the triangulation calculation in this project and can be summarised as below:

Z = (b * f) / (x1 - x2)

X = x1 * Z / f

Y = y1 * Z / f

Where **f** is camera focal length and **b** is the distance between the two cameras.
Other researchers have also used these techniques to implement a system which allows interaction using the Wiimote within a CAVE (Collaborative Virtual Environment) aimed at creating a novel interaction method (Murgia *et al*, 2008).

2.2 Infrared indexing

A potential limitation is that the Wiimote has no indexing for the Infrared sources it is tracking. As illustrated in Figure 1, the indexing of the sources can be different across the 2 camera receivers. This will make triangulation of the sources inaccurate if literal infrared sensor values are taken, for example, Wiimote 1: Sensor 3 and Wiimote 2: Sensor 3. It is possible that these 2 Sensors are actually looking at different sources and therefore performing the triangulation calculations would yield inaccurate results. A solution to this problem is to take the raw data from the Wiimote and order them in ascending values along the X plane. The lowest value of X in Figure 1 would relate to the thumb source, the next X value would be the index finger source and so on. Storing these sorted values in a custom class along with the original sensor index value will eliminate this limitation, and the sources can be accurately triangulated.

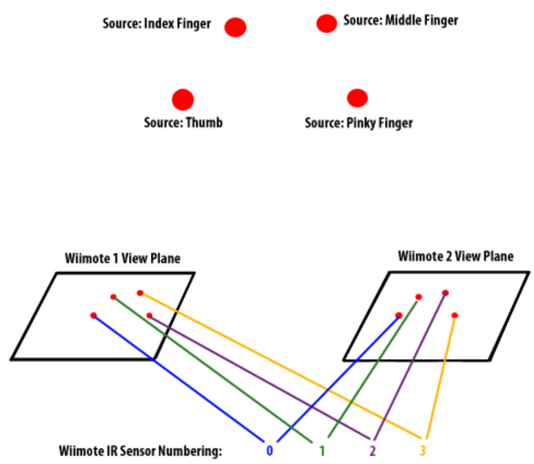

Figure 1: Graphical representation of the IR indexing problem

2.3 Positioning the diodes

Using 4 diodes per hand means that one finger cannot be used for interaction with the system. The decision to omit a diode from the ring finger was arrived at because the ring finger is the hardest to move individually without moving the other fingers at the same time. This could potentially have adverse affects on the accuracy of data recorded.

2.4 The electronics

A prototype device was created using 4 SFH409 GaAs Infrared Emitting Diodes. Each diode was soldered to a resistor rated at 220Ω (220 Ohms). This resistor value was decided upon when the decision was made to use one or two batteries per glove as a power source. Using Ohm's Law the resistance required could be calculated. Two 1.5V batteries (or a single 3V battery) are acceptable as a power source so the required resistance can be calculated. The current capacity of this model of diode is 100mA (milliamps), however for experimentation purposes, a diode current of roughly 15 mA would be sufficient. Therefore, the resistance required to place in series with the diode to limit the current to 15mA would be 200 Ω. The closest available resistor value to this (available in multiples) was a 220 Ω resistor, and used to limit the LED current. Using this resistor value, the current the diode would draw can also be worked out (again using Ohm's Law).

Testing was carried out with multiple voltages to determine the minimum rating that could be used to run a single diode. A single 1.5V battery (AA) was enough to power the glove of 4 diodes. However, each glove has a battery pack attached that will produce 3 volts from 2 AA batteries. This gives the glove a longer life span and a strong signal which will improve the responsiveness and accuracy of the system. Including more batteries than this, e.g., 6V would mean that 4 batteries were required per glove, and this would seriously impact the usability of this device for users recovering from stroke. Figure 2 shows an image of the glove, and Figure 3 the glove circuit diagram.

Figure 2: Prototype glove device

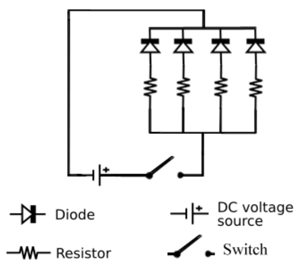

Figure 3: Glove circuit diagram

3. Games design

3.1 Movements critical to post-stroke upper extremity rehabilitation

Of paramount importance is a review of the accurate rehabilitation exercises recommended after stroke, and the mapping of these onto appropriate games design that will elicit these movements tracked via our Wiimote-based rehabilitation glove. These movements and exercises were supplied by researchers at the University of Ulster (Crosbie, 2008). These movements and exercises are summarized below:

Movements critical to post-stroke upper extremity rehabilitation:

- Pick up, Grasp, Release objects of different shapes, sizes, weights and textures.
- Hold and Transport objects from one place to another.
- Move objects within the hand.
- Manipulate objects for specific purposes.
- Reach for objects in all directions (sitting and standing)
- Using two hands to accomplish specific tasks:
- One hand holding, one hand moving.
- Both hands doing the same movement.
- Each hand doing two different movements.
- Throwing and catching actions to gain hand eye coordination and action timing.

Manipulation and Dexterity Practice:

- Tapping exercises.
- Hand cupping tasks to train opposition of the hand.
- Pick up objects and place on various targets
- Pick up objects between thumb and 4th/5th finger.
- Pick up small objects from inside a cup.
- Pick up a piece of paper from opposite shoulder
- Pick up pencil, put down and turn anticlockwise to point in opposite direction(s).
- Stack dominoes.
- Pick up and hold saucer or lid using “Spider grip” (all fingers stretched out as far as possible).

The following games have been designed to elicit the movements critical to post-stroke upper extremity rehabilitation and tracked via the Wiimote-based rehabilitation glove (Barker, 2009).

3.2 “Lights off”

This game elicits the following exercises:

- Reach for objects in all directions (sitting and standing).
- Tapping exercises.

The game is set on a grid of lights that will randomly turn on and off. The number of lights and the time they stay active for will depend on the difficulty level set before commencing the game.

Easier difficulty levels will involve 3 or 4 green lights to be on screen in random locations at any one time (with the dwell time adjustable also). The user taps each green light to turn it off before it turns itself off according to the set dwell time.

As the levels progress in difficulty, the amount of green lights is increased. For the very highest levels, red lights are introduced into the game. These lights should not be pressed and as a result of doing so, the user is penalised. This will add an extra level of cognitive processing required for this game and will make the user think more specifically about positioning their fingers to make patterns to hit only the green lights.

Graphical reports at the end of the game show the total lights turned off, average speed, and an accuracy measurement for all successful interactions. A history of the users' previous scores can be recalled to check progress over the usage period of the system. A high score table can be implemented if this proves motivational to our target audience.

With 4 independent finger sensors available, the user can interact with multiple lights at any given time. This gives the game additional depth due to there being two possible ways to accomplish the task at hand. The first method is to turn off each light individually, and the second requires more thought and accuracy. When lights turn on in certain patterns, it will be possible for the user to position their fingers to replicate the pattern shown on screen, and turn off numerous lights simultaneously. Figure 4 shows an illustration of the implemented 'Lights Off' Game.

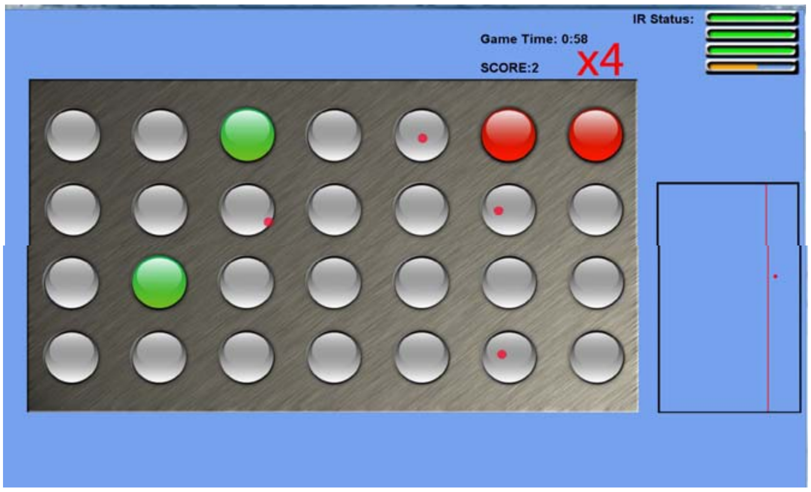

Figure 4: Higher difficulty level in 'Lights off' game

3.3 "Electric maze"

This game encourages the user to focus on where the object is moving to within the game canvas, and to think ahead of where they will need to go to in order to complete the game successfully. It elicits the following exercise:

- Hold and transport objects from one place to another.

The game incorporates this exercise by encouraging the user to direct an object (a ball) through a maze, without letting it touch the sides. Varying difficulty levels influence the complexity of the maze, the size of the object and the time allocated to complete the level. Lower difficulty settings involve a smaller object, more time and a simpler maze in comparison to the higher difficulty settings. An additional feature of this game is the inclusion of optional paths that lead to bonus items that can be used to gain extra points. Graphical reports are also available to the user at the end of this game to show accuracy and time readings. The data recorded will also keep track of the average amount of tremor in the user's hand and also the total score they achieve on each level. The time each level is completed in is also recorded and the combination of all these statistics is used to produce an overall score for the levels.

3.4 "Object morphing"

This game elicits the following movement:

- Manipulate objects for specific purposes.

Using 4 fingers to manipulate an object provides many benefits in terms of improving independent finger usage and hand eye coordination for people recovering from stroke. The users of this game perform object manipulation tasks in a set time limit, and these time limits are customisable so that some of the challenges are not overly difficult and cater for a range of abilities for users at different stages of recovery.

The game involves a stationary object with a moving wall advancing towards this object. The wall has a shape cut out of it and the objective for the user is to morph the object into a shape that will match the hole in the advancing wall. To morph the object, the user is challenged to pinch and grab sections of the object to mould it into the shape required. This could be anything from a simple adjustment (for lower difficulty levels) or a tricky shape requiring more complex manipulation for the higher levels. If done correctly, the shape will pass through advancing hole in the wall and points will be awarded. If not, the wall will stop and the game will end.

3.5 Object stacking"

This game draws inspiration from the original Tetris game. There are significant design changes that refine the idea of the original game so that it can be used effectively in stroke rehabilitation.

Exercises elicited include:

- 1. Pick up, Grasp, Release objects of different shapes, sizes, weights and textures.
- 2. Hold and Transport objects from one place to another.

Using 2 hands to interact with multiple objects on screen at the same time would provide many benefits for people recovering from stroke. The users are challenged to rotate their hands, pinch their fingers, and move their hands and arms in all directions. As with the original Tetris game, this game features different blocks of varying shapes and sizes. In this version the users interact with the objects via the rehabilitation glove and can be moved anywhere within the game area. The main difference to the original game is that the blocks can be placed anywhere the user chooses to drop them. This means that misplacing a block could force the tower to collapse, adding an exciting new element to this game. Object Stacking encourages users to fully extend their arms to reach up and grab objects from the top of the screen, and manoeuvre them into a sensible position on an ever growing pile of blocks.

3.6 "Balloon game"

The exercises taken from the requirements scoped with the University of Ulster to incorporate into this game are:

- 1. Reach for objects in all directions (sitting and standing).
- 2. Tapping exercises.

The combination of requiring the user to reach in all directions whilst also have to hit moving objects will improve hand eye coordination as well as improving reach. The Balloon Game extends the original "Lights Out" game, and requires the user to hold on to an item, move it around the screen and eventually use it to pop balloons. A score is awarded for each balloon successfully popped and a score is awarded for the accuracy in which each balloon is popped.

Difficulty settings are customisable for dwell time (how long the item is on screen for), amount of balloons popped and overall game time.

3.7 "Pipes"

The exercises taken from the requirements scoped with the University of Ulster to incorporate into this game are:

- 1. Using two hands to accomplish specific tasks
- 2. Hold and Transport objects from one place to another
- 3. Move objects within the hand.
- 4. Manipulate objects for specific purposes

The combination of all these exercises into one activity will keep the user engaged whilst not having to repeat the same actions over and over again but still getting the same benefits due to the periodic repetition of the individual exercises. 'Pipes' involves using two hands to manipulate 3D objects - a series of pieces of pipe, all of varying shapes and sizes, to connect two ends of pipes so that an item can pass through them. Played against the clock which can be adjusted to the stage in the rehabilitation process, pieces require moving into position in the X, Y and Z planes, and then can be rotated and twisted around either of the axis to ensure the pipes are correctly connected.

4. Clinical evaluation plan

Given that four games have now been implemented the clinical evaluation plan will now be described. This evaluation plan will be started in September 2009 and will the most extensive study undertaken so far to assess the efficacy of serious games in stroke rehabilitation.

4.1 Design

Two groups will be used - intervention and matched control compared on changes from baseline to post intervention with a nested qualitative study with the intervention group.

4.2 Participants

60 patients between 18 and 85 years, who have had a stroke, who are no longer receiving any other therapy (community stroke team, intermediate care, early supported discharge) and who still have residual upper limb dysfunction. Patients will be recruited from those who have been treated at Nottingham's stroke unit and will be identified while on the stroke unit and invited to start the trial as soon as active service intervention has ceased.

4.3 Exclusion criteria

The following exclusion criteria will operate for this study. From stroke unit records patients will be excluded if they have:

- severe visual impairment
- premorbid disability in upper limb function (Rankin (1957) >3)
- no detectable movement in the upper limb.
- known diagnosis of dementia or depression
- the inability to tolerate sitting in a chair for 30 minutes
- severe symptomatic arm/shoulder pain
- inability to follow a two stage command
- due to be discharged to residential or nursing home care
- still receiving upper limb rehabilitation

4.4 Intervention group

Patients randomly allocated to the intervention group will have the VR system in their homes for a period of 10 weeks. In order to achieve the target exposure time of 60 hours they will be advised to use the system for 20 minutes 3 times a day for 10 weeks to make allowance for missed days or missed sessions. An upper threshold for usage of the system will be advised in order to avoid excess exercise of the upper limb.

4.5 Equipment

The Wiimote based rehabilitation glove will be used. This will allow the simulation of reach to grasp tasks in the games. Games will be displayed on a 24" flat screen monitor. A suite of 4 games will be provided based on suggestions received from the Nottingham Stroke Research Consumer group (voting on their favourite 4 games described in sections 3.2 - 3.7) and participants in the pilot study that would involve frequent repetitions of upper limb movements (i.e. pull, push, reach, grasp) that are necessary to effect many activities of daily living. Each game will have different levels varying in speed at which events occur and with which responses are required as well as in complexity of challenge in order to keep the participants motivated to continue to use the system. Participants' scores will be displayed on the screen at the end of a game and there will be a permanent visual display of their progress in terms of scores and levels played. Once they have achieved a critical score at one level they will be offered the option of progressing to the next level. When a participant returns to a game either at the beginning of a session or after playing another game, they will be given the opportunity to continue at the level they were at previously or, if the critical performance has been achieved, of moving on to the next level. Offering the participant the option to remain at the lower level ensures they are not presented with too much of a challenge before they refamiliarise themselves with the game's requirements. A log of when the system is in use will be collected by the computer as well as what games are being played and what scores the user obtains.

4.6 Control group

Patients randomly allocated to the control group will have normal care in their homes for a period of 10 weeks.

4.7 Outcome measures

Outcome measures will be recorded at baseline, 5 weeks and 10 weeks. These measures will include:

- Action Research Arm Test (ARART, Lyle, 1981)
- 10 hole peg test (Annet, 1970)
- Nottingham Extended Activities of Daily Living (NEADL, Nouri and Lincoln, 1987)
- Barthel Index (Mahoney and Barthel, 1965)

4.8 Procedure

Potential participants will be recruited from the research database of admissions to the stroke unit at Nottingham City Hospital.

At six weeks post stroke patients will be sent a Study Information Pack containing:

- An Invitation Letter asking them if they are still experiencing upper limb problems and inviting them to take part in the study
- An Information Sheet explaining the study
- A Consent Form
- A postage paid reply envelope addressed to the Research team

Those agreeing to take part will be contacted to arrange a home visit by the therapist to establish that the potential participants continue to meet the inclusion criteria and collect the baseline assessments (ARART; 10 hole peg test; NEADL; Barthel).

Participants will be randomly allocated to either the intervention or the control group and for those assigned to the intervention group, a visit will be arranged to deliver the equipment, set it up and for the research assistant to demonstrate its use to the participant and their carer. If the research therapist feels that the participant has understood how to use the equipment or that there is a carer who understands how to use it, the intervention can commence and the research assistant will phone the participant after two days to check that they have been able to use the equipment in its intended manner and offer to visit once more to demonstrate how to use it. If they still seem unsure of how to use it by the end of the first visit the RT will arrange to visit in the next 48 hours. The RT will then visit fortnightly to retrieve data and check progress. They will leave a phone number on which they can be contacted during working hours if they need any advice or if the equipment fails. The number and type of requests for help will be recorded s well as the number of extra visits and notes kept of any queries or problems that are raised in each visit or phone call.

5. Conclusion

This paper has reviewed the development of a prototype Wiimote based rehabilitation glove that will track patients' interactions with games that have been designed to elicit real rehabilitation movements. The development of this system will help in the assessment as to whether the benefits obtained from current expensive clinical systems can be obtained with less sophisticated affordable systems, i.e., the rehabilitation potential of commonly available computer games and associated games controllers.

As with all new technology its uptake into mainstream use (and ultimately how it's viewed by the wider research community) will be dictated by how effective and popular it is evaluated as being in real educational, rehabilitation or social settings. This was certainly the case for virtual reality (Cobb and Sharkey, 2006), and if the hype and subsequent disenchantment with that technology that the committed researchers in this field have had to whether is to be avoided, then the serious games research community should move quickly to carrying out well planned and significantly large evaluation studies. For this reason the extensive clinical study planned for the Wiimote based rehabilitation glove and accompanying games is fully developed in this paper.

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Thanks to the Nottingham Stroke User Group and to Jacqui Crosbie for providing extensive information on clinical rehabilitation exercises for post stroke patients.

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A Game to Aid Behavioural Education

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Abstract: Computer games are often seen as at best a mindless distraction and at worst a way in which children and young adults are lured into bad behaviours. A recent government advertising campaign caused great consternation among game manufacturers as they saw it as portraying computer games as a major cause in childhood obesity. At the same time many children who are exhibiting behavioural disorders (violent behaviours, attention deficit etc.) end up excluded from school and have to be helped to deal with these symptoms of their underlying problems. This treatment often involves a teacher in one to one and small group activities seeking to engage the children in discussion about their behaviour; the idea being to get the children to understand the relationship between their own and others behaviour, thoughts and feelings. Such children often find the activities difficult to engage with. However, computer games have already been shown to be useful tools in engaging such students in discussion. One aspect of this is that the children can gain a form of empowerment in their relationship with the teacher through the game. Another is the intrinsically motivating and engaging and nature of games and the range of activities that can be introduced. A number of games are being developed to aid this study. This paper focuses on one game that is now in its test phase. The game is a 3D, super hero themed role-playing adventure based on exploration, collection and interaction with in-game characters. It has been designed for children aged 8 to 12 in the early stages of treatment for behavioural, emotional and social problems and has been built around concepts derived from the cognitive behavioural model. The game aims to allow educators/workers to introduce and discuss important topics with the child in a non-confrontational way; To aid in development of the child/worker relationship by providing a fun activity where the child is afforded control; To provide education aimed at developing coping strategies through learning about the relationship between thoughts, feelings and emotions, and by exploring techniques for recognising and questioning faulty thinking patterns. These concepts are explored though symbolic modelling of problem behaviours and associated cognition by in-game characters. The player has an active role in attempting to understand and find solutions to the problems faced by these characters allowing the child to become a part of the solution rather than the cause of the problem. The first stage of the testing was to present the prototype game to a group of professionals in the field. Their response was largely positive and many of their responses have been incorporated in changes in the design. Currently the game is being tested by a group of children and their responses are being used in the remodelling of the game.

Keywords Behaviour disorder, adventure game, mental illness

1. Introduction

The rising numbers of school aged children suffering from behavioural, emotional and social difficulties (BESD) is a serious issue facing schools and child welfare institutions in the United Kingdom. PLASC census data in 2006/7 showed an overall numbers of children reported as suffering some form of BESD increasing from 134,810 to 139,410 nationally (DCSF 2007). The Special Educational Needs code of practice issued by the Department for Education and Skills defines BESD as:

> *"A learning difficulty where children and young people demonstrate features of emotional and behavioural difficulties such as: being withdrawn or isolated, disruptive and disturbing; being hyperactive and lacking concentration; having immature social skills; or presenting challenging behaviours arising from other complex special needs. Learning difficulties can arise for children and young people with BESD because their difficulties can affect their ability to cope with school routines and relationships." (DfES 2001)*

Research suggests that conduct problems and hyperactivity disorder in early age increase the likelihood of criminal behaviour later in life (Babinski, Hartsough & Lambert, 1999)

The Computer game as an entertainment medium has been the focus of much bad press for encouraging bad behaviour and contributing to the growing numbers of children suffering poor attention spans and ADHD, a hyperkinetic disorder which itself is classed a BSED in schools (DCSF 2008). However, there is now a growing body of work showing that serious computer games can be powerful learning tools when designed and utilised for educational purposes (Gee 2003).

This paper focuses on the design and implementation of a serious game for young children classified as suffering BSED and receiving support from special school units, nurture groups or social services.

2. The history of computer games for social/emotional learning and therapeutic support

Computer games have been seen as an attractive medium for those working with young people since the early 1980s when the first home computer systems began to take electronic gaming out of arcades and into the home. The following is a brief overview of work to utilise both mainstream titles and bespoke software for social learning and therapy.

2.1 Early work

Richard Schoech, Professor-School of Social Work at the University of Arlington, Texas along with a psychological assistant named Betty Clark created one of the very first therapeutically focused games titled “Adventures of Lost Loch”, they published their findings in 1984 (Clark, Schoech 1984). The game was an entirely text based adventure game designed specifically for adolescents in therapy for issues relating to low impulse control and represented a significant attempt to scientifically test the hypothesis that computer games can aid in the delivery of therapy and contribute to motivation. The game involved a fantasy quest to lead a band of adventurers though a dangerous cave in search of the stolen crown of the King. Scenarios were provided and the player presented with three to four possible decisions regarding how to proceed. A score was given to the player based on the impulse level of the decision they selected, points were added or subtracted based on the level of impulse control of the choice made. Good decisions were rewarded and poor decisions presented additional problems. The game attempted to utilise techniques commonly used by cognitive therapists to teach the player to consider alternative methods of solving problems and teaching self statements to help the player cope with errors and mistakes. The game was tested, with real therapists, by four children aged eleven through seventeen all deemed to have presenting problems associated with low impulse control such as fighting, stealing and playing truant from school. Initial results were positive. The clients involved seemed eager to play the game and attendance of the therapy sessions involved increased from an average of 66% attendance to over 90% with only a single session being missed.

Hy Resnick, again a professor at a U.S. school for social work, this time at the University of Washington published initial details of his purpose designed computer game in 1986 (Resnick 1986). The game, entitled BUSTED, was a computer game designed to reduce antisocial behaviour in young offenders through improvement of consequence awareness. The game was targeted directly at young people in corrective institutions or care homes. BUSTED was a computer based board game with a layout similar to a Monopoly board. Players moved around the board by rolling (computerised) dice. Around the board were situation squares, upon landing on such the player was given a random situation and a number of possible actions they could take in response. The outcome of the scenario was then generated randomly from a small pool based on the choice of response.

BUSTED was only a prototype at the time of the publication, it remained unfinished for a further 15 years when it was eventually passed on to and finished by Les Cowan. At the time, however, Cowan was working on his own computer game - The Optex Adventure system (Cowan 1994).

Optex was designed by Cowan while working as a Social Worker in Scotland. He had been given a “preparation pack” for young clients involved in adoption breakdowns. The pack included a number of short scenarios involving characters in similar situations which the child would be asked to consider the outcomes and repercussions of a selection of choices the character could make. Cowan set out to computerise this process, the resulting Optex Adventure System, was an authoring tool to allow the creation of text based multiple choice adventure computer games.

Throughout the 90s several attempts were made to integrate ordinary computer gaming systems into therapy as a 3rd object. Gardener experimented with the Nintendo hit Super Mario Brothers (Gardener 1991). Child practitioner Ron Kokish also experimented with a commercial computer game title as a tool for play therapy, this time Ultima for the Apple computer (Kokish 1994). Both concluded that the computerised games could be very helpful in play therapy and experienced excellent results in engaging the children’s attention.

2.2 Commercial work

In 1994, continuing on from his development of OPTEXT, Les Cowan founded the company Information Plus which would produce “social learning software”. His first title was interactive story based and named “Bruce's Multimedia Story”, released in 1998, then in 1999 he updated the original premise behind OPTEX into a multimedia adventure called “Billy Brakes the Rules” (Cowan 2002).

In 2006 Zipland Interactive, a company based in Tel Aviv Israel and headed by child therapist Chaya Harash released a research based psychological computer game designed to help children deal with emotional distress stemming from a parental divorce. The game, named Earthquake in Zipland, was designed to implement Strategic Paradoxical and Solution Focused principles in therapy. It features a multimedia point and click interface and a story revolving around a moose living in a land divided into two halves via a zip. No specific mention of divorce itself is made during the game, which, instead, focuses on metaphors, initially an earthquake which separates the two continents with each parent on one side. The player then embarks on a quest to reunite the continents and the two separated parents. As the story unfolds it becomes apparent that this is an unrealistic and unachievable goal (Ziplandinteractive 2008).

2.3 Recent academic work

A team of academics at the Computer Science Department, Trinity College Dublin developed a computer game in 2005 entitled “Personal Investigator”. This attempts to implement “Computer Mediated Adolescent Psychotherapy” (Mathews, Coyle et al 2004). The game follows the framework laid out in Solution Focused Therapy (SFT). The player takes on the role of a trainee detective, who searches for solutions to personal problems, the goal is to become Master Detective by talking to other detectives and listening to stories from adolescents about how they overcame their problems. Personal Investigator was intended for use as a tool to engage adolescents.

Paul Stallard the acclaimed authority on CBT with children and author of Think Good Feel Good has also recently undertaken some therapeutic work with computer games. (Stallard 2005)

A team at Nottingham Trent University have recently developed a game aimed at adolescents who, for various reasons, are deemed to be at risk of being socially excluded. The game places the player on a volcanic island in danger due to an imminent eruption. In order to escape, the player must acquire crew members who are recruited as the player completes personal development tasks. The developers again stress the game as a tool for engagement of adolescents but also are keen to stress the strengths of computer games as a unique platform for learning (Brown, Shopland et al 2007).

Most recently, Treasure Hunt, a game designed to utilise CBT techniques as a support tool for psychotherapists has been developed by a partnership between the Departments of Child and Adolescent Psychiatry and Computer Aided Architectural Design, at the University and ETH in Zurich, Switzerland. The game is designed for eight to twelve year olds and takes place aboard an old ship, captained by an experienced sailor who needs the child’s help to solve a mystery. It aims to support the therapeutic process by utilising theoretically solid Cognitive Behavioural Therapy techniques, offering attractive electronic homework and allowing the child to practice rehearsing basic psycho-educational treatments (Brezinka, Hovestadt, 2007).

3. A role playing adventure game for children with BESD

Our work concerns the development of a computer game designed to provide education on behaviour, coping strategies, thoughts feelings and emotions to primary school aged children suffering from some form of BESD. It has been designed to be played by children with one to one adult supervision. The game intends to both educate directly through the play experience and to provide a useful context for the adult supervisor to discuss important topics with the child.

3.1 BESD and mental health

> *“Behavioural, emotional and social difficulties” is a term used in schools and is to be understood in a largely educational context. Externalised problem behaviour often interferes with educational development and normal schooling. The root cause of such behaviours however can often stem from clinically definable mental health issues. While a disruptive and aggressive child might be defined as having an emotional and behavioural problem within an educational context. A medical practitioner may describe the same child as having a clinical conduct disorder (DfEE 2001).*

There are a myriad of internal and external factors that can negatively affect a child's mental health. External problems such as those in the home, family or community are difficult to deal with as they are outside of the control of those working with the child. The Department for Education and Employment published guidelines for schools to promote mental health in schools in 2001. They suggest that that there is a complex interplay between factors of risk to a child's mental health and those affecting their resilience (DfEE 2001). Resilient children are more likely to find way of coping with problems and difficult situations than those with less protective factors. The guidance lists the following factors specific to the child as an individual as positive regarding resiliency:

- Secure early relationships
- Being female
- Higher intelligence
- Easy temperament when an infant
- Positive attitude, problem-solving approach
- Good communication skills
- Planner, belief in control
- Humour
- Religious faith
- Capacity to reflect

The game aims to provide general education on behaviour, coping strategies, cognitions, emotions and social themes as well as encouraging the development of coping strategies and resilient thinking patterns in the player.

3.2 Pedagogy

Educational content in the game is delivered though interactive narrative and characters modelling common behavioural and thinking problems. This content was designed using educational techniques derived from cognitive behavioural therapy. CBT has been shown to be effective in the treatment of children suffering behavioural and conduct related disorders (Sukhodolsky et al 2004). It attempts to influence dysfunctional emotions, behaviour and thoughts through a goal-oriented, psychotherapeutic procedure.

The game is based on the core theory that behaviour can be changed through observation. Symbolic modelling is a common technique used in CBT. In therapist led CBT, problematic situations are modelled by actors which could be live or recorded. These situations can then be analysed with the client and dysfunctional cognitions, emotions and behaviours discussed. The situations can then be re-modelled using specific coping strategies to examine how better outcomes might be achieved. Education by symbolic modelling allows the child to experience solutions in a non-threatening and supportive environment. The technique is also well suited for use in a character and narrative based computer game.

Another advantage of using this technique to explore issues of dysfunctional behaviour is that it avoids classifying the child as being the source of the problem. They can instead take on a role where they become part of the solution, learning about and actively helping in-game characters to cope with various problems. Observing and actively participating in the journey of a character with similar difficulties and thought processes to the player as they learn how to develop coping skills that make an evident positive change could be extremely beneficial and motivating. The game strives to motivate the question: “If the character from the game was always in trouble and miserable for the same reasons as me, and they found a new way of dealing with things and now they are happier, why can’t I do the same?”

The key disadvantage with this method is that it relies exclusively on pre-written content, a problem that is shared with all computerised education of this kind. The best option is always to deal with matters that specifically affect the individual concerned. Analysis of one’s own problems will always be more useful than analysis of those of others. While this kind of personalisation cannot be achieved by a pre-written game, it can be a useful point of reference with which the adult supervisor can engage the child and discuss events that are specific to the individual and relate these to the content in-game. Interaction with the person supervising the player is an important aspect of the game. The in-game content should be discussed with the player throughout. They should be encouraged to think about the situations portrayed and relate these to their own experiences.

3.3 Game theory

It is now well established that educational computer games offer the possibility of enhanced motivation when compared to traditional materials (Gee 2003). This is a particular advantage when considering the target demographic. Disruptive behaviour and non-compliance coupled with low attention spans if not ADHD make for a notoriously difficult group to engage. Boys make up the majority of children in the target demographic and computer games are extremely popular with boys in this age group. These factors make a good educational computer game an attractive option among possible learning activities.

This extra motivation that we hope to harness can only be achieved if the game succeeds in being entertaining. Likewise, without real educational benefit any educational game is without merit. Educational games that consist of educational content additional but separate to game mechanics are sometimes referred to as Edutainment. This approach has been likened to an attempt to serve chocolate covered broccoli (Laurel 2001). This has been largely unsuccessful as the educational content is often easy to ignore or skip so as to return to the more fun but un-educational game play. The child will eat the chocolate and spit out the broccoli. To avoid this problem, the game was designed specifically to include the educational goals as part of the gameplay itself. It should therefore not be possible for a player to progress through the game without developing and understanding of the educational content.

3.4 Game mechanics

It was important to base the game play mechanics on an established and successful model. This both ensures a level of familiarity and gives the best chance of providing a fun experience. Of all the different game genres the mechanics of a role playing adventure game fit the learning objectives the best. As such the game follows the play style of a traditional role playing game as far as is possible.

Game play in most role playing game titles revolves around combat of some type. The combat element was replaced by a non-violent trading card style game which can be played against various in-game characters. The following principles found in most role playing games have all been included in the design.

- Exploration of the environment
- Communication with in-game characters
- Trade
- Character customisation and development
- Item collection
- Detailed storyline

4. Implementation

A prototype version of the game, complete with 2 levels, has been developed using Microsoft's XNA framework. It features a full 3D environment, fully animated 3D characters, sound and voice acted dialogue.

4.1 Trading card game

The trading card game substitutes for the combat element in traditional role playing games. Typical mechanics involve encountering enemies and using weapons of some kind collected throughout the game to dispatch them. Enemy difficulty increases as the player's character and weapons become more powerful. The card game is entirely non violent but incorporates the same principals. Each card has certain values attached to it, some are stronger than others. The player must build a collection of good cards in order to be able to continue to win against stronger opponents. As the game is developed it is planned to incorporate an educational theme into the card game itself. This could be achieved by giving each "card battle" and each card a theme based on particular thinking or behavioural problem. If the player chooses cards that correspond to the correct theme of the battle then these cards will receive a bonus. This serves to encourage the player to consider the meaning of these themes in order to succeed.

4.2 Game overview

The story begins as the player arrives at “Hero League” headquarters, figure 1, a mysterious place filled with glowing crystals.

Figure 1: Introductory screen – arrival at the “Hero League”

The player is the recruited into the league as an apprentice hero. In order to progress through the ranks and start obtaining super powers the player must assist their superior, “Captain Concept”, in helping people. The first mission involves a child named Gary, who the Hero League has discovered is about to be expelled from school for hurting another child. The player is shown the situation that will lead Gary to lose his temper and lash out. A number of children in the playground are teasing Gary and being quite cruel, Gary is quiet throughout until he loses his temper and kicks one of the girls, figure 2.

Figure 2: An example scene from within the game – Gary looses his temper

Captain Concept then shows the player the scene again but reveals exactly what Gary was thinking and feeling throughout. The player is then tasked with retrieving several special themed cards from the shadowy chaos agents so that Captain Concept can use them to learn more about Gary’s problems and discover some ways to help him. The player then explores the environment and interacts with various characters and searches for “Chaos Agents” to retrieve the special cards. When the player encounters a Chaos Agent they must select from their collections of cards a set to battle with and play a game against the agent, Figure 3.

If they are successful they receive a special themed card which reveals more information about Gary and his difficulties at school. Each card gained becomes a lesson that can be given to Gary which can show him coping strategies and better ways to deal with the problems he has faced. Each also corresponds to thinking errors Gary makes in the altercation that leads to him being expelled. The player must then help Captain Concept by watching the scene again and selecting the lesson card that corresponds to the relevant error. If they get these choices right Gary is teleported out of the situation and the lessons are delivered by Captain Concept. One of the lessons concerns anger management, in this Gary is taught to count to ten and try to think of something relaxing when he first feels himself start to become angry. If this lesson is chosen correctly Gary does not lose his temper when the other children tease him, instead he counts slowly to ten and takes deep breaths. At this point a teacher arrives and breaks up the situation, the girl responsible for most of the teasing gets in trouble instead of Gary. The player is then rewarded at the Hero League headquarters and granted a superpower of their choosing which will be able to be used in the upcoming levels to do additional quests.

Figure 3: A chaos agent

5. Future developments

The prototype level described in the previous section has been demonstrated to child care experts and the director of social learning software company Information Plus, Les Cowan. Feedback has been largely positive, Les Cowan was particularly impressed by the 3D graphics and animated models. The current stage of development is collaboration with teachers and practitioners directly involved in working with children. A full rewrite of the current content is possible to ensure that the issues and lessons contained in the game will be relevant and helpful to real children with real problems. Additional game play mechanics are also planned to enhance the game. A helper character will be added to accompany the player as he explores the environment. Whenever an opportunity to interact with another character occurs the helper character will read aloud the various options open to the player about how to communicate. This will allow for much greater interactivity without requiring excessive reading of written text. In section 3 certain factors were listed that are considered to aid resiliency against mental health problems in children. As the development of the game continues focus will be placed on content which fosters these traits in the following ways:

Positive attitude, problem-solving approach

- Problem solving will be central to progress through the game, often the player will be faced with choices where there are no clear right and wrong answer
- Positive thinking and the problems that can be caused by a negative outlook are centrals themes throughout

Good communication skills

- There will be numerous opportunities to interact with other characters throughout the game
- These will include many good and bad ways of communicating with people and the consequences of both will be explored in the storyline

Planner, belief in control

- The concept that behaviour can be changed with a little knowledge and effort is again a central theme
- The message that we are each largely in control of our own destinies is explored through observation of the different choices made by both play and characters and the consequences of these choices

Humour

- Humour can be an important part of a fun gaming experience, as such there will be things purely designed to be light-hearted and funny

Capacity to reflect

- The ability to reflect on events and consider the meaning of the characters stories will be critical to progressing through the game, without reflection it will not be possible to win

6. Discussion

Effective education on complex subjects like thoughts, feelings, emotions and social situations is a difficult thing to achieve when dealing with young children. The prospects for success will depend greatly on the accuracy of the symbolic modelling used and the level of association that can be achieved between game characters and the player. Computer games present exciting potential for use in learning and are an especially promising medium in regard to character based narrative. By providing an involving and interactive storyline with believable characters and real problems it is hoped that an environment can be created in which children can play and learn about such complex concepts in a safe and also an entertaining way. It can be demonstrated though symbolic modelling that positive changes are possible, that behaviour can be controlled, and that there are many possible ways of dealing with problem situations, some with profoundly better consequences than others. Above all it is hoped that the player can be encouraged to question their own methods of dealing with problems by observing the journeys of the in-game characters and associating these with their own experiences.

This paper has described a game which seeks to provide education on behaviour, thinking, emotions and social skills for children receiving support for behavioural, emotional or social problems. It has also been designed to offer a genuine gaming experience that will be familiar and enjoyable to many children who play conventional computer games. The game has been evaluated by practitioners and an expert in the use of games for social and behavioural learning. However, it has still to be evaluated extensively on the target audience. A number of weaknesses in the current system have been identified and these will be addressed before a wider evaluation program involving children is undertaken.

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User Modelling in Learning Games

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Abstract: Our research work deals with the development of new learning environments. We believe that Game-based Learning can significantly enhance learning. That is why we have developed learning environments based on graphical representations[1] of a course. These environments allow us to set up experiments with students in our university. The emergence of online multiplayer games has led us to apply the metaphor of exploring a virtual world, a pedagogical dungeon, where each student embarks on a quest in order to collect knowledge related to a learning activity. We think that the way of acquiring knowledge during a learning session is similar to following an adventure in a Role-Playing Game (RPG). Although the students appreciate this approach, there is an obvious need for awareness, especially for the teacher. This lack of awareness is related both to the knowledge acquired by a particular student and to the behaviour s/he exhibited in the game. In the light of this statement, we consider that it is crucial to exploit indicators concerning these two aspects: the knowledge (success and failure for sub activities) and the behaviour (talkative, cooperative) of the different students during the pedagogical session. In our approach, we can calculate such indicators using the traces from the collaborative learning activity. We propose in this paper to gather all these indicators into a specific user model dedicated to learning games. The user model thus becomes a key object in our game architecture, and students and teachers may follow-up and evaluate the learning progression through the user model (UM). As the user model becomes central in this approach, there are crucial needs that must be satisfied. First, the UM must be updated with respect to the effective activity, and second, the different users must be able to visualise the result easily. We thus propose a way to visualize such user models directly in the game, making a complete immersion of the students and the teacher possible. Moreover, as we will see, these artefacts, representing learning progression, knowledge or behaviours may also be visible to other students and are additional elements that enhance collaboration. Finally, as the user model is an object known to the users, it can also be a reactive object, and in this paper we propose a way to express intentions by acting on the user model. For instance, a teacher can express his/her intentions for a particular student skill to be improved. The learning scenario will thus be adapted to take this constraint into account.

Keywords: User model, learning game, RPG, skills, learner profile

1. Introduction

Our research work deals with the development of new learning environments. From our point of view, the emergence of learning games is seen as an evolution of “classical” LMS (Hijon 2006). Learning Games are already recommended as possessing several pedagogical qualities. For instance, they offer a specific and progressive learning curve adapted to each learner, they allow distance learning, and they can encourage specific usages in education such as collaborative learning or project pedagogy.

But, learning games provide such benefits only if the teacher is able to follow each activity in the pedagogical session and if the learner is aware of his/her learning progression. We have already presented (Gendron 2008) a means of collecting this information directly in the learning game via the definition of indicators based on traces left by the student activities. In our approach, we have calculated such indicators using the traces of the collaborative learning activity.

In Role Playing Games (RPG), an avatar representing the gamer includes individual characteristics; in a learning game, the student representation should also include pedagogical information in a specific object available both for the student and the teacher(s). Furthermore, it should be possible to use in other learning environments this information concerning both the knowledge acquired by the student and the behavioural aspects (talkative, cooperative, slow). We thus consider that all this information should be gathered in a unique object (the user model) that should be persistent. On that point, we agree with Vassileva’s idea: the user model is decentralised in new learning environments and belongs to the user (Vassileva 2003). The user model can be a way of representing the student, bringing together the relevant characteristics for the learning aspects (skills, behaviours, preferences). This approach leads to systems where the user model is not directly integrated in the learning tools, but is accessible through inter-process communication. Kobsa demonstrates in (Kobsa 2001) the advantages of such a distributed approach.

[1] a 3D representation in 2006 and a Zelda-like 2D representation in 2007.

In this paper, we propose to present our work around a User Model adapted for Learning Games (UMaLG). As a matter of fact, previous works, experimentations and teachers' feedback elicited several requirements concerning student representation in learning games. The introduction of such a model in a learning game raises a certain number of questions. These questions (and their answers) give the outline of the paper. What is inside the UMaLG? Can this information be classified and how? (Section 2) How to make this information available to the users inside the game? Through which graphical ways is it possible? (Section 3) How to update the UMaLG dynamically? (Section 4) Can the UMaLG serve as a collaborative object between the students and the teacher to negotiate pedagogical objectives? (Section 5).

2. User model for student representation in learning games

In LMS, the concept of learner profile or student model is used to represent the characteristics of a learner (Brusilovsky 2001; Rueda 2003; Vassileva 2003). These numerous characteristics can be classified into several categories: common characteristics, preferences, skills, and behaviours. We thus set out in this part what is inside the user model and a possible classification of the attributes (characteristics) of the user. Finally, we point out which improvements to current user model require attention.

A student is identified and represented by specific, generally static, information, especially in an academic domain. These **common characteristics of the user model** are important from an administrative point of view and are always present in a user model in order to identify a person individually.

A student is described by his/her name, student ID, past and current courses, diplomas, etc. Such information may be collected automatically from administrative services, or the system can explicitly ask the user him/herself when a new account is created in the learning game.

These characteristics are often used to adapt an application, making the system user-friendly (usage of the name, of the address to find local references, etc…).

The second category of User Characteristics deals with the **user's preferences**. In this category, we can find the User Interface Preferences (fonts, colours) or the subjects the user is keen on (if they are related to the application, of course).

Some preferences may be implemented in order to provide the student with adapted graphical interfaces or adapted modality of information presentation (text, image, sound, video) (Brusilovsky 2001). This is particularly pertinent in pedagogical systems where knowledge acquisition is enhanced by a way of teaching that is adapted to the personal means of information memorization (Choukroun 1985) of the user (visual, auditory, data format, etc.). This approach is however seldom used because the teacher needs to provide the same information in many formats or modalities, which is very time consuming.

The part of the user model containing information on the **user skills** refers to the knowledge acquired by a student. The characteristics contained in this part change more often than those described in the previous two parts. User skills are widely used to personalize the path for knowledge acquisition, and to adapt the form of presentation. (Brusilovsky 2001) explains in detail how links can be extended or hidden according to the user's knowledge of a particular concept. In video games, especially RPG, the progression in the game is directly controlled by the skills of the avatar. For example, it is impossible to reach an island if your avatar does not swim or does not have access to a boat… The "swim skill" has to be acquired in order to explore this island.

In order to make our Learning Games adaptable, and to make the activity requisites possible, we base our UMaLG on the same concept: a learner is defined with skills (and different levels for each skill) that allow access to new exercises or to a part of the game world. As in traditional teaching, where some exercises require specific knowledge, the scheduling of exercises depends on the skills of the student and the game world is automatically adapted to each student according to his/her user model. It is possible to see a skill level as a key enabling the following exercises (and following part of the world).

Finally, the fourth part contains characteristics deduced from the **behaviour of a user**. This part is particularly useful in new learning systems where the collaboration and the social aspects are central. It is therefore important for a teacher to be aware of the different behaviours of his/her students: collaborative, talkative, hesitant, etc.

These characteristics are crucial for regulating a learning activity (Marty 2007). For instance, a teacher can define in his/her learning scenario (definition of the sequencing of the actions in the game) that an activity is available only if the cooperation inside a group of students reaches a certain threshold.

As we can see, the user's characteristics are numerous and it is a challenge for the game designer to present them to the users without obliging them to change their focus of attention. In addition to the current trends in the user model field, there is a real need for considering the user model as a real object, central in the system. This object is used to adapt the learning aspects in the game and the game itself. It should be easily updated according to the new knowledge or the new skills of the user. As a real object, we should also perform actions on it, such as *interaction* or *visualisation*. The interaction with the user model opens new perspectives in which the user can act on his/her own representation, expressing wishes on what skills s/he would like to enhance. The visualisation is directly linked with the visual representation of the user model: an adapted and user-friendly representation of the user model is important to keep the learner immersed in the game (Carron 2009). We thus propose to link the standard user model formalization (text, xml) with a graphical one.

3. Graphical representation of the user model

In classical video games such as RPG (e.g. World of Warcraft, Dofus), some information, characteristics or properties appear directly in the game displayed on the avatar representation. In order to remain immersed in the game, it is crucial that the user model has a form related to the game. Figure 1 is an example where the user model is represented on a scroll[2]. This approach is useful when the user needs to consult details on the user model (as when someone consults a map). However, it may be suitable to represent the main characteristics directly on the student avatar.

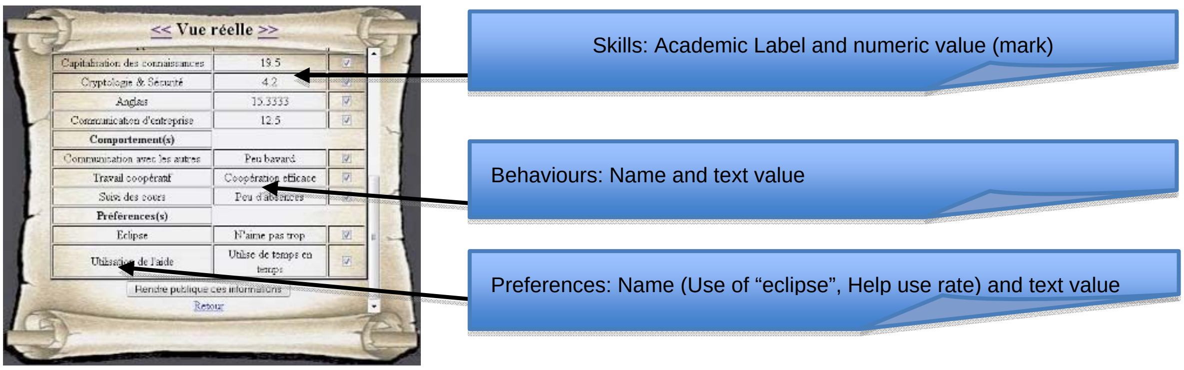

Figure 1: Example of user model for learning games

Here is an example of how we have represented some characteristics of the students in the latest learning game (Carron 2008) that we have developed. In this learning game, the teacher was interested mainly in the knowledge acquired by the student and in his/her behaviour. We have thus defined a graphical correspondence for the characteristics contained in the "skill" part and in the "behaviour" part. Some parts (sword, shield, helmet, etc.) gained or possessed explicitly by the avatar represent skills; we add a graphical representation to the user model for integration in the game. Six parts are localized on the avatar representation to display selected and specific skills (see question marks in fig. 2). As explained in (Carron 2009), for immersion and motivation purposes, real persons are represented directly in the game.

We can see in figure 2 that there is a match between some characteristics in the textual user model (to be consulted when full details are needed) and in the graphical view corresponding to the avatar (displayed in the game). The same avatar is represented here with more impressive values at the

[2] To illustrate our purpose, we present pictures of a user model, applied to our learning game called "pedagogical dungeon" in which a « heroic fantasy style » is used.

right of the picture. Each part is represented with different displays (emphasis) in order to distinguish the levels of a given skill.

Figure 2: Example of graphical representation

In this game, we wanted the behaviours to be graphically represented too. As for our collaborative indicators (Gendron 2008), we chose to represent behaviours with different animations around the avatar. The form, the speed, the number (density), the height and the size of elements (see fig. 3) moving around the avatar representation may be used to give information concerning the behaviours highlighted for a direct representation in the game (see yellow balls around the avatar at the bottom of fig. 2).

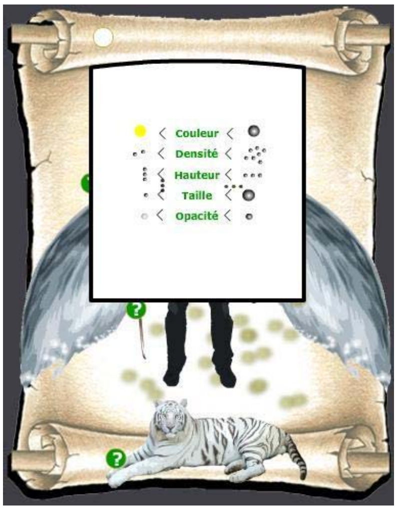

Figure 3: Configuring elements composing animations representing specific behaviours

Currently, the semantics associated to these visual indicators (concerning skills and behaviours) are free, chosen by and known to the administrator of the game and may require practice to be naturally or intuitively interpreted in the game.

The visualization of the user model is very useful for and attractive to the users. This is even more the case when the data are updated dynamically. In the following section we present how such a learner model is updated through traces left by the users.

4. Evolution of the user model

In commercial websites or in collaborative platforms for knowledge management for example, the main and well-known problem of a user model is to keep it updated (Fink 2000). We will see in this section how to take into account such an evolution in a learning game.

From our point of view, trace observation and Role Playing Games provide new possibilities to define a learner model. Our approach consists in taking advantage of the traces left by the players participating in the mediated learning activity to calculate awareness indicators for the learning game (Gendron 2008). As a matter of fact, it is thus possible to implicitly identify skill progression but also behaviours and preferences of the users (Carron 2008) and interactive behaviour among learners (Dimitracopoulou 2005; Dimitriadis 2006). It is consequently achievable to define and update a specific user model. In a learning game and in our context of work, the problem is easier to solve because the user model is focused on the properties of a learner. A correct answer to a pedagogical activity, to an exercise in the game or even the completion of a scenario in a learning game will give points, and will modify the value of corresponding skills in the learner model.

As shown in (Carron 2008), it is possible to obtain information from traces left by the users when using the learning game. The basic idea of our approach is to have probes providing information on basic events occurring in the "pedagogical dungeon" (e.g. entering a room, chatting with someone) and to compose them in order to have more general assertions (e.g. this student answers correctly but works alone). The definition of specific rules will let the system use a specific trace to update one (or several) of the specific characteristics of the user model in the learning game (see fig. 4).

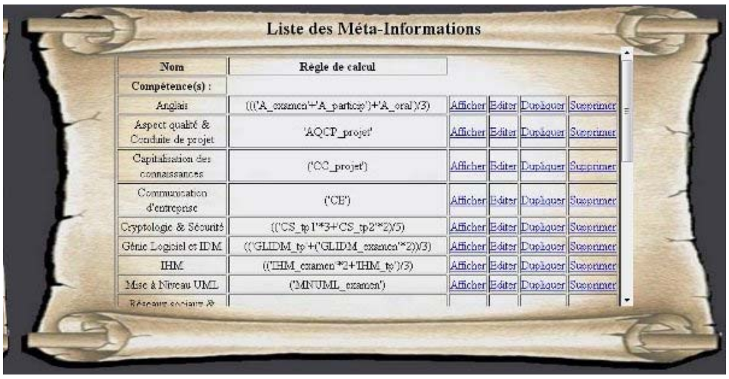

Figure 4: List of rules concerning the update of the skills

For example, our learning games are equipped with a tracing possibility based on a dedicated observation multi-agent architecture (see fig. 5) (Carron 2006; Loghin 2008). Actions such as correctly answering a quiz or using the instant messenger tool may be traced and thus collected by elementary probes. Each probe contains parameters and, depending on these, a particular aim in order to improve one or several characteristics appearing in the user model. For example, a threshold concerning talkative behaviour (x messages sent) is reached. The local part of the user model is updated thanks to rules[3] (see 1 in fig. 5), then propagated to the full version on a server (see 2 in fig. 5) and to concerned clients (e.g. teacher), possibly directly inside the game via indicators (see 3 in fig. 5).

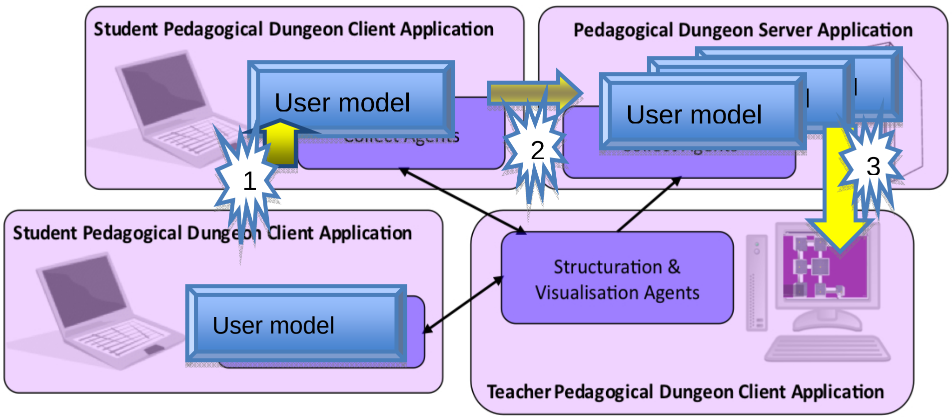

Figure 5: Observation multi-agent architecture

Although a user model is generally considered as a private, more or less realistic view of a user, we propose to take advantage of observation in learning games and extend our vision of an UMaLG by adding another specific fundamental point of our learner model. It concerns the concept of interactive future views. As we will see presently, rules may be used to help the learner to reach goals proposed by the "virtual" views.

[3] For example: Rule ::'MessageNumber > 20' => behaviour(talkative, high)

5. The UMaLG as a collaborative object

From what we have described, it is clear that the UMaLG is an important piece of information for the user. This model can serve in other learning environments to personalize them but also as data for expert research (we here approach the field of knowledge capitalization). The user can see the UMaLG as a kind of passport describing his/her skills and behaviour. If s/he is interested in providing this passport to someone else, this object can be used as a real collaborative tool. In a pedagogical set-up, the teacher and the student both have a view as to how the student can improve his/her personal skills and behaviour. These views are not necessarily the same. A student may want to focus on one improvement such as “be even better in computer programming” whereas the teacher finds it more important for this student to “improve his/her foreign language ability” or to “adopt a more collaborative behaviour”. All these considerations led us to extend our UMaLG to include different views.

Starting from the current UMaLG (real view) for a particular student (calculated as defined previously), the student would like to improve certain characteristics of his/her avatar (exactly as a user tries to make his/her avatar evolve in an RPG, which is a fundamental motivation point in such games). By defining these desired improvements, s/he defines his/her personal target, a future virtual UMaLG view. In parallel, the teacher can have his/her own vision of the improvements needed and defines the academic target, a future virtual UMaLG view. This object can thus take several forms and can be a negotiation object for making an action plan for the improvement of a particular student. This is richer than a simple mark report, because the behavioural aspects are present, too.

We now describe how the actions are possible on the UMaLG.

Personal Target

This view is interactive whereas the real one is static. In order to set personal goals (levels to reach), the learner is allowed to act on cursors, to tune the value of certain characteristics (see fig. 6). Such a view will help the learner to keep in mind his/her wishes and what to favour in terms of learning exercises in order to reach these objectives.

Figure 6: Example of “Personal Target” view of the user model for learning games

Academic Target

This other interactive view is dedicated to the learners but only modified by the teachers. Some cursors may be “pushed” in order to advise the student to make an effort especially on a particular characteristic (skill, behaviour or preference): “reach this value in such a domain, be more cooperative, be less talkative, use the chat or this tool more, improve your English, etc.” (See the resulting view for the student in fig. 7).

Furthermore, the system is able to provide an action plan for reaching the objectives described in the targets by using the rules and values of the different characteristics (calculated as described in 4).

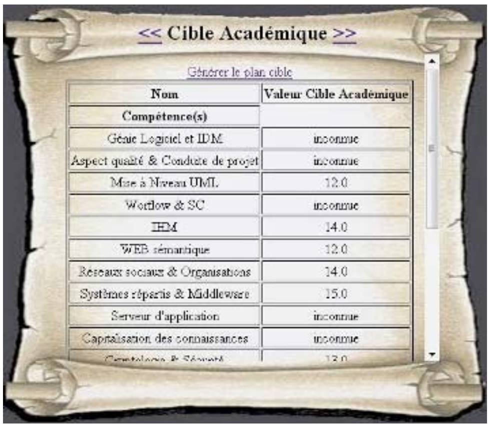

Figure 7: Example[4] of “Academic Target” view of the user model for learning games

Plan generation to reach virtual views

Metadata are associated to each pedagogical action (scenario, exercise, quiz or whatever similar learning action) available in the environment. These metadata describe which characteristics the pedagogical action is supposed to improve, and the application scope of the exercise. This last point allows us to take into account the level of difficulty of an exercise. If it is simple, and if the user is already an expert, he won’t gain any experience by doing it. It is the same if an exercise is difficult and the user is a novice in the related field.

For each objective set in a virtual view, it is possible to add a plan of activities to carry out in order to reach it. For example, an activity plan may propose new scenarios selected in order to enhance a particular value concerning a skill or a behaviour that must be improved. As shown partially in fig. 8, an activity is composed of a description (name), a goal and a set of actions that allow this goal to be reached. The action plan is generated from the set of characteristics to be improved and from the description of the available pedagogical actions. Applicable exercises that enable the identified characteristics to be improved are added to the plan.

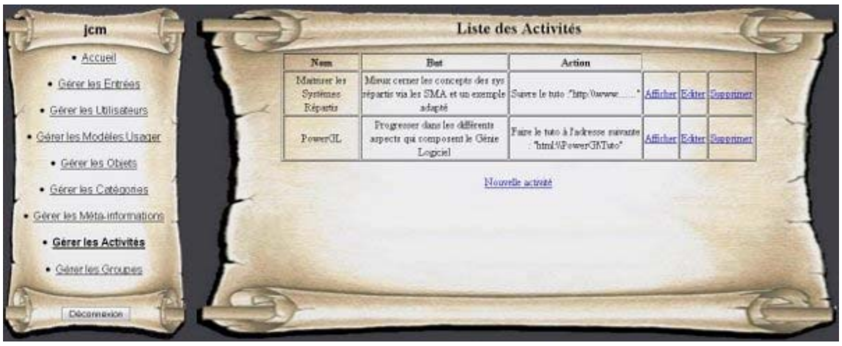

Figure 8: Activity plan

All the propositions we have made on user modelling apply to individual users. However, as already mentioned in the introduction, learning games allow collaboration in the learning process. We now propose to extend the user model concept to groups of learners.

Group Model

For the teacher and in the context of collaborative learning, we offer the possibility of managing the characteristics of groups of students. The administrator of the group is generally the teacher and for each characteristic chosen, s/he needs to know the minimum, the average and the maximum values. For instance, defining a specific group model is well suited for evaluating a project group in a project-based pedagogy (see fig. 9).

[4] ***NB: Here, non interactive because logged as owner and not as teacher.***

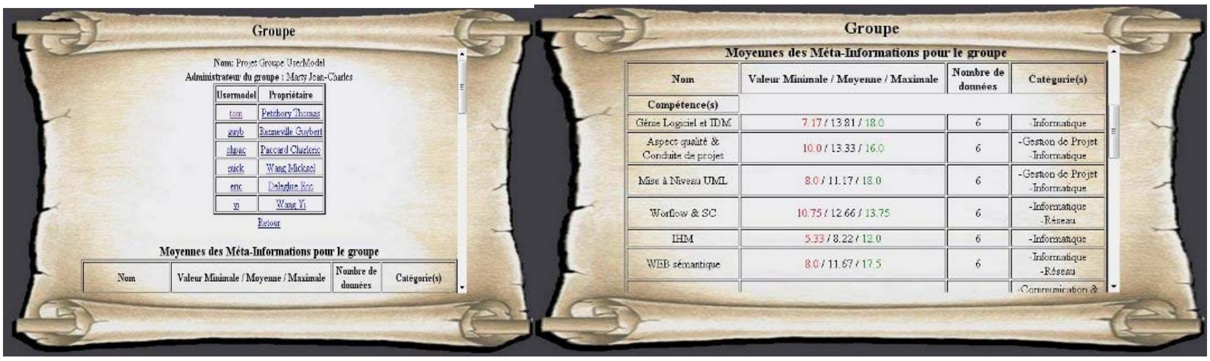

Figure 9: Example of group model

All the statements presented for individuals concerning their user models remain true for groups. It is therefore possible for a teacher to set some objectives through the group model. However, generation of plans can be somewhat tricky because actions can be appropriate for some people and not for others. This means that new metadata on pedagogical actions concerning group improvement should be defined. This work has not been carried out yet.

Experiments

A small experiment has been made in order to validate the feasibility of this approach. A group of 15 students has used our learning game including the user model described in this paper, in a practical work session in computer science. Although the session produced valuable results from the students' point of view, many improvements must be foreseen. Some students reported the fact that interpreting the semantics of the behaviour graphical representation was such a hard task. It is interesting to point out that increasing the immersion for the users finally turned out in a loss of awareness, since textual information contained easily understandable semantics. We also noticed that students did not use "naturally" the group model. They tend to adopt an individual approach while playing a learning game. This can be due to the nature of the proposed learning scenario, which did not contain pure collaborative tasks, but this must be checked. From the teacher's point of view, it is quite difficult to express the metadata on exercises and to describe the associated rules. It is of course very difficult to generalise from such a small number of students. We are aware of the fact that the domain of study is very specific and that we need to evaluate this approach with a larger range of students and teachers in different fields.

6. Conclusion and perspectives

In video games, information concerning the characteristics or properties of the avatars representing the user is generally available and visible to other players. In this article, we have illustrated a way to integrate into and update a user model in a learning game. Similarly to what is found in RPG, new parts are proposed: skills and behaviours. Important features of learning games (observation of learning progression and collaborative facilities) are thus directly exploited to enhance learning sessions.

A user model adapted for learning games may be seen as a collaborative object describing a learner, remembering personal and academic objectives and proposing plans to achieve them. Moreover, other players may then use this object to find adequate partners to progress in the game ("Such a user being strong in such a domain, I may ask him/her for some help").

An example of this user model is illustrated here with one of our learning games; however, a new more robust version is currently being developed, implementing such a user model in a more generic environment. We are still working on skill and behaviour representations in order to adapt them more easily to every (game design) environment. As side effects, some improvements also have to be made with respect to the game scenario definition (metadata on exercises) in order to take into account the evolution of the user model.

In the PROCOGEC project (Collaborative Software of Knowledge Management) supported by the French Research Agency (ANR), we propose a more general framework regarding the use of collaborative traces in order to update the user models. Our main perspectives of work will try to exploit our proposition for learning games in knowledge management collaborative platforms (Beenen 2004; Beylier 2007).

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Virtual Learning Landscapes to Enhance the Student Learning Experience

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Abstract: In recent years, Game Based Learning (GBL) has received considerable attention as an approach to improving the educational experience for students. In particular, Higher Education institutions have used GBL to help improve student engagement and retention. Research conducted at the University of Ulster over the past three years has demonstrated that enhanced representation and feedback techniques, inspired by game design patterns, can significantly improve student engagement in terms of both participation and performance. Extending the ideas from this work, in this paper we discuss the pedagogical implications of these results for structuring the learning process and enhancing a student's sense of identity within the learning context. We propose the use of a Virtual Learning Landscape (VLL), couched in a multi-user virtual environment (MUVE), where the landscape is symbolic of an educational programme and the multi-modal feedback experienced by a student within the environment is representative of their progress on a course. The proposed VLL framework uses game technology to provide an interactive virtual environment that students may traverse to gain better feedback compared to traditional means. Through dynamic interaction with a virtual environment the student can gain a better understanding about their educational strengths and weaknesses. The visual landscape allows for additional cues about particular aspects of the educational programme in relation to the overall context of the learning objectives. We perform a requirements analysis for the proposed VLL system and discuss core structural principles. The architectural design is presented and alternative learning components suggested.

Keywords: Virtual worlds, identity, feedback, engagement

1. Introduction

The past decade has seen many changes in higher education in the UK. The Higher Education Funding Council for England lists widening access as one of its strategic aims, the rationale being that it is vital for social justice and economic competitiveness. As a result, class sizes in many disciplines have increased over a period of time in line with government targets while funding in recent years has been reduced (Wiji Arulampalam et al. 2005). Like many others, in our University we are teaching to a wider ability range of students than we did ten years ago. Lecturers are becoming increasingly reliant on computer assisted learning (CAL) technology and learning management systems (LMS) to cope with increased demands on their time within the holistic managed learning environment (MLE). Changes to University funding models, the changing profile of the student demographic and changes to student funding have made student retention a priority for many HE institutions and there have been a variety of initiatives introduced in order to address this issue. Addressing conflicts between recruitment and retention, offering stronger study skills and learning support mechanisms, integrated into the curriculum and offering peer mentoring have all been proposed as methods of improving retention. What is generally agreed is that student retention is closely linked to engagement – the student who is actively engaged in his/her studies is less likely to drop out. In this paper we present a game based learning approach designed to improve student experience through by enhancing their sense of educational identity. This approach is more based on structuring and enhancing the educational learning process than it is about bringing games into the classroom situation.

2. Games and game technology for learning

Interest in Game Based Learning (GBL) has increased in recent years aided by the increasingly supported view that GBL approaches may help make learning more fun. We play games for many reasons (Perry & DeMaria 2009, pp.xx-xxvi) though the most immediate of motives is to be entertained. As such, many GBL approaches seek to leverage the "fun" aspects of games into an educational learning process, as a kind of encouragement of engagement. However, it has become increasingly understood that games offer more educationally than to just inject fun into learning scenarios. Well constructed commercial videogames may be considered as effective designed learning machines (Gee 2003). Recognising this capacity of commercial games and also how that fun is just as important to learning within an educational process as learning is central to effective progression through a commercial game (R. Koster 2004). So the use of games in education is not about injecting fun that is missing from traditional learning processes but rather it is about trying to enhance the fun that is inherent in most learning anyway.

2.1 Games patterns for GBL design

Let us consider the MDA model shown in Figure 1 (Hunicke et al. 2004). This is a practical model with an obvious structural analogy to Managed Learning Environments (MLEs).

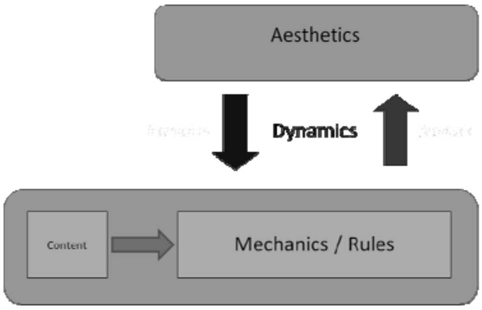

Figure 1: MDA: Basic layers of a computer game

In the MDA model we may think of the *mechanics* of a game as rules encoded by the programmed logic. This underlying formal system constrains what a player can do or achieve within a game through code, e.g. movement, interactions, or scoring. The rules of a game may be explicit, as in game scoring systems created by the designer, or implicit, as with emergent player strategies that evolve through *dynamic* interactions within the game world. Rules, constraints, or styles of play designed by players are separate from the programmer "coded" mechanics. The game rules (formal) together with the player rules (informal) may be referred to as the *institutions* of a game (Thomas & Brown 2009) and it is institutions that fully describe the limits of gameplay, particularly within multiplayer games. In a game environment, a player receives *aesthetic* multi-modal, immediate feedback (visual, auditory, haptic) on the basis of their interactions.

Salen and Zimmerman's (Salen & Zimmerman 2003) definition of a game as "*a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome*" nicely summarises and updates definitions by Caillois (Caillois 2001) and Huizinga (Huizinga 1955). Their definition incorporates the central idea that a game inherently contains well defined or discoverable challenges with realisable rewards. A player interacts with the world to take on a challenge and receives positive or negative rewards based on the outcome. In this way, most games have a greater emphasis on ludus than paidia (Caillois 2001). That is, the mechanics layer of a typical game is more fundamental to gameplay than the aesthetic layer (R. Koster 2004); a primary goal of a player is to uncover the rules of play in order to be a better player and win the game.

The GBL system design that is utilised in the experiments described in Section 2.2 is based on emphasising the ludic structure of an existing course, and providing feedback to a student based on participation and performance within an MLE. Computer games may be considered as powerful, effective teaching systems that are designed to teach rules or impart knowledge (Thomas & Brown 2009; Gee 2003). In the same way the institutions of an educational course may also be considered analogous to the "rules of a game" and aesthetic feedback provided to students on this basis. The overall goal of our experiments may be thought of as to expose the implicit and explicit institutions of a course by treating its structures and processes like a game and so empower a student with an improved educational self-awareness. The hope is that an enhanced sense of educational identity may lead to improved engagement within the educational process.

2.2 GBL feedback experimental results

Several game based learning feedback (GBLF) experiments have been conducted at the University of Ulster (Charles et al. 2008; Charles et al. 2009; McGinnis et al. 2008). These GBLF experiments have evolved through a series of iterations to test the hypothesis that feedback techniques inspired by commercial game design can enhance student engagement. Here we summarise the key findings of the experiments and follow on to provide an analysis which draws out the important lessons for taking the GBLF principle forward. The motivation for these experiments is based on the observation that games are particularly good at providing feedback to players. Feedback is one of many things that computer games and educational systems have in common; timely, informative feedback is crucial for learning, engagement and progression both in games and education (Charles et al. 2008).

Although there have been several evolutions of the basic experimental and system design, the central principle has remained the same. Statistics on student performance and participation are recorded, including attendance, class participation, extended study tasks, voluntary revision, reflection and personal development, group work, and a number of other factors that provide some level of information about student engagement. During experiments, these statistics were fed back to students in as timely manner as possible using charts and other web based graphics. The aesthetic feedback of student statistics on a programme of study exposed the underlying institutions of the course; providing students with an opportunity to interact with the MLE in a more dynamic manner. Like a game, through this closed loop feedback system, students are able to learn the “rules” of a course; the implicit and explicit practices that enable them to become effective learners. In this way we can see that the GBLF approach is modelled on the structure of a game, where the institutions of a course are thought of as being analogous to learnable game rules. A reward system is used where students are awarded points and achievements (like the Xbox Live! approach) on the basis of their dynamic interaction with the system and how well they perform based on the underlying system rules. These points and achievements form the basis for aesthetic feedback to the student.

The quantitative and qualitative results of the GBLF experiments have proven consistent over two years. In addition the GBLF experiments were implemented on three different Computing student year groups and in each case engagement was seen to be improved and the following factors generally encouraged:

- A pleasurable learning experience
- Better performance
- Improved student participation in voluntary and non-voluntary tasks
- Higher levels of attendance
- Study beyond the basic material
- Students took on extended challenges
- Better group dynamics

These first experiments have been very successful in representing the institutions of an existing course within the structure of a game and using this as the basis to inform the representation of a student’s educational identity. In this way, an emphasis has been placed on course mechanics rather than aesthetic representation of student and course. We believe that the GBLF approach has most to gain by focusing more on the aesthetics of the system in future. In (Hunicke et al. 2004) eight fundamental modes of game aesthetic where identified:

- Sensation: Game as sense-pleasure
- Fantasy: Game as make-believe
- Narrative: Game as drama
- Challenge: Game as obstacle course
- Fellowship: Game as social framework
- Discovery: Game as uncharted territory
- Expression: Game as self-discovery
- Submission: Game as pastime

Submission relates to immersion within the game, and the emotion relating to sensation/pleasure encompasses a wider range of the player experience than simply to use the word fun. Pleasure in a game may be gained in many ways, exposing both negative and positive emotions, including the transversal of a narrative and through exploration and discovery of self. Of these eight modes of aesthetic expression, self-discovery and fellowship are particularly relevant to educational system design. It is believed that the GBLF system design can be improved by focussing on these key aesthetics in particular and developing a richer interface.

3. Virtual worlds for learning

Perry an DeMaria define a game world as “*the entire environment in which players have their experiences*” (Perry & DeMaria 2009, p.409). Creating opportunities for interactions within a virtual world that give rise to pleasurable experiences is a central goal for designers. However, Bartle’s

(Bartle 2003) categorisation is more practical for our purposes. He states that a virtual world must have the following five components:

- The world has underlying rules that enables players to effect changes within it.
- Players represent individuals or entities in the world. This is their character and interactions with the world are channelled through their character.
- Interaction in the world takes place in real-time. Feedback is immediate.
- The world is shared.
- The world is (at least to some degree) persistent.

This criteria for virtual world design fits well with the educational requirements for our proposed virtual learning landscape (VLL) design. Virtual worlds are flexible spaces and may be used for many purposes that may or may not be game-based (challenge oriented). Bartle argues that the tendency of current virtual world design to emphasis either the achiever (ludus) or socialiser (paidia) preferences is largely historical (Bartle 2003) and that virtual world design needs go back to its roots (Bartle 2009) and restore the socialiser/achiever balance within the same game world. Revisiting notions like the “elder game” where after players find mastery within the world they have other roles to take on, such as mentor and world builder. Bartle envisages a virtual world which accommodates varying styles, and differing abilities. He argues that a virtual world may be more designer-directed to begin with and increasingly more player-directed over time.

3.1 Virtual worlds and identity

There are a number benefits in the use of virtual worlds for education (Salt et al. 2008), some of which may summed up by what Lim calls the “*six learnings”* from Second Life: learning by exploring, collaborating, being, building, championing, expressing (LIM 2009). These are recurring themes throughout much of the writing on virtual worlds both for entertainment and specific learning contexts, and so we consider these in the design of our VLL multi-user virtual environment (MUVE). However, learning by being, self-discovery, and identity are central to our approach so we will now consider these aspects of a virtual world experience in more detail.

Virtual worlds can have a role in reinforcing the ego of a learner as “*avatars act as agents of identity*” (Taylor 2009). Embodiment within an avatar endows the learner with some measure of agency and presence within the world, thus transforming the virtual world into a sense of space (Thomas & Brown 2009). A sense of “being there” within virtual worlds require us to think about “knowing” rather than knowledge. “Learning to be” first rather than “learning about” (Thomas & Brown 2009). Situated learning is central to the learning process within virtual worlds, and the power of situated learning is in its ability to help shape notions of identity in relation to the institutions or infrastructures of the virtual space (Gee 2003). One’s identity is defined and constrained by the “rules of the game” or the structure of a virtual world. This is especially so within our VLL world since some of the infrastructures of the VLL will be constructed by information related specifically to the learner, for example the height of 3D landscape may be dynamically altered based on student performance statistics.

Virtual spaces take us on journeys of self-discovery that we share with others. We collaborate as we explore these spaces, and as we gain mastery we build and become leaders.

3.2 VLL requirements

There is tension between a virtual world participant’s agency and the virtual world’s institutions. Increased imposition of institutional structures inevitably results in a reduction of agency (i.e. more designer direction leads to less participant control, choice, and freedom). So, what is the role of the teacher? Can a balance be struck in the design of a virtual world between paidia, offering freedom to explore and express, and ludus, in providing guiding pedagogical structural support for learning? There is an educational dilemma to consider because increased sense of agency comes at the expense of teacher-centered learning objectives. The learner is more empowered though some control for the learning process transferred from the teacher. So an overriding consideration in the creation of a virtual world for learning is in how to facilitate learner self-determination whilst also enabling appropriate pedagogical guidance.

In our earlier discussion we have uncovered a number of crucial factors for the design of learner-centered systems, many of which are common across games, virtual worlds and in learning technology design. Well designed games and virtual worlds, whether educational or entertainment based, should be user-centric, and learning is at the core of this. Providing a learner with an avatar within a virtual learning space is a crucial requirement. It engenders a powerful sense of being and acts as a placeholder for their identity. An avatar facilitates social fellowship and provides richer opportunities for expression and exploration in a virtual space. Ideally an avatar should be able to be altered to appropriately represent the user.

A virtual world needs to be highly interactive, i.e. things to do in the world rather than simply have things to see. A virtual world design should be accessible and interesting to variety of different types of participants. We may consider Bartle’s achiever and socialiser as two key classifications of type within virtual worlds and in doing so we recognise that this dichotomy should be accommodated in the virtual world design. Some students enjoy competition whilst others prefer collaboration; some learners thrive on tackling on set challenges whereas others are happier to establish their own goals. Balancing choice and control is at the crux of much virtual world design.

Retention in virtual worlds has also been a topic for debate recently (Raph Koster 2009). We can learn a lot from investigating new commercial virtual worlds such as Metaplace and FreeRealms. The world should feel persistent and alive, and to some degree evolve over time. The easiest way to make a world feel vibrant and dynamic is to enhance the multi-user aspects of the world. Attract players into the world and facilitate their interaction. Virtual world economy, culture, and politics need to created and nurtured in a way that provides rewards for active participation within the world, and supports the growth of structural aspects of the world. For example, in Metaplace a player is provided with a wide range of feedback including a player profile based on to what degree they are a socialiser, builder, or explorer. Players are rewarded with “coins” for participation within the world (which can be spent on new items), “badges” for particular achievements, and players “level up” in the manner of an RPG. This economy helps bring the world to life and a player forms a stronger attachment to their avatar/character as it develops (a player profile) over time to hold a closer likeness to the player (or how they would like to be seen). A player’s avatar becomes an investment and an emotional connection strengthens over time. The capacity for an avatar to represent its user progresses over time, as choices are made and goals/landmarks are reached, and so the possibility of a virtual world participant becoming embedded social within the world may also increase.

4. Virtual Learning Landscape design

For our VLL design to be successful it needs to be part of a MUVE which prioritises social interaction (see Fig. 2). Many virtual worlds provide a range of social opportunities on top of the usual social network channels such as chat windows, forums, blogs, embedded video and web links, RSS feeds, twitter tools, etc. For example, a central hub is commonly used as a primary meeting place for virtual world design. It is important that a virtual world has a logical focal point; a centre of gravity where people congregate and connect with each other. The social hub within our MUVE can be a powerful mechanism to facilitate groupings of learners which cut across the existing boundaries of course, year group, and friends. These groups may be short-lived and loose (ad hoc) or have more temporal permanence through a user actively joining an existing group formed of users with a common interest (e.g. a guild). The social hub can also have real world meaning and practical purpose and in our design the hub has many of the commonly used social networking tools but can also provide a few other hooks. For example, we have made a prototype of a central hub based on an abstract representation of our campus (see Fig. 2). This visual representation of the campus and also represents a logical visualisation of an underlying website of links to helpful information: student accommodation, student union, student support etc. For example, in the place of a text link to the library we have a hyper-linked 3D model of the library, placed as it would be on campus. The use of a virtual landscape to present the complex interconnection of information required by a student within in higher education can be a very powerful modus operandi.

As discussed in Section 2, one of the key findings of recent feedback based GBL experiments were that, even though students enjoyed personalised feedback, a majority preferred that sensitive personal performance information was made only privately available to them. This is one of the areas that require most care. The requirement to support a certain amount of bragging rights and the ability to demonstrate prowess within the community should be balanced against the possibility that the feedback system may lead to undue negative self-image. These safeguards are particularly important as we consider the design of the VLL, which will potentially expose the very core of a student's current educational capability. Granting a student access to a personal space, e.g. the houses provided for players in PlayStation 3 Home, enables a student to have a private area of the virtual world that they can tailor to their own needs. Their achievements may be displayed in a trophy cabinet (e.g. PS3 home), as certificates on the wall or similar. They may keep the space entirely to themselves or invite friends in. As can be seen in Figure 2 our MUVE design includes a personal space.

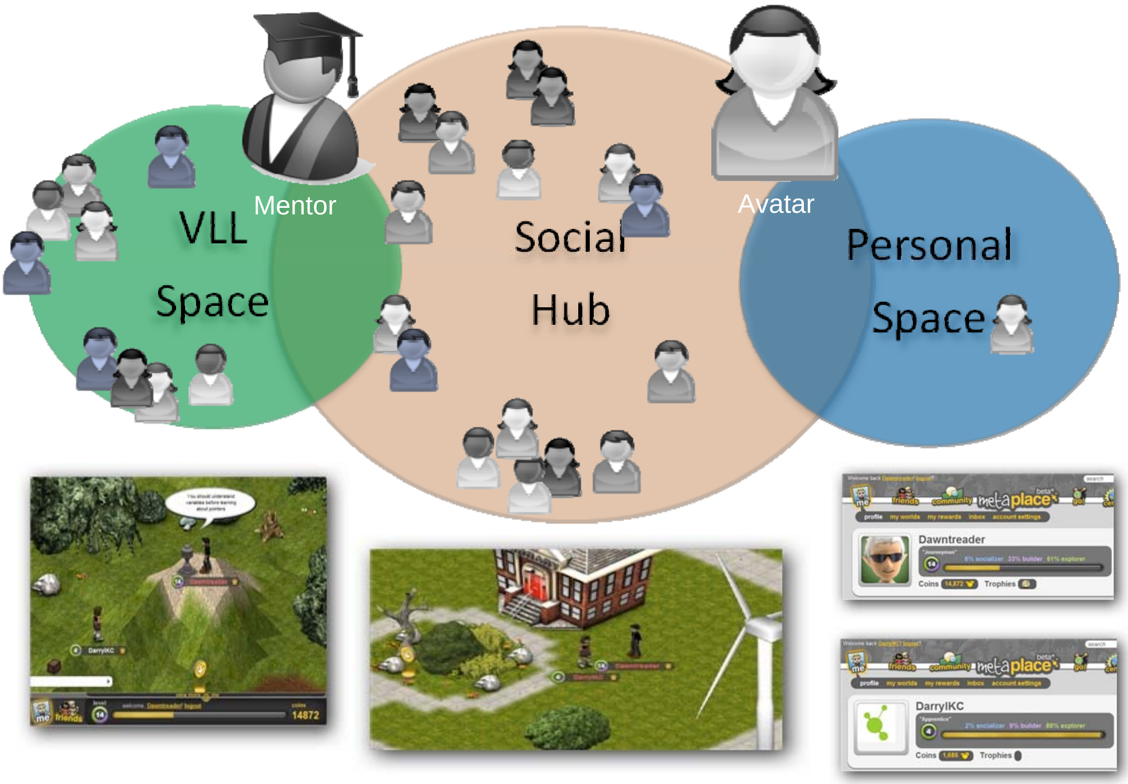

Figure 2: MUVE structure incorporating a Virtual Learning Landscape. Also shown are screen shots from an early prototype in Metaplace (Beta)

The economy of virtual world is important, and Metaplace provides an excellent model of how this may be set up to help address the problem of retention. Metaplace has three types of virtual capital: coins that are awarded to the player avatar as they participate in the world, trophies for specific achievements, and avatars also level up on the basis of their contributions to the community. Coins are the basic currency within the world for buying and selling items, for example to personalise your own space. The levels of a character and the trophies that they have attained are a form of social currency; it illustrates an avatar's standing within the community and helps form the cultural, social and political fabric of the world. It helps bring the world to life, and it increasingly strengthens the attachment that a person has with their avatar, the virtual world and the co-inhabitants of that world. In our MUVE, as a learner's avatar levels up, gathers achievements and thus gains stature, that person is offered the opportunity to lead or mentor younger or less capable members of the society. Through such ideas, structured hierarchy is established within the world.

The third aspect of our MUVE architecture is the Virtual Learning Landscape. The VLL may be considered as a kind of educational virtual sandbox for student feedback; an area within the MUVE enclosing a 3D virtual landscape that may be explored by individuals, or by groups of learners. Learners move around the environment to investigate the relationship between an abstract visual representation of their current educational understanding and the core concepts/knowledge required on a course of learning. A dynamic relationship is established between the avatar and the virtual landscape once the learner enters the VLL. Each time the learner enters the VLL feedback is generated by means of the avatar-landscape interface, and this is different for each learner or groups of learners. An avatar's capabilities and characteristics are generated from learner statistics (e.g.

attendance, quiz results, class participation) and these attributes reflect on an avatars ability to interact with virtual world. The landscape on the other hand is terraformed to abstractly represent core concepts or knowledge of a course where, for example, a large hill symbolizes the more difficult aspects of a course.

Our VLL may be best understood through a practical illustration. The following case study assumes that core knowledge/concepts represented within a VLL sit across a course rather than being related to a specific module.

Individual Study: Betty Jones (BJ) is a 1st year undergraduate student on a computer games course. Physics was her best subject at school and she would like to be well placed to be able to pursue a career as a games physics programmer upon graduation from university.

- BJ's avatar enters the VLL and she is able to move around a landscape containing hills and valleys. She is able to interact with landscape and objects placed on the landscape. The hills represent core concepts/knowledge on her course and when her avatar moves close to a hill she can click her mouse on objects placed on and around the hill to illustrate material that is important to learning about that particular core concept (hill). Through this she able to quickly determine the important aspects of her course.
- BJ moves her avatar towards the mountain that represents Games Physics (a specialist topic in final year) and notices that it is quite steep compared to Programming Hill (taught in each year). Her avatar is endowed with physical attributes that relate to her year of study and her individual course statistics. As such she discovers that it is necessary to climb on to the foothills of Programming Hill before moving on to Physics Mountain. She notices several sign posts in the foothills of Programming Hill that represent familiar topics from Java I programming module. By clicking her left mouse button on the objects that represent these topics then different related areas "light up" within the landscape to illustrate the relevance of these topics to the key concepts/content within the course. For example, clicking on the "variables" placeholder lights up much of the landscape, because this is such a core concept to the computer games course.
- BJ tries to steer her avatar up Physics Mountain but finds that she can only go part of the way up. A message box "pops up" to tell her that she has not covered the perquisite subject matter (on the course) or proved herself capable (through voluntary quizzes, lecture interviews etc.) of conquering Physics Mountain. However, she can explore the foothills and click on information place-holders that help her understand which core concepts, knowledge and skills relate most to her favourite topic. Through exploration she discovers that her weakness in Maths may have an impact on her capability to specialise in Physics and information placed on the learning landscape helps her understand how she can find help to improve this.
- A right mouse click on the Game Physics Mountain reveals a context menu. One of the options is to pull up a 2D diagram that illustrates the principles on which game physics rely – namely, "Newtonian Physics" and "Numerical Integration". Simultaneously the map view updates, showing a colour-coded representation of where in the course these subjects appear. Another right click option allows her to see a list of fellow students who have attained various achievements in the topic such as the Game Physics Top of Class trophy. She is also able to identify fellow students who are willing to act as mentors and "guilds" that she may join that are complimentary to her skills and interests. A further option in the context menu brings up career pathway illustrations relating to the topic context.

These are only a few illustrations of the potential power of the VLL to enhance a student's educational identity. The VLL may also be extended to group use. Individuals can form groups and enter the VLL as described above, simply to explore the landscape collectively, or to play simple games. Because each learner's avatar is endowed with different attributes based on their educational standing (one can visualise this as a typical avatar in an RPG), this makes for some interesting gameplay dynamics – particularly in multi-player games. Games based on this premise can add substantially to the retention qualities of the overall MUVE. Another useful separate group application of the VLL is to alter the height map within the VLL based on the composition of the group of learners who enter the VLL. In this way the VLL can be used to more fully explore the strengths and weakness of groups. It may be used to organise balanced groups for coursework assignments.

5. Conclusion

In this paper we have discussed the importance that feedback plays in empowering a learner to establish and understand their educational identity. We reviewed previous GBL feedback focused experiments and discussed the pros and cons of the basic approach. After a review of virtual world technologies and their use within education, we moved on to outline how virtual worlds can be used to enhance educational feedback and the learning experience. In particular, we have shown that identity and the social dimension are enhanced substantially through the use of virtual worlds. These ideas informed the design of our Virtual Learning Landscape, which is embedded within a socially oriented MUVE. The VLL enables learners to explore their programme of study in a visual way and because their avatar's attributes are formed from their educational statistics, the learner can also gain insights into their own personal educational identity. The embodiment of the learner within an avatar, which exists in a virtual world representing a programme of study, enables the learner to go on a journey of self-discovery that greatly empowers them to make choices within their learning context. The next phase of the project is to complete implementation of the MUVE/VLL based on the findings our prototype experiments. It is intended that initial trials will begin across year groups of our game development degree course during the next full academic semester using a design research methodology utilised in previous experiments.

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Democratization of Creativity and Cultural Production in Virtual Worlds: A new Challenge for Regulation and Cultural Management

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Abstract: This paper examines the use of online, three-dimensional, immersive virtual worlds, such as Second Life®, as an interesting platform and tool for cultural management, artistic development, knowledge exchange and cultural business. These contemporary computer technologies provide a new showcase for cultural promotion and creative production, as they connect artists and producers with an audience around the world, who, in turn, can access in real time a great variety of cultural content through just a few clicks. The various features of this emerging phenomenon all help to democratize culture, the arts and education, as they bring creations closer to consumers, thus reducing the need for intermediaries and breaking down social, economic and political barriers; this offers benefits to cultural industries, non-profit organizations, governments, collective and individual creators and artists. However, the numerous possibilities ushered in over the last few years not only bring benefits but also pose new challenges in terms of regulation. Indeed, this new stage for cultural and artistic expression and management may require new paradigms of control with a different focus, ones which can provide an alternative understanding of online cultural exchange in real time. Virtual worlds make culture more democratic, as it can be reached for free by a wider range of people in real time; furthermore, artists and creators are provided with an accessible showcase in which they can become better known and where they can interact more directly, immediately and closely with their audience. The possibility and ease with which anyone can create original content in the metaverse is an incentive for creativity, because it allows people to express themselves in original ways that enhance the contents of virtual life. Art thus finds new and different formats, and cultural management discovers new spaces to break into. At the same time, anonymity, privacy and intellectual property are all issues that need to be addressed. The regulation of virtual worlds may require different ways of thinking and the adoption of new paradigms which consider exchange, democratization, cooperation and sharing as essential ingredients of these new sets; as such, any rules must control but not restrict, thus avoiding anarchy at the same time as keeping interaction levels high. In the European Year of Creativity and Innovation it is important to consider the opportunities being opened up by these new technologies in the world of culture and education, as well as the possibilities that are emerging and which remain to be researched.

Keywords: Virtual worlds, cultural management, virtual art, creativity, regulation, fair use

1. Introduction

Recently, the development of multimedia formats and graphics in conjunction with the World Wide Web has also enabled the development of animated, multi-user, three-dimensional (3D) immersive environments with sound that are connected in real time, thus increasing the possibilities of communication, socialization, education and many other applications. These new virtual platforms are also known as *"metaverses"* because they tend to be *metaphors* of the *real universe*. Drawn by increasingly better-quality computer graphics, they enable people to interact in many ways, for example, socially or economically (see García and Martínez 2008, Carr and Pond 2007, Senges 2007, among many others).

Although there are currently many *metaverses* in cyberspace, by far the most popular is *Second Life*[1], a three-dimensional online platform developed in 2003 by *Linden Research, Inc.* (commonly known as *Linden Lab*®); the company has its headquarters in San Francisco (CA, USA) and offices in other US cities, as well as in Brighton (UK) and Singapore. This virtual environment has the largest and most diverse community in the world, and is growing at a considerable rate. According to Linden Lab statistics they reached one million accounts in October 2006 (Linden, P. 2006) and this number has since increased significantly, such that by April 2009 there were about 16.8 million registered signups (Linden Lab 2009b).

2. The features of a Metaverse

The users, or *residents,* can, via the digital representations of themselves, known as *avatars*, interact in real time with other users by written chat or voice. In Second Life, Linden Lab is merely the service

[1] Second Life®, Linden®, and Linden Lab® are trademarks of Linden Research, Inc. This work is not affiliated with nor sponsored in any way by Linden Research, Inc.

provider, just as they specify in their *Terms of Service*, and it is the residents who are continually creating the contents of the virtual environment (Linden Lab 2009c). The Second Life code and programming are open and free, which enable residents to decide and modify absolutely every aspect of their character and environment. Furthermore, the intellectual property of the elements created remains in the hands of the resident who made them. This allows a commercial trade system for almost any goods or service, including the sale of land, real estate, objects and employment. This business is conducted using a local currency called *Linden® dollars (L$)*, which can be exchanged for money from the "real world" such as US dollars (at a rate of about L$270 for $1 USD), euro, pounds, yen, and currency from many other of the world's countries.

3. Cultural and artistic faces of Second Life

The fact that everyone can make and customize any kind of product, and edit every aspect of his or her world with the features that the virtual environment provides, constitutes a genuine incentive for creativity and artistic production, and means that virtual spaces and the environment become filled with all kinds of cultural content.

3.1 Plastic and graphic arts

Hanging a virtual picture in Second Life is as easy as uploading into the metaverse a previously digitalized image, which is then attached to an object placed on the wall. The cost of this upload is L$10, the equivalent of four cents of a US dollar. Thus, hosting a graphic arts exhibition is quite inexpensive, and saves on many of the costs of a real-life exhibition. As a result, professional artists from the real world sometimes show their work alongside upcoming or amateur artists, all of whom therefore have the same opportunities to be seen, thus democratizing these spaces. In this regard, each artist has the same likelihood of being known for his or her work, which is what matters most, regardless of his or her real-life background.

3.2 Music

Music has made a big impact in Second Life because it is easier than in real life for musicians to play their tunes and be heard by lots of people from around the world in real time. Using specific software that can be obtained for free (although there are also payment options with better features), musicians can send the audio signal from their local PC to a server (commonly called stream), which is used to distribute the signal to connected users. Every place in Second Life allows its owner to define the audio set-up of the land and there play the content of a *stream* server in real time. The owners can even give set-up permission to other people, such as managers, assistants or musicians themselves. With a few exceptions, all the concerts hosted in Second Life are free to the public.

Stream servers can easily be lent or rented from other residents, and there are also specific enterprises that offer this service. Most venues which hire musicians or let them play there for free have rented a *stream* server and provide the musicians with the information that allows them to login into the server and send their audio signal into cyberspace. However, everybody, whether or not they are musicians, can rent a *stream* server.

Musicians can also play a previously-recorded audio and host a "playback" concert. The same method is used by DJs who mix recorded music for a dance party or other kind of event. However, there is also the possibility of performing live and being heard in real time around the world. Singers and instrumentalists can plug a microphone or instrument into their local PC and then perform in order to generate an audio signal that will be sent through the *stream* server to the audience in the virtual venue. They can also interact with the audience, receive applause, get immediate reaction to their performance and adapt the show to the taste of those in attendance.

3.3 Design and architecture

Design and architecture also have a special place in the metaverse through the elaboration of all the avatars' components (body shape; skin; formal, casual and sportswear; underwear; costumes; footwear; and hairstyle, etc.), as well as the spaces that can be occupied (houses, buildings, squares, streets, landscapes, hills, valleys, rivers, seas, oceans, etc.). The creation of these elements illustrates the creativity of the artists who made them by using specialized graphic design software and then imported them into Second Life. This is currently the main source of business and trade in this environment.

3.4 Audiovisual

Movies and television have their counterpart in the virtual world through what are known as *"machinima"*, which are animation videos made with digital 3D images. These are a widely-used resource for virtual TV channels, as well as for promotional videos, short films and even music video clips, among many other applications.

3.5 Publicizing events

Every artistic production, once it has been made public, is available to any resident in Second Life. All they need do is login and know the time and virtual address of the event. This metaverse includes many forms of communication for advertising the events occurring in Second Life, and not only artistic ones. Indeed, the Second Life official website includes a section that hosts announcements about events being organized anywhere in the world. Avatars can also subscribe to different groups within Second Life that are created and managed by residents with the aim of bringing together people with common interests. However, the number of groups that each avatar can join in Second Life is limited to 25, so it is necessary to find alternative ways of receiving news. Some applications and programmers have integrated into Second Life the family of web-feed formats coded with XML language, such as RSS, in order to create a sort of alternative group for sending updated one-way information to residents without the need to occupy a slot in the avatar's group allowance.

3.6 Virtual cultural industries

The production, display and exchange of artistic content enable the creation of cultural enterprises dedicated to a wide range of disciplines. Many such businesses not only obtain regular work and income, but also become serious enterprises with a structure, a budget and a team; examples include the management of music groups, artists, venues, concert halls and theaters; recording studios; TV channels; radio stations; and publishing houses, etc. Some of these industries exist solely in Second Life and only manage content of this virtual world. However, others are offices or extensions of real life enterprises that use cyberspace as an additional tool for their business.

3.7 Virtual cultural tourism

Metaverses are used to create three-dimensional replicas of the most representative content and heritage of a real place in the world with which users can then interact. The realism that some of these replicas achieve is impressive. Some of them have been carefully made to scale with rich details and original textures taken from the real place, and thus the feeling of "being there" is easy to achieve. The initiative behind these projects comes from a variety of sources. Some are unintentional — or at least non-explicit — cultural tourism plans, which means that their creators were motivated simply by their own attachment to the place in question (even though they might not be natives themselves). Thus, some of these exhibitions were developed by private individuals who dedicated their time, effort and land in order to recreate a place they love and to share it with other people. However, there are also institutions or organizations (public or private) that have chosen to develop a formal project for promoting cultural tourism in their respective regions.

One such example is the case of Mexico, and Second Life includes many islands that aim to show representative items of Mexican culture. Some of them have a more commercial objective as they present buildings, monuments and squares, sometimes accompanied by information and explanations, that are surrounded by large malls and billboards of real-world businesses.

On the other hand, there are three islands that have been created by a direct initiative of the Mexican government, and which are supported entirely by it. In June 2007 the Mexican government contracted Linden Lab to build on a new island a replica of the archeological site of *Chichén Itzá*, the objective being to promote it as a New World Wonder. Due to the success of this initiative they decided to develop the project by buying another two islands on which to include the regions that form part of the "Mayan World", replicating other archeological sites such as *Palenque* and *Las Ventas*, natural environments like the *Misol-Ha* waterfall and lake, and the colonial city of Campeche. All of these sites are to be found in the southeastern states of Chiapas, Tabasco, Campeche and Quintana Roo.

According to public information, the Mexican government spent during the period June 2007 to December 2008 about US$117,000 on the whole project, including the island fees, builds, musical background, management and promotion of these places. They also have a budget of US$30,000 for 2009 for the maintenance of the three islands. All these places offer residents free guided tours around the islands, as well as explanations of their content (Consejo de Promoción Turística de México 2009).

There are also other kinds of projects supported by private non-profit organizations, for example, the island *Opera Joven*, where a Mexican association developed a project to promote cultural tourism in the state of Jalisco; this included representations of the Tequila Landscape (a UNESCO world heritage site), Chapala Lake, emblematic buildings and monuments from the city of Guadalajara, and mariachi music, as well as handicrafts, traditional clothing and gastronomy in the market of Tlaquepaque.

In addition, many other places have virtual replicas in Second Life, for instance, New York, Havana, Milan, Turin, Assisi, Santorini, Barcelona, Pamplona, Seville, Moscow, Jerusalem and Beijing, among many others.

4. How far away from real life?

Anonymity and privacy are two key issues in Second Life. The ease of creating an account, the minimal requirements for real data and the non-existent (or, rarely, subsequent) confirmation by Linden Lab of the information given by users when subscribing allow each user to determine the extent to which his or her real and virtual life resemble one another. This anonymity offers some people the chance to adopt an appearance, gender, clothing, attitudes, behavior and personality that are very different from their own in the real world. However, Second Life (despite its name) is not just a place for those who want to “escape” from their own life and real circumstances and lead an “alternative life” in cyberspace. On the contrary, it is also used by many people as an extension of their real life (the so-called “first life”), as they give their avatars similar characteristics and relate them to the activities, likes, ways of being and profession they usually have in real life. This is especially the case with professionals, entrepreneurs, academics and artists. Nevertheless, in most cases each avatar constitutes an undetermined hybrid of real life, real wishes and virtual accomplishment. In other words, the user’s ideal *self* is reflected in his or her virtual representation with a mixture of his or her real experience. The line between real and virtual life and their degree of separation have different levels and are always a personal decision of users. In addition, the ease of creating alternative accounts, which means that many avatars can belong to one person, enables that person to assume as many roles and “personalities” as he or she has avatars, thus increasing the variability of mixtures between real and virtual life. At present, there is no reliable way of relating and proving the relationship between the avatar and the user unless that information comes directly from the person behind the avatar, and even then it is difficult to demonstrate that the handler is telling the truth.

4.1 Real artists, virtual artists

Professional artists in real life can enter Second Life, bring their creations to the virtual world and boost their work in other parts of the world. Thus, there may be a close link between a real life artist and his or her avatar (the virtual artist). Indeed, a real artistic résumé may provide a good background to the virtual artist so that he or she gains greater recognition in Second Life, as well as further promoting his or her work in real life. Many artists have found this virtual environment to be an inspiration for their work in the real world, and real-world creations have also been sold in Second Life formats, thus providing income for the artists. An example of this can be found in the New York Times article published on 31 March 2009 (Corbett 2009).

4.2 Real incomes

Most of the time, artists are paid for their works or performances. Thus, photographers and video makers, as well as graphic, plastic and virtual artists can all show and sell their work or services, with the costs and conditions being negotiated directly with the purchaser. The range of prices to be found in Second Life is very wide, and the most common arguments used to justify the high fees are quality and a solid professional background. However, no matter how expensive a work may be, prices are always much lower than in real life. This is why making a living from a Second Life business is, at present, only viable in a few cases.

The most common way for musicians, dancers and performers to obtain an income is by receiving tips from the audience during their performances. However, there are many venues which offer a fixed fee to performers and also allow them to receive tips, so the overall profit depends on how much the audience enjoyed the performance and their inclination to tip. Good advance publicity is therefore important, as is a good reputation for the artist. Some artists also have managers who help them find new venues, obtain bookings and promote their work; for this, just as in real life, they take a percentage of any income. However, having a manager is not a requirement and negotiations are always made more directly.

4.3 Close to the artist

In the virtual world, artists and their audience can interact directly and immediately, something which is not often possible in the real world, and this breaks down the barriers of time and distance. The absence of physical obstacles in the virtual world makes it possible for anyone to communicate directly with artists, managers or venue owners. Anyone, whether a newcomer, artist, owner, entrepreneur or simply a fan, can contact the performer or creator and add him or her to their list of friends, thus enabling closer communication. This, of course, is not possible outside the virtual world and it thus brings audience and artist closer together.

5. Virtual world and real regulation

All the features and possibilities offered by virtual worlds bring not only advantages and benefits, but also challenge some aspects of real life such as regulation. Linden Lab has sought to exercise only limited control over the Second Life activity of residents and aims to adopt a *laissez faire* approach as regards the virtual experience of users. What they have done is establish a set of indispensable behavioral guidelines known as *"Community Standards"*, which are based on what they refer to as the *"Big Six"*: intolerance, harassment, assault, disclosure, indecency and disturbing the peace (Linden Lab 2009a). Residents must report any violation of Community Standards they witness by using a tool included in the Second Life Viewer application (the *"Abuse Report"* in the Help menu). All reports are investigated by Linden Lab and if the violation is proven, the account in question may be suspended or removed.

However, this is the extent of the policing conducted by Linden Lab, and they do not intervene in controversies between users that are unrelated to the Community Standards. The owner of a piece of land has the full right to rule, govern and control his or her property. Linden Lab simply recognizes as the landowner the person who buys it directly from them. As such, land "sales" or "rents" between users mean only giving permission (following payment) to another resident to use the land. However, the final owner (the one who bought directly from Linden Lab) is able at any time to reclaim ownership of the land and eject the occupants without any consequence; it should be noted here that the owner is never able to take or keep the tenant's objects, and must return them. In practice, however, owners rarely exercise this right because their main business depends on the trust given to renters or buyers. Thus, most of the time the real estate business works, although it is always better not to disagree or disappoint the owner, since the tenant has more to lose.

5.1 Breaking controls

Intellectual property protection is not included in the Community Standards of Second Life. However, its infringement is policed by Linden Lab as it is understood to be a violation of the Terms of Service (Linden Lab 2009c). What Linden Lab does monitor is the use of hacker software, such as *Copybot*, which breaks the Second Life blocks with which residents can control their intellectual property and enables the hacker to make exact copies of other users' objects without their authorization, as well as erasing the credits and acknowledgements of the original creators. Linden Lab takes this aspect seriously because the basis of the economy in Second Life is intellectual property protection.

5.2 Fair use of cultural contents

For many people, internet and its many resources pose a serious threat to copyright and intellectual property, and the same can be said of virtual worlds. Indeed, these worlds offer a free way of copying and sharing content without the need for permission or authorization, thus facilitating piracy. The digital recording of images, audio and texts can no longer be controlled. In theory none of the content in Second Life can be copied and reproduced without the authorization of its creator or owner, whether inside or outside Second Life. In practice, however, the images and textures that a graphic, plastic or audiovisual artist may exhibit in virtual galleries can easily be copied, just as the tunes a musician plays and streams throughout Second Life can easily be recorded without the permission of the author or performer. Indeed, there are thousands of ways of making unauthorized copies of Second Life content with varying degrees of programming knowledge, and the infringer does not need to be an experienced and cunning hacker.

However, there is also a common concept in intellectual property law known as *fair use*, which means that although someone's permission is not required, an acknowledgement of the work must be made. If *"piracy"* is understood as taking and using content without permission from the owner of the corresponding rights, it should be remembered, following Lessig (2004), that the history of the content industry is also a history of piracy, and all sectors of the "big media" (film, records, radio, and cable TV) were born of a kind of piracy so defined. Computer technologies advance faster than do laws, and obviously there are no local or global rules which protect creators against unauthorized copies or use. Lessig (2004) argues that in recent decades, copyright and intellectual property laws have developed not to protect creators but, rather, to look after the interests of certain forms of business. In other words, these laws protect *"commercial culture"*, the one that is produced and sold or made to be sold, rather than *"noncommercial culture"*, which is the rest.

Lessig is not arguing against control or the existence of intellectual property laws, and he is not an advocate of piracy. What he propounds is *free* culture. This is not a call for anarchy or to stop paying the artist. For him *free culture*, like the free market, is based on property. However, as he says, a free market is perverted if its property becomes feudal, as does culture if it falls into extremism as regards the property rights that define it. Thus, if internet and virtual worlds are not yet completely regulated, this means, according to Lessig, that the "permission culture" (which he defines as a culture in which creators only get to create with the permission of the powerful, or of creators from the past) has not yet reached cyberspace and, as such, the culture there still remains free. This should not be taken to mean that it is necessarily preferable to keep cyberspace uncontrolled or anarchic. Indeed, it must be regulated, but perhaps it requires different paradigms of control that are more appropriate to this new context, and which care more about creators and artists and that are able to enforce the tradition of *fair use*.

Culture that is created or placed in the metaverse is there for the enjoyment of residents and, in most cases, it is not designed to make a profit, at least not on the scale of the large media. This does not mean that artists cannot be paid or receive an income for their creations. However, the goal is to share forms of expression in a more democratic platform, one which offers ready access both to exhibition spaces and to potential audiences who might receive and enjoy the work.

It could therefore be argued that if there a restrictive policy regarding the sharing of cultural content and creations in cyberspace had been already in place, it may have prevented the emergence of the rich content and diversity of products and options to be found in the metaverse.

6. Conclusions

Virtual worlds make culture more democratic, as it can be reached for free by a wider range of people in real time; furthermore, artists and creators are provided with an accessible showcase in which they can become better known and where they can interact more directly, immediately and closely with their audience. The possibility and ease with which anyone can create original content in the metaverse is an incentive for creativity, because it allows people to express themselves in original ways that enhance the contents of virtual life. Art thus finds new and different formats, and cultural management discovers new spaces to break into.

At the same time, anonymity, privacy and intellectual property are all issues that need to be addressed. The internet and metaverses are yet to be fully regulated, and there are some aspects of cyberspace than remain ungoverned. However, the regulation of virtual worlds may require different ways of thinking and the adoption of new paradigms which consider exchange, democratization, cooperation and sharing as essential ingredients of these new sets; as such, any rules must control but not restrict, thus avoiding anarchy at the same time as keeping interaction levels high.

A *fair use* of contents, especially cultural and artistic ones, could offer a good approach to shared intellectual property in cyberspace, and any laws that are developed must enshrine respect for free culture and the right of authors to receive acknowledgements for their work. As such, regulation must promote creativity and the innovation of platforms, as well as their contents, so as to boost their singularity and originality, the overall aim being to improve and enrich both virtual and real lives.

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Arguing for Multilingual Motivation in Web 2.0: a Games-Based Learning Platform for Language Learning

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Abstract: We have seen a significant change in education in recent years with the emergence of online provision, or eLearning, with its flexibility through both time and location independence. We are starting to see further significant change in education with the emergence of new, participatory technologies of information access, knowledge exchange, and content production, associated with the Internet and new media technologies, frequently described as social software or Web 2.0. One particular technology that has been explored in a non-educational content is the Alternate Reality Game (ARG), a form of interactive narrative, often involving multiple media and game elements, to tell a story that may be affected by participants' ideas or actions. As ARGs are inherently collaborative in nature they have the potential to be a useful vehicle for collaborative activities in an educational context. In this paper, we discuss the development of an Alternate Reality Game for supporting the teaching of modern foreign languages from a technical perspective and how we adapted the open-source Learning Management System, moodle, into a multilingual, collaborative gaming environment. We present the findings of a pilot of the ARG that was carried out in April 2009 and provide suggestions for how this platform could be developed further.

Keywords: ARGs, collaboration, social networks, modern foreign languages, moodle

1. Introduction

Education has changed significantly in recent years with the emergence of online provision, or eLearning, with its flexibility through both time and location independence. There is now further significant change in education with the emergence of new, participatory technologies of information access, knowledge exchange, and content production, associated with the Internet and new media technologies, frequently described as social software or Web 2.0 (McLoughlin and Lee, 2008). One particular technology that has been explored in a non-educational content is the Alternate Reality Game (ARG), a form of interactive narrative, often involving multiple media and game elements, to tell a story that may be affected by participants' ideas or actions (Connolly *et al*, 2008). ARGs are inherently collaborative and have the potential to be a useful medium for collaborative activities in an educational context.

As part of an EU Comenius project, ARGuing for multilingual motivation in Web 2.0, we have explored the use of ARGs for supporting the teaching of modern foreign languages. In this paper, we discuss the development of an ARG from a technical perspective and how we have adapted the open-source Learning Management System, moodle, into a multilingual, collaborative gaming environment. In the next section we discuss Alternate Reality Games and their use both within a non-educational context and an educational context. In the subsequent section, we examine the requirements for developing an Alternate Reality Game and how we have used and adapted moodle into a multilingual, collaborative gaming environment. In the final section, we discuss the findings of a pilot that used moodle as an underlying ARG platform carried out in April 2009 and provide suggestions for how this platform could be developed further.

2. Alternate Reality Games (ARGs)

Alternate Reality Games (ARGs), or “immersive gaming”, is a blend of online narrative and puzzle solving (similar to an online scavenger hunt). The narrative is gradually revealed through a series of media such as websites, Instant Messenger (IM) conversations, text messages, emails and in some cases, TV and newspaper adverts and telephone calls. Central to the development and running of an ARG is the *puppetmaster*, who is simultaneously an ally and adversary to the player base, creating obstacles and providing resources for overcoming them in the course of telling the game’s story (Connolly *et al*, 2008). Fundamental to the solving of the game is collaboration – players must work together to solve the puzzles and ultimately the game. One further technological area that has been identified as having strong impact on learning is the emergence of social networking. Interestingly, not only are ARGs a form of computer game they are also heavily built around social networking.

2.1 Use of ARGs in a non-educational context

One of the earliest ARGs was developed in 2001 to market Steven Spielberg’s film *A.I.: Artificial Intelligence* and a series of Microsoft computer games based on the film. It was based on a complex murder mystery played out across hundreds of websites, email messages, faxes, fake ads, and voicemail messages. The game had over three million active participants worldwide; in essence, it was a type of massively multiplayer online game (MMOG). Due to the size of the assets involved in the early stages of development, the game became known as “The Beast”.

Microsoft also used this type of game to create significant market hype around the launch of the XBox game *Halo 2*. Called *I Love Bees*, the game wove together an interactive narrative and a War of the Worlds-style radio drama set in the future, broken into 30-60 second segments and broadcast over telephones worldwide. The gameplay of *I Love Bees* tasked players around the world to work collaboratively to solve problems, with little guidance. For example, the game gave players over 200 pairs of GPS coordinates and times, with no indication as to what the coordinates referred to. Players eventually worked out that the coordinates referred to telephones and the times to when the phones would ring. Each time a player correctly answered a phone question, the player was treated to 30 seconds of new material. One of the most exciting elements of the game for some players was the possibility that they would get one of the rare live calls in which the drama’s actors talk to the person who answered the phone and then incorporate the conversation into the drama itself. The game culminated by inviting players to visit one of four cinemas where they could get a chance to play *Halo 2* before its release and collect a commemorative DVD.

McGonigal (2008) argues that the gameplay within *I Love Bees* develops “collective intelligence” through three stages: a) collective cognition, b) cooperation, and c) coordination. She believes these distinct stages of collaboration occur through three aspects of game design, namely: a) massively distributed content, b) meaningful ambiguity, and c) real-time responsiveness, and “*that these elements form a reproducible set of core design requirements that may be used to inspire future learning systems that support and ultimately bring to a satisfying conclusion a firsthand engagement with collective intelligence*”.

While *The Beast* and *I Love Bees* were essentially marketing games, a more serious application of ARGs was *World Without Oil* (WWO), which was created in 2007 to stimulate debate and discussion for a possible near-future global oil shortage. The game outlined overarching conditions of a realistic oil shock, then called upon players to imagine and document their lives under those conditions. Compelling player stories and ideas were incorporated into the narrative and posted on a daily basis. Players could choose to post their stories as videos, images or blog entries, or to phone or email them to the WWO puppetmasters. The game's site contained the player material, and the game's characters documented their own lives, and commented on player stories, on a series of community and individual blogs, plus via IM, chat, Twitter and other media. By playing scenarios out in a serious way, the game aimed to apply collective intelligence and imagination to the problem in advance, and create a record that has value for educators, policymakers, and the public to help anticipate the future and prevent its worst outcomes. The experience aimed to bring about real change in its participants by building a community around a common, collaboratively constructed future-oriented game narrative.

Other examples of successful commercial ARGs include:

- *Perplexcity* (perplexity.com) a commercial UK-based game that was launched in 2005, in which players had to purchase physical sets of puzzle cards that could be solved and the answers input online. Cards were of varying difficulty from those that could be solved alone in minutes to ones that needed thousands of players worldwide tackling a problem simultaneously. Players had to finish a fictional ‘cube’ that had been stolen and buried somewhere on earth (associated with a real £100k prize) by buying cards and solving puzzles.
- *Year Zero* (42entertainment.com/yearzero) a game to promote the album ‘Year Zero’ by the band 'Nine Inch Nails', launched in 2007, where 3.5 million people took part. This included codes hidden in tour t-shirts linking secret messages and telephone numbers, flash drives found in toilet cubicles at events, clues hidden in the album music itself, and messages delivered through distributed mobile phones.

2.2 Use of ARGs in an educational context

While there are a number of well-known ARGs in the non-educational field, very few ARGs have been implemented in the educational field, and little empirical evidence of their effectiveness exists. One of the earliest examples of their use in education appears to have been the eMapps project, which aimed to demonstrate how online games and mobile technologies could be combined to provide new and enriching experiences for children (9-12 year olds) in the school curriculum and beyond (Davies, Kriznova and Weiss, 2006). Some of the main objectives of the project were:

- to build communities of creative, networking children in the New Member States (NMS) of the EU, generating their own cultural content and communicating with peer groups in other countries;
- to contribute to the growth of a community of teachers who are aware of the potential for change through ‘schools without walls’ and who exchange knowledge and experience through communication with counterparts in other NMS countries;
- to develop adaptable interactive tools (primarily games played on a mobile platform) with which to deliver learning objectives and which help to integrate the use of ICT in the delivery of the school curriculum.

The project developed a game platform based on the concept of a map with embedded objects, which teachers could adapt and use in their own local setting, to create a pedagogically sound online game mapped around a defined territory (for example, a school’s city centre, a local nature reserve, a historical site or a tourist attraction). The players were teams of pupils, divided into two groups:

- one group controlled and managed the “game desktop” from a PC or laptop based within the school, sent “challenges” to the players in the field to guide their activities, and received information back from the players in the form of photo, audio or video evidence as proof that they had met the challenge;
- the other group used a range of mobile handheld devices such as smartphones, GPS devices, PDAs and laptops to navigate the game territory while completing the tasks and challenges, which made up the game.

During this time, the teacher monitored and controlled the activities of both groups by releasing instructions and feedback via the desktop. In the evaluation of the pilot of the platform, teachers reported that children had learned new facts across a range of curriculum subjects (one of the strengths of the game being that it could be cross-curricular), new technology skills with handhelds, and transferable ICT skills. The teachers also reported improved generic skills especially: teamwork and cooperation, analytical appraisal, collaborative decision-making, negotiating, independent decision-making, self-reliance, planning, navigating in real and virtual spaces and self-confidence. Teachers also reported that:

- in four schools game playing stimulated other work such as artwork, acting, writing and video making;
- in six schools children remembered what they learned (although this wasn’t universal across all schools);

- in all schools children achieved their intended learning outcomes;
- parents were generally supportive of the actuality of playing educational games.

Some unexpected outcomes were that passive children emerged as leaders in some games and shy children, especially girls, spoke up in the games (Brophy, 2008). The project did find though that there were significant barriers at to the use of such games within school education around issues like ICT facilities, teacher training, health and safety, cultural and language barriers, linking games to the curriculum, and lack recognition of social skills in assessment (Balanskat, 2008).

More recently, the JISC (Joint Information Systems Committee) funded the ARGOSI project to use an ARG to support the student induction process in a Higher Education institution with the aim of providing an engaging and purposeful alternative to traditional methods of introducing students to university life. The ARGOSI project had four key objectives (http://playthinklearn.net/argosi.htm):

- to enable students to meet the intended learning outcomes of the library and information skills at a first level at HE;
- to create social networks during the induction period;
- to improve student confidence in navigating the city and university campus;
- to encourage students to engage in, and enjoy, the induction experience.

The ARGOSI project attempts to overcome many of the weaknesses in the 'traditional' induction process for new students. Induction is typically an extremely intensive first few weeks where students are overloaded with information from across the University. This information often lacks any real context because their studies have not really begun. Induction also appears to provide a distinct lack of city orientation and instead merely focuses on the social aspects. An ARG provides an alternative forum for students not only to study serious learning outcomes but also to create networks and familiarise themselves with the city and university campus. The ARGOSI project delivers induction information over a gradual time period avoiding information overload. It encourages students to establish friendships and work within communities in order to accomplish challenges within the game and discover the secrets that underlie the story.

3. Designing and developing the ARG

The aim of the ARGuing project has been to investigate the use of ARGs to motivate secondary school students to learn a modern foreign language. The plan was to develop an appropriate ARG that would allow groups of pupils across Europe to work collaboratively to solve the game. The game was to be such that the pupils would have to communicate in the language they are learning to solve the puzzles. Like other ARGs, not all of the game would be scripted prior to commencement of the game and the teachers, as puppetmasters, would be able to dynamically intervene to scaffold and further challenge the pupils. Moseley (2008) listed the following features that ARGs offer that could be of value to educational contexts wishing to increase engagement, critical problem solving skills and communities of practice within the subject:

- *Problem solving at varying levels (graded challenge)* - enables students to pick their own starting level and work up from there;
- *Progress and rewards (leaderboard, grand prize)* - this could also be assessment
- *Narrative devices (characters/plot/story)* – this does not have to be fictional: academic subjects have histories, themes, news etc.;
- *Influence on outcomes* – let students decide or influence some aspects of their course as this helps to scaffold their path into a critical academic thinker;
- *Regular delivery of new problems/events* - key to maintaining engagement; thinking about ways to keep things moving without putting extra pressure on staff;
- *Potential for large, active community* - which is self-supporting/scaffolding - the potential is less as the group decreases and the subject interest/specialization narrows;
- *Based on simple, existing technologies/media*.

There are a number of design challenges that we faced in this project, such as:

- How to design an integrated set of multi-lingual, multi-media problems that require collective effort to solve.

- How to create an interface to communicate individual, differentiated roles within the collaborative structure.
- How to design for collective intelligence, rather than "hive mind" or "mob effect".
- How to produce a replicable solution that can be used by modern foreign language teachers across Europe.
- How to ensure the system is "secure" so that only authorised users can access the system (critical for many European countries where children are involved).
- How to evaluate the usefulness of ARGs for learning a modern foreign language.

The last challenge was very important to the project to demonstrate the effectiveness (or otherwise) of this approach. However, there has been a dearth of empirical studies analyzing the usage of games-based learning and general models of evaluation are currently lacking (Connolly, Stansfield and Hainey, 2007) and this will have to be addressed early on in the project.

3.1 Requirements for the game

The storyline that we developed for our ARG is based on a set of characters who, through a collective effort, plan to build a contemporary *Tower of Babel*, a place where people understand the interconnectedness of themselves to other people, animals, the planet, and the rest of the universe. The characters, along with the game participants, discover throughout the game how to build the foundations of the tower. These foundations, based on the principles and values of Europe, include: democracy, tolerance and respect, freedom and the rule of law, and access to education.

By building the foundations and the tower, step by step, the intention is that the students will gain an understanding of other languages and cultures. From an implementation perspective, the tower was to be designed as an ever-growing wiki (visually and in content) where students and teachers could add their own building blocks. The "building blocks" for the tower would be puzzles, assignments and quests in multiple languages and in different subjects. Quests can be puzzles, assignments and questions. Sometimes this may require answering multiple choice questions, translating languages, uploading files, searching on the Internet or simply trying to solve puzzles that present the player with information, an interface or a situation that lacks context. These were to be delivered through forums, blogs, websites, short video clips, and emails. Participants would not be able to access the next clue until they had completed the current assignment. Participants would be able to communicate with one another through forums, guilds and IM.

Multi-lingual capability

The game had to be multi-lingual. For the initial pilot, English, French, Spanish, German, Dutch and Bulgarian would be supported.

Profiles

Players have profiles and can browse other players' profiles. The profiles hold some basic information about each participant, such as specialist areas, interests, skills, completed quests, languages spoken and how many points they have, both "building blocks" and "empathy" points. The empathy system is the average rating given by other players based on their experience collaborating with the player in question – very similar to the eBay rating system and player rating scores on Microsoft's Xbox Live platform. The profiles are essential to aid the process of player collaboration – players can browse the profiles looking for someone with an adequate skill set to collaborate with.

Supported media

As we have already mentioned, ARGs are a cross media game and therefore the platform should support the following media:

Blogs: Key characters from the ARG story have their own blogs. Some of the character blogs would be translated into multiple languages while others would be provided in a limited selection of languages – participants are expected to collaborate with one another to interpret the blogs. The blogs tie in with plot development of the storyline and occasionally play parts in quests, such as providing clues or hints. The blogs also provide a mechanism for puppetmasters to intervene with the game if the community is struggling with a specific quest.

Wiki: The wiki, named “Tower of Babel”, is the heart of the game space, where quests are uploaded. Solutions to quests will also be uploaded to the wiki – this provides an opportunity for participants to reflect on their and other players’ contributions, hopefully further enriching their understanding and appreciation of the quest’s learning outcomes. The content being uploaded could contain several media types – images, text, video clips, audio clips, mini games (such as flash or java games) and links to other sites.

Forum: While the wiki may be the heart of the game space, providing the community with quests to complete, the forums are the essence of the ARG. The forums are employed as a means of facilitating communication and collaboration amongst participants. It is on here that the concept of collective intelligence should be evident – players seeking out guidance on quests from other players with specific knowledge and skills. The forums should also promote the discussion of quest related topics amongst community members, where participants can share views and opinions – similarly to the wiki this should enrich the learning as students’ appreciation of discussion topics increase.

Guilds: Players should be able to form themselves into guilds to work collaboratively together to solve quests. The guild concept would be similar to the clan/guild structures in MMOGs.

Video and Audio: Part of the storyline would be presented to players in the form of short video clips (in English with subtitles)

Mini Games: Some quests could employ the use of mini games (eg. in Java or Flash). A basic example would be a puzzle game that participants would need to complete to unlock a hint to a quest.

Email: Email would mostly be used by puppetmasters to inform participants of important game related events. Messages also include the addition of new quests and, at the request of players, hints and tips to quests.

SMS: Similarly to email, SMS could be used for quest updates, hints and tips. It could also be used as part of a quest – send a SMS text with a key phrase or string of characters to a mobile number which would generate an automatic response with the answer or hint. Due to time and funding constraints, this was not implemented for the pilot.

IM: While the forum provides a means of communication, an IM interface allows participants to communicate in real time. Perhaps playing a less important role than the forum and more geared towards socialising, it still presents participants with another opportunity to network with other players.

Assessment

An aim of this project is to provide a learning environment that the students feel they truly own. To achieve this sense of ownership, the level of assessment should remain informal. The assessment of players’ solutions, and the allocation of points, should remain as simple and informal as possible so as to not make players feel they are ultimately being controlled by their teachers. Players will have the opportunity to reflect on their work while comparing their solution to other players’ work on completion of a quest.

The game will use two scoring systems – building blocks awarded for the completion of a quest and an empathy score which rates the player’s collaboration as voted by other players. While the allocations of the building block points are to be informal, these could be used as a means of assessing how well a player is doing within the ARG and also the games effectiveness with regards to the project objectives.

Security

The platform had to be secure and only allow registered students and teachers to access it.

Puppetmasters and teachers

Puppetmasters (ARG project members for the pilot) would have complete control over the game, although eventually the hope is that teachers would assume this role. Puppetmasters would be able to monitor how the community is coping with quests and provide hints and tips through the various communication channels supported. Teachers will also have a degree of control, lower than that of the puppetmasters, as they will be mostly monitoring their own pupils. The teachers from the participating schools will be asked to help moderate content, both player designed quests and individual answers to quests, from their students. The ARG, from the teachers' perspective, mainly relies around monitoring their own students who are participating. For the pilot, puppetmasters created the quests, while teachers helped assess student work and decided if "building block" points were to be awarded. Puppetmasters and teachers were also be at hand to provide guidance to their pupils. Once the main quests are complete, it was intended that teachers and students would be able to generate their own quests for other participants to attempt. Teachers could use the themes discussed in their class and create new quests with their own content to fit their educational programme.

3.2 The ARG platform

After establishing the requirements, the project was faced with two choices: build the ARG platform from scratch or adapt one or more existing platforms. Given the timescales, the former option was excluded and we investigated existing open-source solutions. Again, there were two main choices:

- select an open-source solution for each of the key functions (eg. wikis, blogs, forums) and integrate them together so that there was a single, consistent user interface, common database and single sign on capability;
- find a platform that contained much of the functionality required and extend it to provide missing components.

The former option again was difficult given the time constraints and we instead evaluated a number of platforms that had the required functionality. Many of these turned out to be Virtual Learning Environments (VLEs) or social networking systems. Given that scoring (assessment) was something that we wanted to have within the game, we eventually decided to base the games platform on an open-source VLE. Many of the open-source VLEs (moodle, Sakai, Claroline) provide a number of common features for facilitating and supporting online learning, (Dougiamas and Taylor, 2003; Yueh and Hsu, 2008):

- document sharing (eg. for online distribution of lecture notes);
- assignment uploading;
- online assessment (for formative and summative assessment, multiple choice quizzes, true/false, and free text);
- online gradebooks;
- forums for asynchronous discussion;
- chatroom/online classroom for synchronous web-based text-based discussions.

Many VLEs also support the development of plug-ins and extensions – allowing additional features to be added by the developers or by third parties (for example, video conferencing or wikis). After an evaluation of these platforms, we choose moodle (http://moodle.org) as the basis for the ARG, as it had many of the features that we were looking for. moodle is based on PHP and MySQL and can be extended, although we did find that the learning curve was sometimes quite large to fully understand how the various components integrated together. The missing features that we identified were as follows:

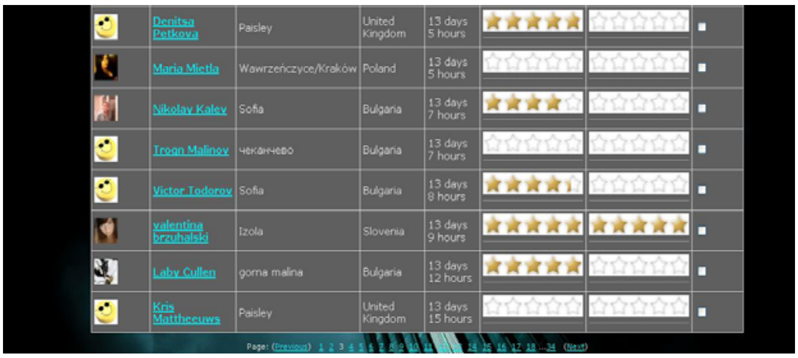
- A game "look-and-feel" (called a "theme" in moodle) While moodle has a number of free themes available through the large moodle community, and a number of commercial themes also existed, we found none that had the particular "Tower of Babel" look-and-feel that we wanted. This shortcoming was easily overcome by developing a special moodle theme based on XHTML and CSS, as shown in Figure 1.
- An empathy system and a top scores table for students to compete with others Both these features were addressed by adapting moodle to allow forum and blog entries to be rated by students, based on how helpful they found the postings, and to show the average empathy rating

as a star scheme on the Participants page (see Figure 2). We also modified the Participants page to display the student's current score using as star scheme.

- Construction of the Tower of Babel We wanted each student to see their progress through the game represented through the continual construction of the Tower (in effect, correctly answering a quest, added another building block to the Tower). To do this, we created s Flash animation that showed, as a percentage of the maximum game score, how much of the Tower they had constructed (see Figure 3).
- Automating the posting of forum/blog entries by the game characters One of the requirements was to produce a platform that could be used by language teachers after the completion of the pilot. At various points in the game, some of the storyline is released through forum and blog postings. Rather than having to manually make these postings at an appropriate date and time, we wanted to be able to create these postings and advance, specify when the posting was to be made available, and for the system to make the posting at the specified time. To do this, we produced some PHP code to allow the puppetmaster (language teacher) to specify the name of the character making the posting, the text of the posting, the date and time of the posting (relative to a game start time that could be specified in advance), and the forum/blog where the posting is to be made. This was stored in the MySQL database in a new table and a background cron job was written, which ran every hour, to transfer the posting to the appropriate MySQL table at the specified time.

It is remarkable that there were only a few changes that had to be made to extend moodle into an ARG.

Figure 1: Tower of Babel theme



Denitsa Petkova	Paisley	United Kingdom	13 days 5 hours	
Maria Mietla	Wawrzeńczyce/Kraków	Poland	13 days 5 hours	
Nikolay Kalev	Sofia	Bulgaria	13 days 7 hours	
Troan Malinov	чеканчево	Bulgaria	13 days 7 hours	
Victor Todorov	Sofia	Bulgaria	13 days 8 hours	
valentina brzuhalski	Izola	Slovenia	13 days 9 hours	
Laby Cullen	gorna malina	Bulgaria	13 days 12 hours	
Kris Matthecuws	Paisley	United Kingdom	13 days 15 hours	

Figure 2: Empathy and scoring

4. Initial results of the pilot

Prior to running the main pilot in April 2009, we ran two mini-pilots to evaluate early releases of the platform/game: one in November 2008 in Bulgaria and one in Spain in February 2009. The mini-pilots identified a number of issues that we addressed prior to the main pilot:

- The game was too long. In the first min-pilot, the game lasted 15 days. For the second mini-pilot and the main pilot this was reduced to 8 days.
- There were too many quests. Again, with a reduction in the duration of the game, we reduced the number of quests available.

- Some of the quests were not fully integrated with the storyline. Again, this was addressed before the main pilot.

Prior to the pilot, we ran an online training course for teachers (repeated three times to give teachers flexibility on when they wanted to attend). The results of this training course are discussed in Tsvetkova *et al*. (2009). An analysis of the effects of the pilot itself from a student perspective are discussed in Connolly *et al*., (2009). The main pilot ran from 22 April 2009 to 30 April 2009, with 328 students and 95 teachers from 28 schools across 17 European countries. During the game, the students uploaded 826 files (images, audio, video, and presentations) and submitted 9,135 quest answers. Out of 104 responses given by students on completion of the game, the main things that they like about the game were: collaboration with other students (63%), using the computer for language learning (59%), solving the quests (54%), and the storyline (47%). The problems raised by students were: quests were too difficult (34%), quests were too easy (16%), lack of engagement with the characters (23%) and storyline (17%). Overall, the students felt that the game had motivated them to learn a second language and 92% of students felt there should be more use of ICT within language teaching. 89% of the students liked or absolutely loved the game.

Figure 3: Animation of Tower of Babel construction

Overall, the project team were very pleased with the results of the pilot and consider that the use of Alternate Reality Games for motivating students to learn a second language has been highly successful. There were a number of problems the team identified with the pilot that we would address for any future runs of the ARG:

- Quests that were not automatically scored by the platform had to be individually marked by the puppetmasters or the teachers. With over 300 students playing the game on a daily basis, this put a significant strain on the markers to ensure that the quests were scored in a timely manner to allow the students to move on to the next quest. Out of the 47 quests set during the pilot, 8 required manual scoring. While our use of ARGs was about *motivating* students to learn a second language rather than supporting the teaching and learning of a second language, this balance was acceptable. However, if the game was being used to teach a second language, multiple choice style questions that can be automatically marked by the platform may be less appropriate than getting students to actually communicate verbally or in writing in the second language, and therefore the balance of manually marked quests may rise, resulting in some difficulty getting the quests marked in a timely manner so that a student's progress in the game is not impacted.

- We would like to have implemented mini-games (eg. in Java or Flash) to further engage and motivate the students but did not have time to do this. Moodle itself has a game module (http://docs.moodle.org/en/Game_module) that supports eight game types such as hangman, crosswords, millionaire, sudoku, hidden pictures, and snakes & ladders.

- We maintained the default terminology that ships with moodle (for example, Participants and Courses). These terms can be modified within moodle and again, given time, we would have modified these terms (eg. Players instead of Participants and Quests instead of Courses).

- Many ARGs involve search for clues across multiple websites. Our game took place within one moodle platform. Moodle has a network module (http://docs.moodle.org/en/Moodle_Network) that allows a user in one moodle installation to access resources in another moodle installation. The feature supports single sign-on so that once the user has logged on to the first system, the user does not need to log on to the second system. Given time, we would have had a number of moodle installation, each with a different look-and-feel (ie. a different moodle theme), to give the impression that the student is accessing different websites.

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Modelling Players' Behaviours and Learning Strategies in Video Games

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Abstract: User profiling is a relevant research topic in both video games and educational software development. For the former, it helps to provide a more enjoyable experience that is tailored to users' preferences; for the latter, it aims to provide a learning environment that adapts to subjects' abilities, disabilities or learning preferences. The aim of this paper is to combine both approaches in order to create a model that accounts for both cognitive and emotional needs of the subjects, and that provides an environment where they feel immersed, empowered, motivated and willing to learn. Because people have different learning styles, needs and preferences, their motivation to play video games, their behaviour and their learning strategies can differ significantly. Unless these singularities are acknowledged, learning benefits on the part of the learner could vary greatly. Although several educational video games were based on Intelligent Tutoring Systems (ITSs), that included a flexible approach to learning and that adapted the educational strategies to learners' skills, very few researchers have tried and managed to model players' behaviours and learning preferences in video games. This paper presents an ongoing quantitative study that aims to profile gamers based on their personality traits. It is based on an online survey carried out with 33 subjects aged between 18 and 44. This survey includes four parts, each of them assess personality traits, motivation for playing video games, emotions sought while playing, preferred features and learning strategies. Following data collection, a correlation analysis was carried out in order to identify significant links between personality traits, in the light of the *Big-5* model, and other factors that can affect learning and emotions in serious games. Significant correlations were identified suggesting that the Big-Five model could be used for user profiling in video games in order to increase both learning outcomes and motivation.

Keywords: Education, video-game, user profiling, personality-traits, adaptive system

1. Introduction

1.1 Why profile users in educational games?

There is currently a growing interest in the field of user profiling for eLearning and video games. For the former, user profiling helps to improve learning outcomes and usability, whereas for the latter, user profiling is essentially targeted at improving players' enjoyment. The effectiveness of educational games has not been proved consistently, and studies have suggested that this could be due to the fact that the content might not be adapted to the players, and that a user-centred approach, that adapts the educational and entertaining features of the game, could ensure that all users benefits from and enjoy these games (Magerkp et al., 2005). To implement adaptive educational games, developers and researchers need to base their design on two different, yet complementary fields: Adaptive Educational Systems (usually based on cognitive considerations) and Adaptive Video Games (focusing on players' behaviours and emotions). However, this task can prove difficult, because as suggested by Van Eck (2006), the creation of educational games can result in a *Shavian Reversal* where the game is neither fun nor educational. It is very difficult to balance the dramatic and educational aspects of a video game, and a trade-off usually needs to be reached between entertainment, realism and learning content. Too much entertainment might distract users from the learning outcomes. However, providing a content that is too rigid and with little provision for entertainment might decrease the interest in the game and hence, defeat the purpose of the video game. As noted by Rollings and Adams (2003), the degree of realism implemented in a video game should always support entertaining purposes

The purpose of this paper is to show that, by using a hybrid approach that accounts for learners' cognitive styles and personalities, it should be possible to design an educational video game that is stimulating at both cognitive and emotional levels, and adapted to players expectations and preferences.

1.2 Related research

User profiling aims to categorise users and predict their behaviour or preferences. Very few adaptive educational games based on users' personalities have been released. This is due to the fact that user profiling in video games is still at its infancy; although several models have been released most of these models are based on surveys or data collected during the game. For example, RoseWater

(2006), based on an online survey defines three types of players in RPG games (Timmy/Tina: play for fun), *Johnny/Joanie* (play to express themselves) and *Spike/Barb* (play to win). Likewise, Bartle (1996) defines four types in MUDs (Multi User Dunjeons) and MMORGs (Massive Multiple Online Role Playing Games): *Achievers* (strive to progress to higher levels), *Socializers* (interested in the social aspect of the game), *Explorers* (need to discover new ideas and location) and *Killers* (enjoy imposing themselves). Another model designed by Bateman and Boon (2005), partially based on the work of Bartle (1996), identified four types of players: *Conquerors* (play to win), *Managers* (enjoy strategy and tactics), *Wanderers* (play for fun) and *Participants* (story-oriented and enjoy social experiences). Obvious links appear between these models. For example, *Participants* and *Socializers* are both interested by the social dimension of the video game, *Wanderers* and *Explorers* are motivated to explore, and *Conquerors* and *Killers* are both driven by competition. Even if these models bear some similarities, there is no link between them that makes it possible to compare users across models using universal metrics. However, the last model (Bateman and Boon, 2005), because it is based on the MBTI (Myers Brigs Type Indicator) personality model, offers some hope that standardized tests (e.g. personality tests) might be used to categorise and predict players' behaviours. This categorisation might be extended to learning in video games since links between personality types and learning strategies have already been established (Heinstrom, 2003; Keirsey,1998), although behaviours in and outside the game might differ based on personality traits.

1.3 Background of the study

In 2006, the author has led a controlled study aimed at assessing the benefits of tailoring the content of an educational game based on subject's personalities. This study included 80 pupils aged between 13 and 14 years and the results showed significant correlations between subject's personality traits, their behaviours, and their strategies for learning in video games. Data was collected from surveys and within the game, and personality traits were measured through the IPIP (international Personality Item Pool). The study notably showed that, based on their personalities, some subjects were more inclined to game the system (try any solution until it works), ask friends for help, or play to discover new levels.

Although this study provided valuable insight on the way video games could be tailored to suit players' preferences, it also showed some limitations in terms of findings and experiments. First, the subjects were essentially female teenagers aged between 13 and 14 years and there was a need to extend the findings to a wider spectrum of the population (e.g. in terms gender and age). Second, while the study was focusing on learning in video games, it did not present any correlation between subjects' personalities, their motivation to play and their behaviours. It seems important to particularly understand what types of emotions and challenges they sought based on their personality traits, because, as suggested by Lazzaro (2004), people primarily play video games to feel different types of emotions Third, the personality test used in this study required 50 questions, which, to some extend, can be perceived as long and tedious. A new method, requiring significantly less questions, yet accurate, needed to be used.

As a result it was decided to conduct an additional study including adult respondents, that measured their personality traits using fewer questions and that drew correlations between their behaviour, motivation and learning strategies while playing video games.

2. Method

2.1 Procedure

An online questionnaire was designed using a combination of HTML and PHP. Answers to the questions were then saved to an online SQL database and then exported to a CSV file. The questionnaire included four separate sections.

The first section gathered demographic information (e.g. age, gender) as well as information on subjects' gaming frequency.

The second section measured subjects' personality traits in the light of the Big-Five model. It was based on the TIPI (Ten Item Personality Inventory), a methodology developed by Gosling et al. (2003) that employs only 10 questions to measure the five personality traits present in the *Big-Five* model: Openness (openness to new experiences), Conscientiousness (hard worker), Extraversion, Agreeableness and Neuroticism (prone to anxiety). This methodology, when used in conjunction with other questionnaire has the advantage of being short, reliable and valid. Subjects answered 10 questions using a seven-point Likert scale. Related levels for each personality traits were then computed through PHP and saved in the database for each respondent.

The third part of the questionnaire included questions aimed at identifying the motivation to play (e.g. competition, socializing, self-esteem, entertainment or relaxation). It also sought to understand if players, based on their personal characteristics, always needed to be challenged or if entertainment was a sufficient condition to continue playing.

The fourth section analysed sources of enjoyment in video games based on their type (e.g. simulation), or structure (e.g. complex rules, specific goals or open-ended).

The fifth section was aimed at identifying successful learning strategies employed by subjects in video games. The strategies considered included learning under pressure (e.g. time), a need for guidance, and the preferred format for information (e.g. text, audio or video).

2.2 Participants

33 participants aged between 18 and 48 took part in the new study. They consisted of students (47%), employed (44%) or unemployed (9%) people. Most of them were male (72%). 48% of the respondents were aged between 18 and 24 years, and 42% of the respondents were aged between 25 and 34 years. The participants were contacted by email and given the link to the questionnaire.

87.5% of the respondents were aged under 25 and played at least once a day. 57% of the subjects aged between 25 and 35 and played at least once a week. 81% of the respondents who were aged between 15 and 24 were students. 78% of the respondents who were aged between 25 and 34 were working.

3. Findings

3.1 Personality and motivation to play

A two-tailed bivariate correlation test was performed and the following correlations were identified:

- Conscientiousness and playing to socialize ($p<0.05$; $\alpha=0.367$)
- Conscientiousness and playing to feel better about oneself ($p<0.01$; $\alpha=0.596$).
- Extraversion and need to be constantly challenged ($p<0.05$; $\alpha=-0.345$)
- Extraversion and playing to forget about things (e.g. escapism; $p<0.05$; $\alpha=0.439$)
- Openness and playing to forget about things($p<0.01$; $\alpha=0.361$)
- Neuroticism and playing to be challenged ($p<0.05$; $\alpha=-0.416$)

These results show that for conscientious subjects, video games play an important role for relaxation and self-esteem. Video games also seem to fulfil a need for escapism (e.g. Extraversion and Openness) and do not always need to be challenging to be successful (e.g. Neuroticism).

3.2 Personality and source of enjoyment

A two-tailed bivariate correlation test was performed and the following correlations were identified:

- Extraversion and simulation games ($p<0.05$; $\alpha=0.428$).
- Conscientiousness and the absence of specific goals in video games ($p<0.05$; $\alpha=-0.402$)
- Conscientiousness and open-ended games ($p<0.05$; $\alpha=-0.372$)
- Conscientiousness and multi-player games ($p<0.05$; $\alpha=-0.374$).
- Subjects wit a high level of Openness enjoy simulation ($p<0.01$; $\alpha=0.451$)

The results show that the type of preferred game can be based on the players' personality (e.g. simulation for extraverted and *opened* subjects). Some common game design rules such as clear goals should be particularly followed for conscientious subjects. However, the converse is also true: for example, whereas open-ended games are usually considered as more attractive to players, because their offer more ways to achieve a goal (Rouse, 2001; Salen and Zimmerman, 2003), they might not be appreciated by conscientious subjects. Interestingly, some subjects might not enjoy multi-player games (e.g. Conscientiousness), probably due to the fact that this feature provide them with less control over the game or that they might not enjoy having to multi-task more than they would in a individual game.

3.3 Personalities and learning strategies

A two-tailed bivariate correlation test was performed and the following correlations were identified:

- Agreeableness and asking friends for information ($p<0.05$, $\alpha=-0.402$).
- Neuroticism and solo-learning ($p<0.01$, $\alpha=-0.456$)
- Neuroticism and trying any possible solution ($p<0.01$, $\alpha=-0.432$).

The results show that learning strategies differ depending on subjects' personalities and to some extend correlates with previous study on personalities and learning strategies (Keirsey, 1998). For example, people with a high level of Neuroticism, are known to be prone to anxiety; this behaviour is reflected in the results above which shows that they prefer to be guided when playing the game and also that they tend to avoid doing the *wrong things* by not trying any possible solution. Instead they prefer to seek for help. The results also suggest that the more competitive (low levels of Agreeableness) a subject is and the more it is inclined to ask friends for help. It also shows that subjects with a high level of Agreeableness, who by definition are inclined to empathise with others, do not ask for help. They might instead be the ones providing help.

3.4 Conclusion and future work

Whereas many models are available to categorize players, the use of personality might be helpful to standardize these classifications. It offers a valid yet reliable way to categorise individuals. Based on the TIPI, significant correlations where established between personality traits and behaviours in video games. Results notably showed that video games could, based on personality traits, have a positive effect on self-esteem (conscientious subjects), and be used for escapism (extraverted and opened subjects). It revealed that some common game features might not suits all players; for example, subjects prone to anxiety might not seek challenge in a game.

This paper has highlighted the need for user profiling in educational video games. It has explained the basis for the use of personality traits in the design of user profiles. The study described in this paper has illustrated that personality traits in the light of the Big-Five model could explain the behaviours of players in video games in terms of motivation, learning strategies, and source of enjoyment. It has also shown that common game design practices need to be adapted to players, because the source of enjoyment can vary greatly amongst them.

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Animating DGBL in Pre-School, Primary and Special Education: Three Case Studies

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Abstract: This paper reports on three digital GBL pilots which have taken place, respectively, in pre-school, primary school and special education settings, for project assignments of the “ICT in Education” MSc program jointly run by the University of Athens, the University of Thessaly and the Technological Educational Institute of Piraeus, Greece. The pilots reported have involved 9 educators and 44 students in total and have been based on freeware micro-games, some new games developed from scratch as well as the “Magic Potion” digital adventure tale developed by the University of Athens Laboratory of New Technologies in Communication, Education and the Mass Media within the EPINOISI project. Interventions have focused on animating the application of DGBL material in class and effectively documenting student reactions and attitudes. Conclusions have been drawn on the learning potential of successfully animated DGBL interventions and on the expectations of young learners towards the games employed. The first pilot concerns a pre-school intervention for learning basic math concepts. Four sessions have been organised with the participation of 10 pre-school students, using freeware micro-games from the Up To Ten and Poisson Rouge web sites and the Minisebran suite, as well as a simple Flash game designed ad hoc. A prototype code of conduct during gameplay has been put in place and a number of conclusions have been drawn by observing and evaluating student reactions and opinions, expressed by the students through drawing and talking about their likes and dislikes. The second pilot has involved application of DGBL material on linguistic topics, in order to investigate whether digital games can enhance the functional-communicational perspective of language. The intervention involved two primary schools with a group of 15 students each, and observation/discussion were employed for evaluating results. Conditions of communication were created in which the students used the language, collaborated to seek clues and information, formulated and evaluated hypotheses and expressed opinions. During the last part of the pilot each student group was asked to describe a language game that would serve as a challenge for the other group, and two such prototype games were developed in Flash. This activity gave the students the opportunity to express themselves and apply their knowledge on structure and use of written language, while at the same time providing a frame of communication and “competition” between the two schools. The third intervention focused on DGBL material for children with autism disorders (AD). Four children with AD were given access to DGBL material in order to investigate the potential of digital games to activate their attention, bring a playful character to the learning process and make more amusing the achievement of objectives. The material employed includes online freeware games and commercial edutainment software, as well as parts of the “Magic Potion” digital adventure tale, whereas the educators created an additional Flash game for social/emotional skills. A number of remarkable outcomes have been observed during this pilot, whereas interesting issues were highlighted regarding game usability, student collaboration and the role of the educators.

Keywords: Digital games-based learning; case studies; pre-school; primary school; special education

1. Introduction

The use of digital games as educational tool created new capacities of growth of innovative elements in the training process.

Even though the digital games , according to researches, based their main characteristics - rules, objectives, results and feedback, conflict, challenge, interaction, script - can support the process of learning because they help in the growth of new cognitive faculties (Prensky, 2001) they continue to cause mixed sentiments of enthusiasm and concern amongst the teachers in favour of active teaching, as it always happens when facing every technological innovation.

Taking in consideration these issues, we realized that the educator should play a more integral part on the DGBL procedure. Instead of being solely the final mediator between the game and the student, the educator should be the designer and implementer of the game having thus full control of the gaming experience in the classroom.

This paper, investigates the integration of the DGBL in the primary education, based on a case report of 3 DGBL pilot projects designed and applied in classroom settings by primary education teachers. These field implementations and studies were practical assignments for the course “Design and creation of Digital Applications” for the academic year 2008-2009. The course is part of the Joint Masters (MSc) Program “ICT in Education” jointly run by the National and Kapodistrian University of Athens, the University of Thessaly and TEI of Piraeus, Greece and is addressed to primary education teachers with main interest in ICT, digital media and especially in digital games.

The educators designed the DGBL procedure, designed and implemented the games and chose their additional sources. They were in total control of the practical issues during classroom usage and they made small scale research during the DGBL experience of their students. They were free to design their own applications and conduct different types of studies depending on their teaching experience and approach. It is worth noting that these interventions had two main keynotes: the development of the process of integrating digital games in the teaching process and on the other hand the investigation of how much the enrichment of traditional ways teaching action with the use of digital material influences the response of students in their active participation in specific educational matters.

2. Integration of the digital games in the primary education

2.1 Pre-school intervention for learning basic math concepts through digital games

2.1.1 Case study

The first case reported in this paper concerns a pre-school intervention for learning basic math concepts. Four sessions have been organized with the participation of 10 pre-school students, using freeware micro-games from the Up To Ten and Poisson Rouge web sites and the Minisebran suite, as well as a simple Flash game designed ad hoc. A prototype code of conduct during game play has been put in place and a number of conclusions have been drawn by observing and evaluating student reactions and opinions, expressed by the students through drawing and talking about their likes and dislikes.

2.1.2 Rationale and planning of the intervention

The teaching of mathematics in the preschool education intends to help the children interpret the world that surrounds them; it also helps in the categorisation, the correlation, the classification and finally the organisation of their surroundings. In kindergarten a suitable environment should be created so that the children can start to think in ways that define the science of mathematics and in the same time realise its social dimension. The new Cross Thematic Curriculum Framework for Compulsory Education of 2003 enhances this dimension in mathematic education and taking into consideration the technological developments it includes the use of PC as well.

As a teacher knows how to use the capabilities of the digital games, he has the potential to contribute to the upgrading of the knowledge and improving methods of teaching. However, its use does not automatically solve all problems and to overcome any difficulty that one encounters in the classroom. Teaching by using digital games requires a creative manner of teaching in conjunction with the appropriate educational intervention. There are several aspects of educational use of digital game. However, through a structured and organized teaching, digital game can be smoothly integrated in the educational process and create innovative learning conditions, with more fun and playful nature.

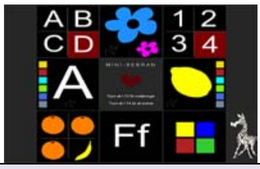
Our research focuses on the investigation of the interest that a digital game can provoke and its usefulness as an educational tool in a kindergarten classroom.

Before our intervention we had: (a) to choose what educational goals of mathematics we would want to observe, (b) then had to find digital materials that could achieve our educational goals and while taking into consideration that it should be compatible with computers that would be used in the interventions, (c) almost in the same time with the first two steps of the preparation we made contact with the teachers of the private school in order to show our interest in cooperating in this research, finally (d) we organized the way of recording the key steps of the activity and organized the computer room in the kindergarten classroom.

The outcome of this research is based on (a) the record of our observations during the participation of the children in the activity, (b) the collective assessments done at the end of every activity, (c) the individual drawings that the children made in the end of all the activities to show what they liked and disliked and (d) the transcription of the individual assessments of the children which were recorded using a PC.

2.1.3 *Educational material*

Table 1: We used the following games, each one of which served specific goals

GAME	SOURCE	EDUCATIONAL GOALS
INTERNET		
Messy Drawer-Up To Ten 	http://www.uptoten.com/kids/kidsgames-mixedbag-tidieddrawer.html	Counting of objects
Poisson Rouge 	http://www.poissonrouge.com/123/index.htm	- Reciting the numbers from 0 to 9 - Reading of the mathematical symbols - Correlation
	http://www.poissonrouge.com/board/index.htm	- Sequence of numbers - Correlation
	http://www.poissonrouge.com/dottodot/index.html	Sequence of numbers
STAND ALONE APPLICATIONS		
Minisebran 	http://www.wartoft.nu/software/minisebran/	- Reciting and writing of numbers - Correlation
GAME DESIGNED BY OUR TEAM		
Let's play with numbers 	Game designed in Macromedia Flash	- Reciting the numbers from 1 to 10 - Reading of the mathematical symbols

2.1.4 Organization of the classroom sessions

We realised four educational interventions in a private school of Athens. The sample of students taking part in the activity comprised 10 students.

2.1.5 Conclusions

We should mention that the duration of our research was limited and as a result it could not come to some conclusions of universal value. Our sample was chosen by the kindergarten teachers of the school with which we collaborated. In addition we should point out that the children of the school had already used computers in other activities. Their previous acquaintance with computers helped our research. While processing the answers of the students we realised that the digital game can contribute positively in the mathematical education of pre-school children and contribute in the growth of social dexterities. It familiarizes the students and the teachers as well with the new technologies and finally, it strengthens the positive attitude toward the new ways of teaching. The children - players enjoyed the games but at the same time criticized those were less interested. The collaboration between them was quite good and there was an intense debate amongst them in order to solve problems during the game. We noticed that the games that we considered to be less interesting to play, stirred the children’s interest.

Finally we would like to emphasize on the essential role of the human participants in response to a digital game and the effectiveness - in relation to the anticipated objectives of the designer- is determined by the response it gets from the players and the people that bring the player in touch with the game, which in this case are the teachers.

2.2 Applying DGBL material on linguistic topics in two primary schools

2.2.1 Case study

The second intervention presented has focused on applying DGBL material on linguistic topics, in order to investigate whether digital games can enhance the functional-communicational perspective of language. The intervention involved two primary schools with a group of 15 students each, and observation/discussion was employed for evaluating results. Conditions of communication were created in which the students used the language, collaborated to seek clues and information, formulated and evaluated hypotheses and expressed opinions. During the last part of the pilot each student group was asked to describe a language game that would serve as a challenge for the other group, and two such prototype games were developed in Flash. This activity gave the students the opportunity to express themselves and apply their knowledge on structure and use of written language, while at the same time providing a frame of communication and “competition” between the two schools.

2.2.2 Rationale and planning of the intervention

The co-existence of traditional ways of teaching language skills together with the investigation of new approaches and with rapid social changes that have emerged due to modern applications of ICT, give rise to important developments in the didactics of language. As modern instructive theories for language show, a simple apposition and memorization of grammar and syntax rules does not constitute sufficient grounds for learning (Frances, 1999). A positive attitude towards the process of linguistic learning needs to be developed, which involves the active solving of language problems as well as utilization of the students’ ideas. As a result new approaches have emerged for linguistic teaching, emphasizing the functional-communicational dimensions of language.

In this line of thought, digital games can be employed as a tool for teaching of language based on two important features: (a) their flexible communicational approach towards language and (b) their ability to accommodate training activities that contribute to the growth of students’ communication skills.

Keeping in mind the above, two educational interventions have been designed for teaching language in the second grade of a public and a private primary school, located in neighboring areas of Athens with somewhat different socio-economic status. The main research question underlying these interventions concerned the extent to which traditional ways of language teaching can be enriched by employed digital games-based material, as well as the influence that such an approach can have on the active involvement of students.

The sample of students taking part in the interventions comprised 15 students (11 boys and 4 girls) in each one of the two schools involved, separated in three teams of 5 students in each school. The instructional topics of interest included word accentuation, article-adjective-noun agreement, conjugating nouns and verbs as well as forming the basic structure of a sentence.

The methodological tools employed to gather student feedback were (a) observation (collection of qualitative data through the observation of student behavior and reactions to classroom events) as well as (b) conversation with the students.

The pilot interventions took place for a period of two weeks, during which four sessions were realized in each of the two schools involved.

2.2.3 Selection of the educational material

The digital games-based material employed in the intervention comprised the following applications:

- Activities about language skills selected from the "Magic Potion" game (http://www.media.uoa.gr/epinoisi), executable as autonomous applications that incorporate instructor-defined educational content. The intervening authors provided content corresponding to the learning curriculum of the second grade of greek primary schools on the instructional topics mentioned above. This material was selected due to a number of reasons: (a) it incorporates elements of fairy tale able to attract and activate the pupils' interest; tales constitute an instructive tool in that they allow a teacher to approach the intellectual world of children and bring them in contact with social and natural phenomena in an unsophisticated way, thus providing an affective framework that can enhance the childrens' oral expression without making visible the educational objectives behind oral and written grammar and syntax phenomena; (b) the game's story narrative constitutes a way of communication in itself, enhancing the pupils' perception of the significance of linguistic structure in a practical and amusing way; and (c) it allows adaptation of the language exercises at the level and contents appropriate for the specific instructional case.

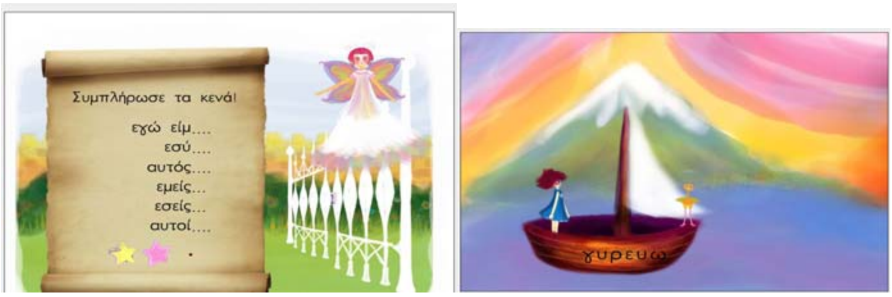


Figure 1: "Magic Potion" game

- Activities from the Sebran game suite (*http://www.wartoft.nu/software/sebran/*), and more specifically the "Find the letter" and "Hangman" activities to practice the structure (analysis, composition) of words. These activities have been used in a complementary manner, to provide an amusing atmosphere based on games that were already familiar to the participating students. This choice has allowed to save the class time needed for explanations, while providing a level of difficulty proportional to the students' skills as well as situations of victory. As a result, these activities created a frame of competition between the student teams, while at the same time offering a sense of relaxation.

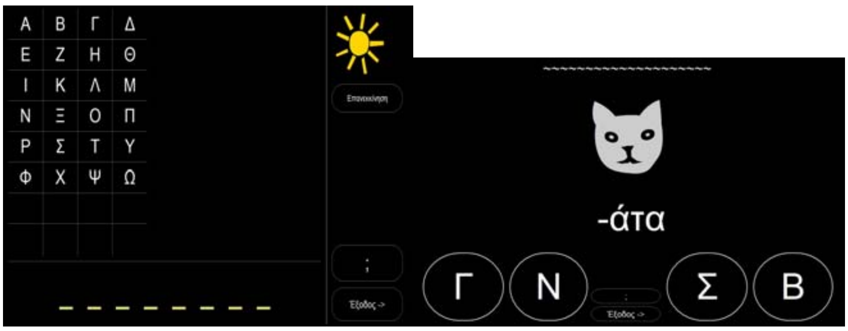


Figure 2: Sebran game

- Additionally, two new game applications were developed using Flash, through the students; own guidance and feedback. These two applications were designed in a way to allow students apply their knowledge about the structure and use of written language and, in the last part of the interventions, they served as a frame of communication and competition between the two participating schools.

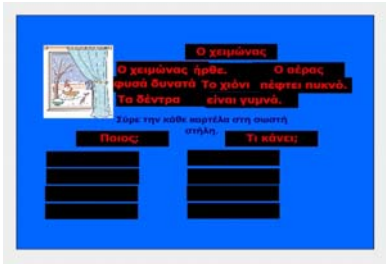


Figure 3: New game applications were developed using Flash

2.2.4 Organization of the classroom sessions

During the first session of the intervention, the teams were structured, roles were distributed within the members of each team and the students familiarized themselves with the “Magic Potion” game, browsing the game’s menu. This has also allowed making an indirect assessment of the students’ familiarization with computers and digital games and identifying potential difficulties at this level.

During the second session, students in both schools looked forward to realizing activities similar to those of the introductory session, but through playing the game this time. A frame of competition was established between the student teams, employing specially shaped evaluation cards with stickers.

At the beginning of the third session in each school the winning school team of the previous activities was announced. Sebran activities were employed as teaching material and the factor of time was employed as a frame of competition. The objective of all teams in that session was to identify the most correct answers in the “Find the Letter” and “Hangman” activities of Sebran, within a given amount of time.

Finally, during the fourth and final session of the intervention we made use of the Flash applications that had been developed based on the students’ ideas, presenting the teams of each school with the application designed by the students of the other one, and thus establishing a frame of competition between the two schools.

2.2.5 Conclusions

Given the limited scale of this intervention and the number of participating students (30 in total), it is not so easy to demonstrate some conclusions of universal value for the in-class application of digital games-based learning. Nevertheless it can be asserted that electronic games can be used - even in the environment of formal learning - for comprehension, deepening and combination of existing linguistic knowledge, as well as for discovering new knowledge on the basis of concepts and skills already established.

At the same time, DGBL has facilitated active attendance of students through their engagement in communication activities and events. These in-class activities have created communicational conditions in which the students have used the language and collaborated in order to seek elements and information which afterwards they have evaluated and categorized. In addition students have been able to make assumptions and then try to verify or deny them, formulating and supporting their views. More specifically:

- The students of both schools were excited with the “Magic Potion” and Sebran games, as well as with the in-class process in general.
- In the frame of competition and curiosity for the development of the “Magic Potion” tale the students focused on that particular knowledge, discussed it and then made a decision; at the same time they managed to apply their knowledge and develop their ideas by creating their own linguistic activities.

- The whole process was based on the linguistic expression of students. The students had the ability to use their knowledge on the structure of language but at the same time apply it on free speech, in order to practice their techniques for argumentative speech and dialogue.
- In both schools the students showed great enthusiasm and participated actively when the language exercises were realized through digital games. It is important to mention that weak students were not weak players when it came to digital game play.
- All-in-all, the students were active participants in the in-class process and exercised their skills for evaluating and applying information.
- Game playing has had a positive effect on the growth of dialogue, exchange of ideas and negotiation between the students.

2.3 Using DGBL material for children with autism disorders

2.3.1 Case study

The third intervention presented has focused on using DGBL material for children with autism disorders (AD). Four children with AD were given access to DGBL material in order to investigate the potential of digital games to activate their attention, bring a playful character to the learning process and make more amusing the achievement of objectives. The material employed includes online freeware games and commercial edutainment software, as well as parts of the “Magic Potion” digital adventure tale, whereas the educators created an additional Flash game for social/emotional skills. A number of remarkable outcomes have been observed during this pilot, whereas interesting issues were highlighted regarding game usability, student collaboration and the role of the educators.

2.3.2 Planning and application of the intervention

The autism constitutes a serious and diffuse disturbance of growth. The term extensive (or diffuse) refers to the complex nature of the disturbance, as it influences three regions of growth: the social interaction, the communication and the imagination(DSM-IV, 1994).

For all of the above reasons the analytic programs are also extended in the instructive methodology that is suitable for students with autism. More specifically, the students with autism are in need of : a) a structured training environment, v) a constant daily program, c) one to one teaching (and less team teaching**), c) alternative ways of teaching (audio-visual instructive material, natural guidance)** and d) enriched educational activities with focused on their preferences and interests (Cross Thematic Curriculum Framework for Compulsory Education, 2003)

The game and more specifically the digital game is an instructive methodology that meets the requirements mentioned above.

Our intervention was realized in the 1st Special Primary School Amarousiou.

This school employs 15 teachers and has 38 students with special educational needs, with ages varying from 4 1/2 to 14 years old.

In our intervention 4 children participated: 2 students with autism and 2 students with Mild Intellectual Disability and Down syndrome.

Most of the students were familiar with using computers since their school curriculum includes a special course for using a PC, in addition all of them had their own personal computers at home.

The DGBL experience took place as a parallel activity to the school program and its duration was 3 hours in 4 days, however the teacher of the classroom used our material for 4 additional hours.

As for technical considerations, the school possessed an IT laboratory with 10 computers, special keyboards with big keys and special lever instead of mouse and an internet connection.

The intervening educators decided to use specific games from web pages, the software of work EPINOISI: `The Magic Potion” and developed also a game using Macromedia Flash©., which are in accordance to the National Curriculum for children with autism, creating for each student his own individualized program, adapted in his or hers dexterities.

The basic goal was to make the students feel free to participate, have fun playing without any pressure or the fear of evaluation from their teacher. The intervening educators' role would be clearly the role of animator and instructor in order for the students to play the games. They expressed worries regarding students' reaction with persons that they were not familiar with or the refusal to participate in game, if they accomplished to include the children in the team they didn't want to disturb the daily school routine. The learning outcomes of the DGBL trial were oriented towards both cognitive and social educational objectives. As far as the cognitive objectives of the trial are concerned, games were chosen that would help students:

- In the socialization, in the acquisition of social dexterities, in the appropriation of social behavior, in the obedience and observation of rules (as rules of behavior).
- group and distinguish objects in categories
- put pictures in order /time sequence,
- recognize colors
- develop linguistic dexterities (oral reason).
- execute mathematic calculations.

Figure 4: DGBL software "The Magic Potion", was chosen and used by the educators in curriculum areas of logical decisions, mathematic calculations, in the socialization

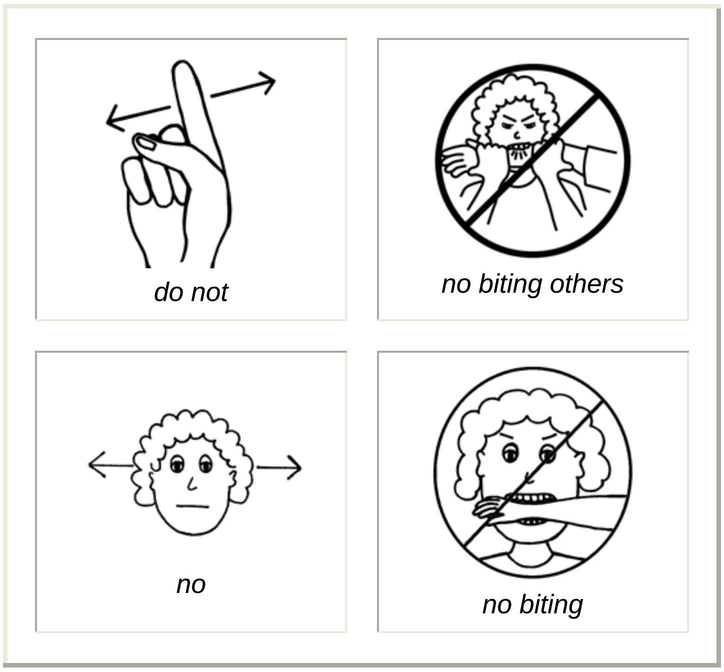


Figure 5: http://www.do2learn.com/picturecards/printcards/2inch/imagegridswords/behavior1.htm

This web site was chosen and used by the educators regarding curriculum areas of social behaviour.

The special school provided a warm reception for the project; the students showed great appreciation. The teachers were open to our intervention. They discussed with the educators the methods, computational digital, that could help the children with autism.

However the first day in the school, held a surprise for us. Two more children with intellectual delay wanted to come join us in the computer room.

During the application, the intervening educators recorded for every student, information such as age, cognitive and emotional condition, duration of playtime, games played and reactions, achievement of objective with or without help, preferences, difficulty or facility playing the games and general observations that seemed to be of significance. All students were finally able to participate in the trial application; 3 of them played all the games, while the remaining student played only games regarding rules of behaviour.

2.3.3 Conclusions

According to the intervening educators, the most impressive observation during the entire trial was the eagerness of the children; they were enthusiastic about participating in the game and they corresponded without difficulties. They had fun with the games, they showed enthusiasm (as much as one can observe in children with autism a competition and appoint a winner.

In the educational intervention that concerns the social dexterities, the students were very pleased and they showed great will to collaborate, much more than in the previous instructive units.

For the intervening educators the application was an exceptionally interesting experience. The contact and the collaboration with the children were enjoyable apart from the initial distress. They felt pleased astonished and useful when 2 students with Mild Intellectual Disability asked them to participate in the application.

The intervening educators have considered this trial application to be quite limited and that it does not allow to reach some indisputable conclusions; however, in this particular case, the use of digital games in the education of students with autism has seemed to confirm some initial expectations, concerning the benefits of this effort:

- a) The training process became enjoyable
- b) Digital games functioned as a challenge, activated the children and changed the amusement into achievement of an objective!!!!!!
- c) Concerning the teachers elected: The interest and the “faith” in the help provided by computers.

3. Concluding remarks

3.1 Findings

According to some of the observations, we can conclude that the DGBL can be integrated successfully in the primary education. More specifically an improvement in students with moderate abilities or high records when they compared their results to previous traditional written evaluation test was noticeable. Concerning the students with previous low records, there was no significant difference. However, all students showed augmented interest regardless of their classroom performance.

Moreover, as it was mentioned in some case studies, the training process became enjoyable, while DGBL functioned as a motivational challenge, which activated the students and engaged them in the learning process. In some cases problems regarding students’ attitude or emotional state that school teachers had not perceived before, were identified.

Especially for the children attending pre-school it can contribute in the process of integration in primary school. It was also noted games can also help children with Mild Intellectual Disability fit in a regular classroom and form social networks.

According to some of the educators involved in these trials, the experience of developing games has proven to be a particularly creative work, since apart from the development of the games themselves, they also had to devise an accompanying fantasy and plot. All educators involved in the trials were more than positive on using DGBL in the near future.

3.2 Critical success factors

Digital games can be applied easily to supplement traditional teaching and reinforcing the collaborative learning. Digital games are an excellent example of multimodal literacy. It also motivates the student to learn which is far more important than the mere acquisition of knowledge. In addition the student takes charge over one section of the learning process.

A fairly big difficulty is to evaluate students in the games: there should be a distinction between skills and knowledge. Teachers should pay particular attention to the expectations of students' attitude regarding electronic games or their ability in playing them. Children should be trained in educational gaming as well, even if this means a simple set of rules.

Inclusion of such pilot interventions in the educational program should be designed in terms of minimizing the burden of students and non-harmful nature of the planned training activities.It is proposed to arrange such activities in a separate time slot, in order to avoid causing problems in the flow of daily schedules. In any case, the key to a successful outcome for intervention is the preparation of students by their teachers.

At the same time, this attempt also constitutes an exceptionally difficult work when the games in question are oriented towards educational purposes. Different types of knowledge and skills on behalf of the educators should be combined:

- profound knowledge of pedagogic theories and perceptions,
- the ability to effectively plan and implement the educational application of the game in the particularly limited and demanding time frame of the daily school timetable;
- the ability to devise games at the same time
- adapted to the intellectual, psychological and emotional profile of the pupils' target group
- attractive and engaging for the pupils
- able to meet the educational objective.

All the aforementioned factors make the work of the teacher, who engages in creating a digital game-based educational experience a successful DGBL application, extremely complicated.

3.3 Open issues

It should be made clear that digital games, just as any other medium, can be of high quality or not. The educator seems to be responsible not only for the proper usage of the game, but for the selection of a game of suitable quality and adaptability to her learning scenario and goals. "The games development industry needs to understand the constraints on schools, teachers, parents and above all children, of time, resources, and the requirements of curriculum and examination if games with more direct educational value are to emerge" (Kirriemuir and McFarlane, 2004).

According to the educators involved in this study, an important factor is the inadequacy of public education in the promotion of innovative projects, as well as the IT inadequacy of many educators who seem hesitant to learn new methods. In addition it is necessary to move past the established opinion that there are means used for drill and practice and to regard them as educational tools which can help in the understanding of complex concepts. Moreover, an equally important parameter as far as success is concerned, is also the focus on explicit and evident educational objectives and the ability of the educator to adapt the game according to her students' needs and abilities.

However, is not only a matter of knowledge but a question of approach as well. According to a research made by John Kirriemuir one of the main faced is "an almost totally negative media impression of computer and video games influencing the opinions of school teachers, heads and parents" (Kirriemuir, 2005). This is complemented by the views of Dorn (1989) who states that the attitude of the teacher towards games influences the outcome, and the teacher's knowledge and skill in using the game is also an important factor.

Accordingly it should be mentioned that in our trials, in the single case of a DGBL activity where the classroom educators were not part of the implementation process, they showed ignorance and lack of interest in using ICT or in the educational outcomes of the study. The intervening educators who designed and implemented the gaming experience made referrals of unawareness and indifference from the part of the classroom educators towards the experience of their students, which is only to be expected since local teachers were not positive regarding ICT and DGBL.

Finally, the educators involved in the above trials all seem to conclude that, research should turn to the development of tools and educational software, which will be based not so much on behaviourism but on interactive models of learning. Open source can also be adjusted in the needs of students as well as the capabilities of the teachers. To achieve this realistic goal it is of great importance that experts from technology and education work together. The profits from such an experience are of tantamount importance for the quality of their educational process as perceived by the children, in order to change the picture of the tedious and boring classroom, to that of a school that creates real motives and can directly address the interests of the children.

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Student's Problem Appropriation in an Epidemiology Game

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Abstract: One of the most important conditions for effective learning in a game is the appropriation of the problem by students. This study aims to produce results on the conditions under which this appropriation occurs, particularly on the roles of teachers, computer environment and collaboration among students. While students dive in or step out of the game, we investigate empirically how they progress from playing the game to elaborating strategies. Our experiment takes place during biostatistics classes and is based on the laboratorium of epidemiology (Ney and Balacheff 2008), a virtual hospital that immerses learners into a full-scale, persistent and distributed simulation combined with a gaming scenario. This laboratorium was collaboratively designed by researchers, experts and teachers. It is used on one hand by medical students who design and implement an epidemiology study, consequently developing critical thinking on statistics and epidemiology studies and on the other by researchers who assess the conditions of learning with such a simulation. The laboratorium design is inspired by recent work on embedded phenomena (Moher 2008) and participatory simulations (Colella 2000) and has four main characteristics. First, it provides an immersive learning experience lived by students who play the role of public health physicians. They experience an otherwise inaccessible professional situation by immersion into a phenomenon (occurrence of a nosocomial disease in a simulated hospital). Secondly, it is based on a distributed simulation implemented without the constraints of single screen boundaries. Indeed students interact with patients through a video-on-demand system on a web-based hospital, with the head of the hospital using their personal phone, or with the ethical committee by e-mails. Thirdly, it is a persistent simulation accessible continuously over several weeks and that evolves partly without student interventions. Finally, the simulation is combined with a collaboration scenario since students collectively design data collection campaigns, gather and interpret group-shared data in a decision making process, and submit together a paper to a simulated medical congress. Targeting second year medical students enrolled in a mandatory biostatistics course, our gaming scenario extends over 13 weeks accounting 32 tutored hours. In this study we will present preliminary results from a qualitative interaction analysis from classroom observations and a quantitative analysis of computer trails. These data were obtained during the first semester of 2009. In this context and according to Brousseau's Didactic Situations theory, we decompose student appropriation of the problem in different moments that we try to identify in the data collected.

Keywords: Appropriation, devolution, simulation, game-based learning

1. Introduction

The core objective of learning games is to offers students a situation that they can "live" (in the sense of a significant immersion), and in which the knowledge is meant to appear as the optimal solution to the problems posed (Brousseau, 1997). Teachers and designers want the students not only to play but also to enter a problem solving process precisely designed to enhance the learning targeted. However, because of the richness of the situation, students may engage in different problem solving related to different meaning attached to the environment. We shall speak here about "the appropriation of the problem" when focusing on the problem teachers and designers intended to devolve to students. By *appropriation* we mean the process through which learners make their own a problem, giving it a sense of relevancy to them personally. We use the term process because the appropriation implies a complex treatment of the situation, and it can evolve over time: Students can "dive in" and "step out" of the game (Ackerman, 1996 ; Colella, 2000) sometimes getting involved in the immediate resolution of the problem, sometimes standing back on their strategies and their experiences. They could also pass from one problem to another. In a game, the problem to be appropriated finds its origin and is embedded in a context that may include a questioning, an enigma, a decision to make, or a practical objective.

The notion of appropriation can be found in Wertsch's sociocultural theory of the human activity. He defines it as "the process of taking something that belongs to others and making it one's own" (Wertsch, 1998). In Wertsch's sociocultural perspective, the path leading to the appropriation is rarely linear and straightforward, from discovery to appropriation. In the context of learning, there are tensions caused by differences between the problem the teacher designed for learning and the student's interpretation in his or her particular context. These tensions can result in what Wertsch calls *the resistance*. What we keep from Wertsch's proposition here is the idea that appropriation is not only bound to the individual but also to the context.

In the beginning of the 80s, the issue of appropriation had been identified by Brousseau in the emerging context of the didactical contract concept (Brousseau 1984). In his theory of the didactical situations (Brousseau, 1986 ; 1997), Brousseau studied the potential gap between student perceived problem and teacher intended problem. He proposed then the concept of devolution to designate the process through which the teacher intends to make the student take responsibility for a problem, and to accept the consequences of this transfer to him/herself. When the devolution does not succeed, a possible consequence is that, rather than addressing problems in terms of the underlying concepts, students address them in terms of what they think that the teacher will expect them to do (Millar, Leach & Osborne, 2001). By analyzing an experiment made in a kindergarten with a video game (Brousseau, 1997), Brousseau identified five levels of devolution: From a level where learners play to produce effects, whatever they are, to a level where learners master problem resolution strategies, in various conditions. The appropriation concept is the dual concept of the one of devolution, the former being on the student's side, and the latter on the teacher's side.

In the science education literature, a concept connected to the appropriation is the one of authenticity. The feeling of authenticity is sought in the learning of methods and attitudes in science, (e.g. Moher, 2006), particularly to engage students in an investigation approach that is similar to the one of the scientists – an "authentic" investigation. The search for realism is a factor, among others, that allows this authenticity, but the evidences of this authenticity are in the student appropriation of the original problem (designed by the teacher). This problem can be put in realistic terms (for example based on data really used by scientists or situations very similar to those in which they are really involved) or transposed. Colella (2000) emphasized the importance of building a problem into which even inexperienced students are going to be able to dive in. The method she employed is original and in the context of epidemiology as for the present study: high school students in science class collected data among themselves. Indeed, they were carriers of virtual viruses (realized through an infrared tag they carried) and had to discover the underlying model of viral propagation. She found indications of students' engagement in their speech about the events (e.g. I am sick, you passed me the virus); a method which we shall also employ.

The goal of our research is to get results on the conditions under which the problem appropriation occurs, and also to propose an operational method to define and evaluate appropriation. To reach this goal in the context of game-based learning, it is necessary to answer three questions:

- (Q1) Model the appropriation: what are the various levels of problem appropriation by students in a game?
- (Q2) Measure the appropriation: what are the criteria to decide if a student has appropriated the problem or not, and the indicators that can be collected by observing the students?
- (Q3) Facilitate the appropriation: what are the means that can be proposed in a game for students to progress in the appropriation process?

We present first results of an experimental research in progress that focuses on Q2 and Q3. It contributes to the evaluation of the impact of game design on learning, the appropriation being a necessary condition for learning (but not a sufficient one). Indeed, if learning based on simulations and games is not controversial any more (Egenfeldt-Nielsen, 2006) including in the field of health education (Lane, Slavin & Ziv, 2001), to integrate these games into formal education and demonstrate their efficiency for learning (what and why) is another issue (Wilson et al., 2009). Our work is based on the theory of didactical situations (Brousseau, 1997) including the levels of devolution of Brousseau (an answer to Q1), as well as the development of an environment for health education. In section 3, we analyze factors that can facilitate appropriation (Q3) in a particular game introduced in section 2. In section 5, we present a measurement instrument and how it functions (Q2) using a qualitative data analysis introduced in section 4. Section 6 is a conclusion.

2. The context of the study

We focus here on a particular curriculum and a particular game environment that assembles several technologies. We will come back on what is generic in our work in the last two sections. The context of our study is based on the Laboratorium of Epidemiology (LoE) which immerses second year medical students in a simulation of a hospital and related institutions, combined with a gaming scenario. LoE was designed by researchers, experts of the domains (statistics and epidemiology), teachers and students, with different levels of participations and according to a methodology described elsewhere (Ney & Balacheff, 2008). The design of LoE was inspired by recent works on embedded phenomena (Moher, 2006) and participatory simulations (Colella, 2000) holding the characteristics of providing students with the experience of an immersive and collaborative learning based on a persistent and distributed simulation. In fact, if LoE shares with video games, among others, the fact that players are characters who interact with other characters, it does not limit itself to interactions on a single screen; the simulation is distributed and players interact through different channels (e.g. phones call, e-mails, etc.).

We adopted an inquiry-based learning approach. LoE is used by students who design and carry out an epidemiological study, write a scientific article, present their results in a congress, and by doing so acquire skills in "critical reading of medical articles" (The National Classifying Examination of the medical schools includes a test of critical reading, which aims to prepare students to think critically about statistical approaches). LoE is also used by researchers who study the learning conditions with this type of gaming simulation. It is thus both an educational project integrated into a course of biostatistics in a medical school, and a research project, a laboratorium, allowing repeated data collection campaigns that are not singular events in students and teachers lives. This integration is an attempt to reduce data collection bias and produce well documented corpora.

The main tasks for students, the learning stakes and the computer environment connected to these tasks are indicated in the following table.

Table 1: Analysis of the main learning stakes of the game

Tasks (in group)	Stakes	Computer environment
Bibliographical research	to know a disease as well as the methodologies in epidemiology surveys.	Library website, Mission Request Text (Governmental Public Health Commission website)
Realize a first epidemiological survey at the hospital	to design and implement a survey (sample quality, indicator quality, ethical considerations, etc.).	Ethical Research committee website, Simulated hospital, E-mail application, Mobile phone
Analyze data	to analyse data with statistical tools and thus understand them.	Medical Information Department, Library website, Statistical software, Spreadsheet application
Write an article then make an oral presentation	to defend their decision tools based on statistical argument and in a scientific presentation form.	Text editor, Congress website, E-mail application

Table 1 gives only a flavour of the computer environment and only the part that is used by students (see also Figure 1). Another environment is devoted to teachers, and mainly allow them to follow students' productions and to interact with them (see next section). A third environment is used by researchers who can visualize computer trails of the users.

In order to solve the problem of their mission, students are going to encounter two sub-problems: (1) design a diagnosis tool of the VTED (Venous Thrombo-Embolic Disease) for hospitals, and (2) do a statistical analysis of a medical database. The first problem contextualizes the second one. The appropriation of these problems by students involves learning statistics, understanding the role they play, and, more generally, the function of statistics in public health. LoE was thus designed as an authentic situation (Moher, 2006) by representing elements of a real epidemiological survey at the hospital while adapting the complexity of the situation to the targeted students and learning objectives. In this paper, we focus on the appropriation of problem (1) that is stated in details in the mission text. This mission text gives each student explicitly the role of a public health physician. To know how students assume and understand this role will help us looking for indicators of the problem appropriation. We believe that what follows may be applied outside health games and mostly requires a game with (i) a context problem that gives meaning to another problem designed to construct learning, and (ii) computer mediated communications between learners and characters of the game.

Figure 1: The orientation page from which students have access to six hospitals and three web sites, all designed for the game

3. Analysis of the potential factors of the appropriation

We identified several types of factors which can facilitate appropriation, from the literature and from an analysis of the game presented above.

3.1 The interventions of the teacher during the sessions

The appropriation of the problem depends partially on the process by which the teacher succeeds in placing the student as the one in charge to solve the problem, i.e. the devolution process. Indeed, the teacher needs to make sure that students understand the questions asked, the information given and the constraints that have been imposed. Different teacher's actions can facilitate the appropriation, such as encouraging a discussion on the definition of the problem, summarizing the discussion and giving appropriate names for the concepts used, or including an exercise session to have students remember previous experiences. Above all, so that devolution happens, students have to accept a system of reciprocal expectancies and responsibilities between them and the teacher, concerning the learning situations (the didactical contract, Brousseau, 1997). During the LoE sessions, a teacher intervenes for methodological helps, and it would be careful to analyze these interventions (not shown here) in a research for factors facilitating the appropriation of the problem (Arsac, 1992).

3.2 The system of interactions with characters of the game

The computer environment was designed to immerse students into a professional experience. One important characteristic of this environment that can facilitate the problem appropriation is the system of interactions, which is similar to the one used by professionals. These interactions are described in Table 2. These allow students to experience live conditions similar to the ones they would live in a real hospital, including feelings (empathy, intimidation, etc.) and constraints (leave a brief message on an answering machine, a patient does not repeat an answer twice, etc.). We will search to what extents each of these interactions are going to facilitate the appropriation of the problem of public health.

Table 2: Feedback aiming to simulate human interactions in hospitals and related institutions

	Action	Feedback
1	Students ask the person in charge of a Medical Department authorization to interview patients leaving a short phone message on an answering machine (personal phone)	Validation of Student's request by the person in charge of the Medical Department (VOIP, SMS)

	Action	Feedback
2	Students send their research protocol to the Ethics Research Committee (e-mail)	Validation of the research protocol by the experts of the ERC (e-mail)
3	Students interview patients in one of the Medical Department (in the simulated hospital, choose a department then a patient then a question)	The patient answers to the question (video)
4	Students make a request for supplementary data at the Medical Information Department (fill a Web form)	The Medical Department sends the students a table of data (e-mail)
5	Students submit their scientific article to the Medical Congress (Web site)	Validation of the article by the scientific committee (Web site and e-mail)
6	Governmental Public Health Commission asks students to report their results (e-mail)	Students send a report to the Commission (e-mail)

3.3 The interventions of the assessors

There are two important evaluation episodes of the students' productions in LoE: A validation of students' protocols carried out by the Ethics Research Committee (ERC), and a validation of the articles by the organizers of the congress (see 2 and 5 in Table 2). The students receive these validations on behalf of the experts of the ERC or the organizers of the congress, and not on behalf of the teacher, although it is the group of teachers who make these evaluations. These feedbacks may allow students to appropriate or re-appropriate the problem, positioning themselves as public health physicians who solve it, as far as they receive feedbacks adapted to the context of the game.

4. Data collection

Several data will allow finding indicators of appropriation of the context problem in LoE. In this paper, we present an analysis of interactions (Table 2). The question is: what in students' acts and words indicate that they take the point of view of a physician who builds a diagnosis tool in public health? These indicators will then have to be confronted with factors that can explain the process of appropriation.

4.1 Participants

The students are in the second year of medicine in Grenoble in a compulsory course of biostatistics. The course takes place during the first semester and is followed by eight problem sessions of four hours each in the second half-year. The participants are all in the same group (N=28, 22 girls, 6 boys) and were allocated to this group by the administration (the 180 students enrolled in this course are distributed in 6 groups running in parallel). They work in teams of four students. Their teacher is the person in charge of the course; he participated in the design of the game and of the scenario.

4.2 Procedure

We analyze four particular episodes in the resolution of the problem (interactions 1, 2, 5 and 6 in Table 2). Having read about the mission through the document that describes it and bibliographical research, students began to design the protocol of their epidemiological survey. In order to be able to interview patients according to this protocol, they have to ask for the authorization of the person in charge of each medical department of the hospital they wish to visit (1 in Table 2). For that purpose, they have to make a call and, having listened to a brief message, they have to formulate their demand in the way they think useful to describe it to this person. They receive an answer by SMS giving them an agreement or an argued refusal. An agreement allows the access to the patients' rooms to the team. This phone call is thus a compulsory stage to continue the epidemiological survey. A team can make several calls, either to have access to several departments, or to repeat their demand after a refusal. At another moment (2 in Table 2), when their protocols are ready, they send it (pdf file) for validation by the Ethics Research Committee. This file should be introduced by a short message. This is also compulsory since only approved protocols can be implemented at the hospital. Later (5 in Table 2), students write a scientific article. They send this article to the simulated Medical Congress. The article is subject to a scientific committee evaluation. The best articles are selected for an oral exposition. Finally (6 in Table 2), the Public Health Commission requires a report of the students' study, to be sent by e-mail.

4.3 Data

The first data set consists of phone messages left by students on the answering machine of the hospital. We collected 15 messages of an average duration of 46 seconds (19s - 152s). These messages were recorded by 9 students in 7 teams over a period of four weeks, during the problem sessions or between them. The second data set consists of e-mail messages that were sent by the students to the Ethics Research Committee, introducing the attached protocol. There are 13 messages of up to 47 words. They were sent by 7 students in 7 teams, over a period of 8 days. There is a third data set including 16 e-mail messages sent by students to the Medical Congress, introducing the attached scientific article. The messages were sent by 8 students in 7 teams, over a period of 8 days. Finally, a fourth data set concerns the outcomes of the report request made by the Governmental Public Health Commission to students. Only 2 teams over 7 sent messages introducing the attached reports, over a period of 8 days.

5. Method of analysis and first results

We carried out a qualitative analysis allowing to qualify various phenomena and to prove their existence. We present here the first results. Another study will be necessary to make a quantitative analysis. It is planned for the beginning of 2010; it will concern all the 180 students.

5.1 Method of analysis

Phone messages are entirely transcribed. Four moments are identified in students' speech: to introduce oneself, to describe one's own objective, to argue one's own demand, to say goodbye. The units of analysis are these moments. These units were successively analyzed to answer the following questions and our purpose was to identify categories of answers for each question: under which identity do students introduce themselves? Is this identity individual or collective? To what extent did they appropriate the text of the mission? Do they see their task as a clinical or a public health study? What kind of relationship do they have with the authority (the person in charge of hospital department)? What kind of relationship they have with patients they wish to interview (do they consider their patients as human beings or just information on a Web site)? What kind of relationship do they have with the staff of the department?

The classification in the categories is made by two researchers in parallel. We produced a grid of analysis of student's problem appropriation in a de-contextualised form with regard to the game LoE, the elements of context being only indicated in brackets (Table 3). We distinguish what is expected if this interaction were to take place in a real hospital, from what is not expected, with intermediate cases. What is expected from students is included more or less explicitly in the mission text or provided documents. We analysed the e-mail messages considering the content of the message heading and the message body. On the message heading we expected students to personalise the message giving it a subject related to their work as well as to the file attached on the e-mail, which either concerned a research protocol, a scientific article or a report. On the message body we expected students who appropriated their role of public health physician to express a formal attitude, structuring the message with greeting, body, closing and signature.

Table 3: Appropriation analysis grid

	Questions	Categories of answer		
		Adequate	Intermediary	Inadequate
Phone messages to the person in charge of a Medical Department	Identity	Character of the game (physician)	Student	Me (himself or herself)
		Member of a team	-	Individual
		Giving one's own name	-	Do not give one's own name
		Being sent by an institution	-	Do not mention the institution

	Text of the mission	Interpretation (context of the disease or the methodology of the survey)	Reproduction	Do not explain the mission
	Function	Task intended by the teacher (public health)	-	Aside Task (clinical medicine)
	Attitude toward characters (patients, staff)	The character is a human being	The character is a source of information	The character is ignored
	Attitude toward a character representing the hierarchy	Very formal	Formal	Informal
	Questions	Categories of answer		
		Adequate	Intermediary	Inadequate
Mail sent to the Ethical Research Committee or to the Medical Congress	Message Heading	Naming a message subject	-	Not naming a message subject
		Giving a personalised name to the added file	-	Not giving a personalised name to the added file
	Message body	Greeting formally	-	Greeting informally or not greeting
		Presence of a message addressed to the receiver	-	No message addressed to the receiver
		Closing formally	-	Closing informally
		Presence of a signature of the writer	-	No signature of the writer

Finally, we attribute a score to each of the categories of Table 3: a null score for the column “inadequate” and a score of one to the column “adequate” (except when there is an “intermediate” category, in which case we attribute a score of two to “adequate” and one to “intermediate”). By adding all category scores, we get a total score for each message. This score can be interpreted as follows: the larger the score the more indicators of appropriation there are in this particular message. Furthermore, we collected validations of authorization requests, protocols, and articles made by the assessors.

5.2 Results

We noticed that although students work in teams of four, it is almost always the same phone that is used and the same person who speaks, often not necessarily the owner of the phone. The same thing happens with the e-mail. Hence, these teams attributed quite spontaneously a spokesman's role to one of theirs.

5.2.1 Phone messages

One of the students identified him or herself as a physician while 8 over 15 of them as medical students, members of a team working on the field of public health. Less than the half of the 15 messages mentioned that they worked for a Public Health Commission. Mostly they were indifferent towards the hospital staff, but 12 over 15 showed interest for the patients and an overall formal attitude concerning the hierarchy. Analysis shows that the majority of the messages were clear and well prepared given the fact that only 2 requests were refused and students produced much more interpretation than reproduction of the content of the text of the mission.

5.2.2 Mail messages

Among the e-mails sent to the Ethical Research Committee 10 over 13 respected the message heading criteria while in the message body criteria 7 over 13 were introduce by a greeting, 11 presented a text body and closing and 8 ended with a signature of the writer(s).

Among the e-mails sent to the Medical Congress with regard to the message heading criteria, 12 over 16 gave to the message attached to the e-mail a subject related to their article and 15 over 16 put a subject related to their work on the message. Concerning the message body, 6 were introduced by a greeting; every message developed a structured text body and 13 messages ended with a closing and a signature of the writer(s).

Only two teams replied to the Governmental Public Health Commission request for report.

5.2.3 Appropriation over time

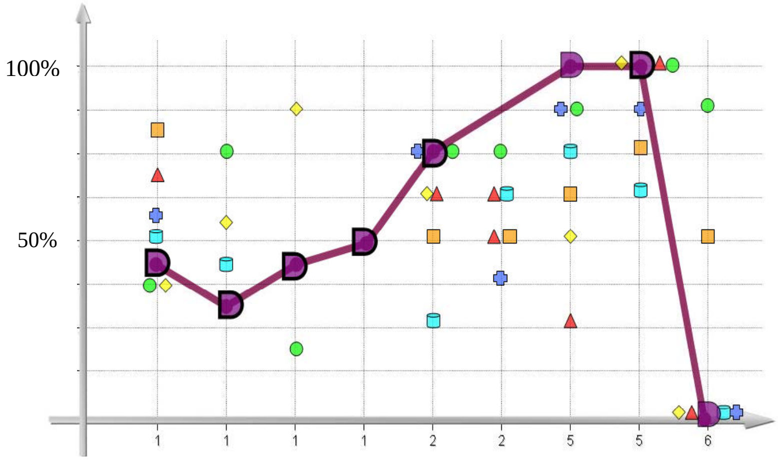

Figure 2: Scores of appropriation throughout the Biostatistics course

In Figure 2, the x-axis represents the appropriation score from 0 to a maximum of 100% of the appropriation indicators, and the y-axis represents the time or the different interaction events between students and the characters of LoE (numbers refer to Table 2). It shows the students appropriation scores throughout the biostatistics course. The different geometric figures represent the different teams (four students per team). We can observe that the scores tend to concentrate gradually on the upper side of the diagram as the game goes on. This shows that students' appropriation improve with time. This diagram highlights one of the 7 teams of the group (bold line). The line linking the different scores starts declining after the first phone call, but rises after the second phone call increasing the score until the forth phone call (interaction 1). Indeed, this team visited every medical departments of the hospital, and the quality of their arguments got better as they kept on calling other departments. On interaction 2 when the team sent the e-mail to the ERC the score rises sharply and reaches a peak on the first message of interaction 5. Note that some figures from this team are bolded others are not. A bolded figure means a validation by the assessors was accomplished. The students action is validated by the teacher behind the ERC expert, the Medical Congress scientific committee, etc. This explains why the team jumps from the first message of interaction 2 to the first message of interaction 5. Indeed, the protocol was validated at first. Note that the first message of interaction 5 was not validated even with a good message appropriation score, which means that the scientific article was not validated at first by the scientific committee; reviewers sent it back for further rectification, accepting it afterwards. After a steady hold of the score between the first and second message of interaction 5, the score plunges on interaction 6. This may be due to an inversion on the interaction direction, since on interactions 1, 2 and 5, the action is an initiative of the students towards LoE. Interaction 6 starts with a request from LoE towards the students (see Table 2), who are supposed to mobilize for a feedback. Another explanation is the circumstances under which the request was made because students were busy preparing the presentation on the subject of their scientific article to the Medical Congress.

6. Conclusion and discussion

The problem appropriation is a required condition so that a game becomes serious. If this appropriation takes place, students enter the game and learning happens. Indeed, the problem is designed in such a way that the knowledge students should acquire is the most adapted tool for the resolution of the problem (Brousseau, 1997). In this project, we take up the challenge of defining, measuring and facilitating students' appropriation of the problems they encounter in a game. In the game LoE as in many games, the problem designed for the sake of learning (here biostatistics) is embedded in a context problem that provides an "ecological" meaning for the construction of this knowledge. In this paper, we present a measurement tool that was designed to measure students' appropriation of the context problem. Therefore, we measured students' attitude towards characters of the game as well as their understanding of the mission they were assigned to. The data where collected when students communicated with characters of the game (by phone or by e-mail).

In order to show how our instrument can be used to analyse students' interactions, we tested it on a group of 28 students in 7 teams. The instrument contains a series of 14 variables (Table 3). Note that each of the classified extracts of messages is an indicator that cannot in itself ensures that the student has appropriated the problem. For example, an informal attitude towards the hierarchy can indicate that the student does not play the game of this exchange with the hierarchy. However, it can also show students' natural attitude about hierarchy at that present moment. Therefore, it is the accumulation of several indicators (total score) that is meaningful rather than just one. Our measuring instrument is under validation and we do so in two ways. First, in interviews with students, we confront them with our interpretation of their attitudes. Second, we compare our data analysis with a third party analysis using the same coding scheme (by a physician rather than researchers in technology enhanced learning). Only the first comparison has been carried out so far and the second one may lead to adjustments of the instrument.

Furthermore, we are going to use our instrument in a number of ways as we analyse a larger data set and try to obtain statistically significant results. First, we can compare the appropriation scores for different interactions in the game. Our distributed simulation provides different communication channels between the students and the game within authentic situations, and we shall study which one facilitate appropriation (Ney et al., 2009). For instance, if one takes the phone interaction, there are several characteristics that could explain the high score of appropriation and were mentioned by at least one student during interviews: The fact that the students use their mobile phone (the students find it "interesting" and more "realistic"), the fact that they talk to an answering machine that limits the duration of the call (need to be prepared), the fact that the character is a human being and not a machine (actually, students do not know if it is their teacher, another teacher or a physician).

Secondly, our instrument can also be used to show how students' appropriation evolves over time. For that purpose, we shall use the levels of devolution of Brousseau (1997) and confront them with data. Students' appropriation of the game problem evolves, and may reach different levels. Before arriving on a level where they are able to elaborate strategies under various conditions, students need to enter elementary levels like "having fun", "act", "test", and "anticipate" before attaining "mastery". LoE provides a persistent simulation environment allowing students time to progress in their levels of appropriation.

Thirdly, our instrument can be used to show students' profile by comparing moments when they are in the mission (high score of appropriation) and when they are successful in the problem solving (productions' validation by assessors). We will use this approach to see whether students who are in the mission are also those who are successful, or not.

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Development and Evaluation of a Game to Teach Requirements Collection and Analysis in Software Engineering at Tertiary Education Level

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Abstract: A highly important part of software engineering education is requirements collection and analysis which is one of the initial stages of the Database Application Lifecycle and arguably the most important stage of the Software Development Lifecycle. No other conceptual work is as difficult to rectify at a later stage or as damaging to the overall system if performed incorrectly. As software engineering is a field with a reputation for producing graduates that are inappropriately prepared for applying their skills in real life software engineering scenarios, it suggests that traditional educational techniques such as role-play, live-through case studies and paper-based case studies are insufficient preparation and that other techniques are required. To attempt to combat this problem we have developed a games-based learning application to teach requirements collection and analysis at tertiary education level as games-based learning is seen as a highly motivating, engaging form of media and is a rapidly expanding field. This paper will describe the evaluation of the requirements collection and analysis game particularly from a pedagogical perspective. The game will be compared to traditional methods of software engineering education using a pre-test/post-test, control group/experimental group design to assess if the game can act as a suitable supplement to traditional techniques and asses if it can potentially overcome any shortcomings.

Keywords: Games-based learning, software engineering, requirements collection and analysis, evaluation, pedagogy

1. Introduction

Requirements collection and analysis is a highly important initial stage of the Database Application Lifecycle and the Software Development Lifecycle. Some problems associated with traditional approaches to teaching requirements collection and analysis could potentially be overcome with a games-based learning solution as games-based learning is perceived as a highly engaging form of supplementary learning by some educationalists. One of the main problems associated with the field of games-based learning is the distinct lack of empirical evidence supporting the approach. This paper will make a contribution to the empirical evidence in the field by conducting 3 evaluation experiments comparing a games-based learning approach to a role-playing and paper-based approach for teaching requirements collection and analysis. The first pilot study was performed in May 2008 at the University of the West of Scotland. The second pilot study was performed as part of a Serious Games module at the University of the West of Scotland in April 2009 and the third was conducted at Glasgow Caledonian University in April 2009. This paper will discuss some of the problems associated with teaching requirements collection and analysis as well as some of the advantages and disadvantages of traditional teaching approaches and if GBL can act as a suitable supplement to these traditional approaches and potentially overcome some of the shortcomings. The requirements collection and analysis game will then be described in terms of its game play. The results of the three individual experiments will then be presented and finally there will be a discussion and conclusion section.

2. Problems teaching requirements collection and analysis and software engineering

The problems associated with teaching software engineering has been reviewed and discussed in detail in a previous study (Connolly, Stansfield and Hainey, 2007). Problems specifically associated with teaching requirements collection and analysis are deeply rooted in the lack of definitional conformity to what a requirement is.

2.1 Software requirements

> *"The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical*

requirements… No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later." Brooks (1987)

The IEEE 1012 Standard for Software Verification and Validation (1998) defines a requirement as "a condition or capability needed by a user to solve a problem or achieve an objective" or "a condition or capability that must be possessed by a system to satisfy a contract standard, specification or other formally imposed document". A requirement is a statement of the required functionality of the system. One of the primary reasons that requirement capture and analysis is so problematic and complex is that a requirement can be expressed in different levels of abstraction or complexity. Sommerville (2006) emphasizes "the term requirement is not used in the software industry in a consistent way. In some cases, a requirement is simply a high-level, abstract statement of a service that the system should provide or a constraint on the system. At the other extreme, it is a detailed, formal definition of a system function." To combat the complication encountered by the different levels of abstraction; Sommerville distinguishes between user requirements and system requirements:

- User requirements (requirements of a high level of abstraction) are "statements, in a natural language plus diagrams, of what services the system is expected to provide and the constraints under which it must operate."
- System requirements (requirements of a highly detailed nature describing what the system should do) "set out the system's functions, services and operational constraints in detail. The system requirements document (sometimes called a functional specification) should be precise. It should define exactly what is to be implemented. It may be part of the contract between the system buyer and the software developers."

2.2 Advantages and disadvantages of traditional teaching techniques

Some of the advantages and disadvantages of traditional techniques displayed in Table 1 are adapted from the following sources: Bonwell (1996), Cashin (1985), Wehrli and Nyquist (2003) and Davis (2001), the ADPRIMA Instructional Methods information website (2009) and Connolly *et al* (2004).

Games-Based Learning can potentially help with some of the shortcomings as games enable meaning to be situated, resulting in situated learning (Lave and Wegner, 1991) anchored learning (Bransford, *et al,* 1990) and "conceptual interaction" (Laurillard, 1996). Situated learning is important as GBL is most powerful when it is "*personally meaningful, experimental, social, and epistemological all at the same time*" (Shaffer, Squire, Halverson, and Gee, 2004). Games provide experiential learning where knowledge is created through the transformation of experience (Kolb,1984) providing the four stages of the experiential learning cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Healy and Connolly (2007) compare the difference between traditional methods and Games-Based Learning (GBL). Some of the main differences highlighted are where traditional methods are passive, GBL is interactive and active. Traditional methods are viewed as outdated where GBL is considered up to date. Traditional methods are based on the teacher passing on the information and GBL is based on the student actively seeking information and knowledge. A key difference highlighted is where traditional methods are proven; GBL has a distinct lack of empirical evidence meaning poor validity.

Table 1: Advantages and disadvantages of traditional methods of instruction

Teaching Technique	Advantages	Disadvantages
Lectures	Instructors have full control of the learning experience. Intrinsic interest of a subject can be communicated through the lecturer's enthusiasm. Large amounts of information can be tailored and presented to large audiences containing material not otherwise available to students. Lectures can provide a model of how professionals address problems and questions. Appeal to students who learn by listening and present very little risk for students.	A lecturer is required to be an effective speaker and become a 'sage on stage'. No mechanism exists to ensure that students are intellectually engaged, meaning that they are often passive recipients resulting in information being quickly forgotten. The attention of the student begins to wane after a short period (approximately 15 to 25 minutes). Lectures are not suited for teaching abstract, complex subjects, or higher orders of thinking such as values, motor skills, analysis and application

		etc. Assumes that all of the students are at the same level of understanding and learn at the same pace. Students that have different optimal learning styles other than listening are at a disadvantage.
Teaching Technique	Advantages	Disadvantages
Role-Play	Participants are actively involved in the exercise. Enhances the learning experience by adding elements of variety, reality and specificity. Provides a safe environment to increase practice experience when real life experiences are unavailable. Immediate feedback is provided and can provide new perspectives on situations. The likelihood of transfer from the classroom to the real world is improved.	Role-playing puts pressure on the learner to perform and can result in embarrassment if the participants are too self conscious. Can be time consuming as good practice usual requires a debriefing session. The role play has to be well planned; monitored and orchestrated otherwise it may lack focus. Puts mental pressure on the acting participants if questions are asked which deviate from the script. Requires appropriate monitoring by a knowledgeable person to provide proper feedback.
Paper-based Case-Studies	Students can apply new skills. Develops analytical problem solving skills. Can be relatively self-paced if it is in the form of a coursework as participants can do it in their own time. Useful method for allowing a large amount of exploration of solutions for issues of complexity.	The case study must be carefully prepared and defined. It may be difficult for the students to see the relevance of the case study to their own situation. Inappropriate results may occur if the case-study has insufficient information. The case study approach is not suitable to elementary education.

3. Simulating requirements collection and analysis using a games-based learning approach

3.1 Game play

The basic idea of the game is for the team (comprising one or more players) to manage and deliver a number of software development projects. Each player has a specific role, such as project manager, systems analyst, systems designer or team leader. A bank of scenarios have been created based on case studies the authors have been using for many years in teaching and learning; for example, the DreamHome Estate Agency, the StayHome Online DVD Rentals company and the Perfect Pets Veterinary Clinic, the Blackwood Library and the Fair Winds Marina. Each scenario has an underlying business model; for example, there will be a budget for the delivery of the project, a set timescale for the delivery of the project and a set of resources (for example, staff with specified technical specializations) that can be used on the project. Additional resources can be brought in for a project although this will have a cost and timescale (delay) associated with it. The project manager has overall responsibility for the delivery of each project on budget and on time and is given a short brief for each project. Communication is one of the key aspects of the game and the project manager must communicate relevant details of the project to the other players. This will be done using a message metaphor – any player can communicate with any other player(s) by sending a message. Players have a message board that indicates whether there are any unread messages.

The player(s) assigned to the system analyst role has to identify the requirements for the project. To do this, the player must move through the game and 'talk' to the non-player characters (NPCs) in the game, as illustrated in Figure 2(a). In addition, there are objects in the game that can also convey relevant information when found (for example, a filing cabinet may convey requirements). For the prototype game we are using written transcripts in place of NPC speech. We hope shortly to use lip-synching within the game to have the NPCs 'talk' to the system analyst. Each NPC's 'speech' will contain some general background details and a number of requirements (the analyst has to distinguish the requirements from the general details). Visiting the same NPC may generate the same speech or a new speech. Each speech will generate a transcript that the analyst can visit at any point in the game (see Figure 2(b)). The transcript is presented as a numbered list of requirements. During the play, the analyst can use the transcripts to produce an initial 'wishlist' of requirements, which can be refined until such time as the analyst believes all requirements have been identified, at which point the analyst can send the completed requirements to the project manager. The project manager now has two choices: send the requirements to the designer to produce an outline high-level design or consider the requirements to be incorrect and ask the analyst to rework the requirements (asking for rework will have a 'cost' associated with it).

(a) (b)

Figure 2: (a) Screen during requirements collection; (b) Screen allowing player to view transcripts

4. Evaluation of the requirements collection and analysis game

All evaluations were conducted using an evaluation framework described in previous publications (Connolly, Stansfield and Hainey, 2009 Connolly, Stansfield and Hainey 2008). For the purposes of this paper the reported results will particularly focus on pedagogy, technical aspects of the game and intrinsic motivation.

4.1 Methodology

The general experimental designs of studies evaluating games-based learning are experimental as opposed to quasi-experimental and are typically based on the pre-test/post-test approach (Maguire et al, 2006). The experimental designs producing the most impressive results associated with pedagogy used the standard pre-test → post-test, experimental - control group design. Whereby a particular group is exposed to the intervention and a particular group is not.

4.2 Evaluation procedures

In the game group each participant was presented with a pre-test designed to: collect some demographic and learner type information, assess the level of knowledge the participant already possessed about requirements collection and analysis and collect additional qualitative information, such as the most important technical aspects that they believe a game should possess. The participant was then presented with a summary information screen that could be referred to at any point during game play. The summary information screen detailed how to operate within the game environment. The participant was allowed to play the game for as long as it took to produce a requirements specification that they believed to be satisfactory, which generally took between 15 and 40 minutes. Upon completion of the game the participant completed a post-test designed to test knowledge of requirements collection and analysis to analyse whether there was a knowledge gain. The questions were not identical to the pre-test but very similar. It also collected information about positive and negative aspects of the game, technical aspect ratings, perceptions and preferences of the learners.

In the role-play group each participant was presented with a pre-test similar to those in the game group collecting demographic information and learner type information and assessing the level of knowledge of requirements collection and analysis. The knowledge test was identical to the game group. The participants were then provided with a summary for the role-playing exercise similar to the summary screen for the game but with all of the game elements removes in paper-based format. As in the game exercise, participants were provided with questions to start the role play. Members of staff and students acted out the parts of the characters in the game using the exact same case study and script that was incorporated into the game. Participants were told to note down any requirements and any additional questions that they asked not included in the script. The role-play exercises typically took approximately 45 minutes to 1 and a half hours and proceeded until all characters were interviewed to the satisfaction of the participants. Participants then completed the post-test to assess whether there was knowledge gain. Again the questions were not identical to the pre-test but similar. It also collected information about positive and negative aspects of the activity, aspect ratings, perceptions and preferences of the learners.

In the paper-based group each participant was presented with the pre-test collecting demographic information, learner type information and assessing the level of knowledge similar to the other two groups. The participants were then presented with the same summary information excluding game and role-play elements. The script for the role-play and the game was provided to the participants and they were asked to underline any requirements that they found. They were also asked to note down any additional questions that they believed to be necessary. Participants were then presented with the post-test similar to those used in the other two groups but tailored for a paper-based study. The knowledge test questions were the same as in the other two groups.

4.3 Pilot study one

4.3.1 Participants

Pilot study 1 involved 39 participants in total with a mean age of 28 (SD, 6.913) range of 19 to 44 from the University of the West of Scotland. 16 participants were assigned to the game group, 13 participants were assigned to a role playing group and 10 participants were assigned to a paper-based group. The participants in the game group were a mixture of 10 (62.5%) undergraduate and 6 (37.5%) postgraduate Computer Networking, Information Technology and Multimedia Technology students. 14 participants were male and 2 were female. The mean age of participants was 25.13 years (SD, 5.572) with a range from 19 to 36. The participants in the role-playing group were a mixture of 8 (61.5%) post-graduate students and 5 (38.5%) undergraduate students studying Computer Games Technology, Networking, Information Technology and Multimedia and Web Authoring. The mean age of the participants was 29.31 (SD, 7.962) with a range of 19 to 44. All participants in the game and role-play groups were undertaking a module called *Introduction to Database Systems*. The paper-based group consisted of 10 PhD research students outside the field of computing who had never been taught requirements collection and analysis before. 8 (80%) were female and 2(20%) were male. The mean age was 30.90 (SD, 6.244) with a range of 24 to 44.

4.3.2 Results

The mean score on the pre-test for the game group was 3.94 (SD = 1.34) and on the post-test was 5.00 (SD = 1.26). A paired samples t-test revealed that the increase in scores between the pre and post test was significant ($t(15) = -3.437$, $p = 0.004$). For the role-playing group the pre-test mean on the knowledge score was 3.69 (SD = 1.032) and on the post-test 4.62 (SD = 1.193). A paired samples t-test show that the increase in knowledge was significant ($t(12) = -2.984$, $p = 0.011$). The mean score for the pre-test in the paper-based case study group was 3.60 (SD = 1.71), and 4.50 (SD = 1.08) on the post-test. The paired sample t-test showed that the result of the knowledge increase in this group was not significant $t(9) = -1.445$, $p = 0182$. A mixed-design ANOVA (Analysis of variance) revealed no significant differences in knowledge levels between the three groups ($F(2) = 0.053$, $p = 0949$) indicating that the game is an effective form of supplementary learning experience.

Participants' ratings of the technical aspects of the game-based learning environment (from very good scored as 1 to very bad scored as 5) were generally positive. The highest rated features were control (1.38), Graphics (1.69), environmental navigation (1.75) and environmental realism (1.81) and the lowest rated were collaboration (2.94), help and scaffolding facilities (2.75) and narrative and dialogue (2.38). Very few ratings of bad (4) or more were used; lower ratings tended to be due to participants rating features as neutral. This suggested that participants were generally happy with the game interface.

Participants' ratings of the aspects of the paper-based case study (from very good scored as 1 to very bad scored as 5) were generally positive. The highest rated features were realism (1.7), narrative and dialog (1.8), realism of the characters in the dialog (1.9). The lowest rated features collaboration

(2.1), help and scaffolding facilities (2.1) and ability to improvise (2.2). Very few ratings of 4 were used indicating that the participants were generally happy with the case study. The realism of narrative, dialog and characters being rated highly is an encouraging occurrence as the paper-based script is a direct representation of the dialog in the game indicating that the case study is acceptable regardless of what format it is delivered in.

Participants' ratings of the aspects of the role-play activity (from very good scored as 1 to very bad scored as 5) were not particularly favourable. The highest rating aspects were collaboration (2.23), narrative and dialog (2.46) and help and scaffolding facilities (2.69). One possible explanation for this is that the role-play was conducted in a traditional class room with members of staff and researchers playing out the parts, meaning that the participants possibly felt more at ease and as if they had access to help for the duration of the role-play.

4.3.3 Students' perceptions of the game

The students were generally supportive of the use of the game in learning. 15 of the 16 participants agreed or strongly agreed that the game could be used in the intended domain in the future and 14/16 felt that the game fitted well into its intended context. 12 agreed that the game was engaging, 9 agreed that the game sustained their engagement, 9 would like to play the game again and 12 believed that the game could increase their skills at tertiary education level.

Positive features of the game:

Several students picked up on the graphics as a positive feature of the game, while several liked the interaction and the conversational nature of the requirements collection:

> *"The interaction."*
>
> *"Conversation, collection of data."*
>
> *"It shows the user how and from where he/she could collect the required data."*
>
> *"Different people to ask i.e. advisor, manager."*

One participant identified the real world setting of the game as useful in making links between being a student and working:

> *"It is good that it feels like you work in a company and have to solve a "real" job."*

One student commented on the game as useful in learning:

> *"Makes you think so helps you learn."*

Negative features of the game:

Participants also offered useful feedback about how to improve the game:

> *"No "end game" to reach a result/resolution."*
>
> *"Speed of character, how all the questions piled up/difficulty of organisation. Information overload at the beginning/no back story"*
>
> *"It was too repetitive."*
>
> *"No real control of the characters."*
>
> *"I couldn't find the right persons for solving the conflicts I found."*
>
> *"I think it must have more controls and more questions to ask."*

4.4 Pilot study two

4.4.1 Participants

8 participants from an honours year module called 'Serious Games' at the University of the West of Scotland were randomly divided into two groups. 4 were assigned to a game group and 4 assigned to a role-playing group. All participants were male. The mean age was 21.50 (SD = 0.756) with a range of 21 to 23.

4.4.2 Results

Participants' scores on the knowledge requirements tests before and after both interventions were compared. The mean score on the pre-test for the game group was 6.25 (SD = 1.5) and on the post-test 11.25 (SD = 1.708). A paired sample t-test showed that the increase in knowledge was significant ($t(3) = -3.576$, $p = 0.030$) in the game group. The mean score in the pre-test for the role-play was 6.25 (SD = 1.5) and on the post-test 8.50 (SD = 1.00). A paired sample t-test showed that the increase in knowledge was significant ($t(3) = -3.576$, $p = 0.037$). A mixed design ANOVA between the knowledge scores of the pre-tests and post-tests of the two groups was not significant $F(1) = 1.580$; $p = 0.255$ indicating that the game group and role-play group were similarly effective.

4.5 Pilot study three

4.5.1 Participants

8 participants from a Computer Games Software Development Course at Glasgow Caledonian University were randomly divided into two groups. 4 were assigned to the game group and 4 were assigned to a role-playing group. All participants were male. The mean age was 19.125 (SD, 1.885) with a range of 17 to 22.

4.5.2 Results

Participants' scores on the knowledge requirements tests before and after both interventions were compared. The mean score on the pre-test for the game group was 4.50 (SD=3.109) and on the post-test was 9.75 (SD = 1.258). A paired samples t-test indicated that the increase in knowledge in the game group was significant ($t(3) = -2.458$, $p = 0.04$). The mean score in the pre-test for the role-play group was 6.75 (SD = 0.957) and on the post-test was 9.75 (SD=0.957). A mixed design ANOVA between the knowledge scores of the pre-tests and post-tests of the two groups was not significant ($F(1)=3.423$; $p=0.114$) indicating that the game group and role-play group were equally effective.

4.6 Pilot study 2 and 3 combined results

Since pilot study 2 and 3 were relatively small studies we will combine the results for the aspects of the game and the role play for the two studies.

The technical rating aspects of the game for pilot study 2 and 3 were generally good. The highest rated technical aspects were: realism of characters (1.75), control mechanism and interface (1.88), narrative and dialog (2.13), character cutomisation (2.125) and realism of environment (2.25). The lowest ranking technical aspects were clear goal structure (2.5) and help and scaffolding (2.5). The role playing aspects for pilot study 2 and 3 were consistent with those of study 1. Higher ratings were observed for collaboration, help and scaffolding and ability to improvise. All other ratings were significantly more negative.

Positive features of the game were:

> *"Graphics, script."*
>
> *"Good graphics, well thought out."*
>
> *"Good graphics, navigation, very well planned dialog. Interactivity."*

Negative features of the game were:

> *"Too much text. Not as fun as a commercial game."*
>
> *"A little slow."*

The majority of the students who took part in the two pilot studies agreed that they would be willing to play the game as part of a computing course and that the game was engaging. All participants either agreed or strongly agreed that the game would fit well into it's intended context for teaching requirements collection and analysis.

5. Discussion

An observation made about the advantages of each technique by the researchers involved was rooted in the identification of requirements in all of the groups. The game group would always manage to identify significantly more requirements in general and more requirements that either conflicted or required some form of clarification. In the role-playing group it was observed that while collaboration, help and scaffolding and improvisation was considered better, due to the fact that the requirements were not specifically highlighted in the exercise, then significantly less were discovered. The paper-based exercise gave the participants the ability to study the script at great length, however, it became apparent that the participants were becoming over analytical and highlighting all of the text the majority of the time without specifically identifying the requirements that were more easily identifiable in the game. One of the major advantages highlighted in the role-playing activity was the ability to improvise, however the fact that a game is a "closed, formal system" (Crawford, 1982) meant that the participants in the game group were not permitted to deviate from the programmed script. While reducing improvisation, this also is a mechanism to stop the participant deviating into irrelevancies. When additional questions were asked outside the script, it put mental pressure on the academic or researcher to come up with a sensible answer that adhered to the case study as a whole. This may indicate that GBL is more of an adaptive platform for teaching subjects that are highly textual and abstract in nature.

In terms of the games effectiveness at providing a supplementary learning experience, the ANOVAs presented no significant difference indicating that the game was just as effective as traditional techniques for getting participants to learn the material. The major strength of the game was its ability to get participants to identify a significantly higher number of relevant requirements and confliction and clarification requirements.

The comparison of the game with the paper-based case study and role-play groups has verified that the case study is sufficiently complex and well structured for future experiments.

6. Future directions

We have established that the GBL approach to teaching requirements collection and analysis is just as effective as traditional techniques in terms of learning and in some cases more suitable. Further analysis of the results collected in this study will attempt to determine if the game is more intrinsically motivating and more engaging than the traditional techniques. The purpose of the pilot studies was to ensure that valid analyzable results would be collected by running the evaluation. The pilot study revealed a number of improvements that could be made to the evaluation instruments entailing removal of some redundant questions, addition of questions and slight alteration to other questions to eliminate ambiguity. Future iterations of the evaluation will be conducted with an external group to test if the findings of the pilot study evaluations are consistent.

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A Survey of Students' Motivations for Playing Computer Games: a Comparative Analysis of Three Studies in Higher Education

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Abstract: Computer games are exceptionally popular and play an increasingly important role in the lives of children and adults. This popularity has captured the attention of educationalists interested to ascertain if the highly engaging features of computer games can be used to help people learn effectively. To properly develop computer games for learning it is important to have an appreciation of what motivates people to play computer games. This paper will present the results of a survey of students' motivations for playing computer games at Higher Education (HE) level and their views of what features of computer games may be useful for learning. The survey was performed at the University of the West of Scotland in March 2009. As well as presenting the results of the 2009 survey, the paper will draw comparisons on two identical previous studies performed in 2005 and 2007. The study will assess whether the game playing habits, motivations for playing computer games, motivations for playing computer games in a HE setting, attitudes and perceptions of students are consistent over a four year period.

Keywords: Games-based learning; computer games; motivation; game genres, attitudes

1. Introduction

Computer games are regarded by some educationalists as highly engaging and it is hoped that by understanding these engaging features, computer games can be used to help people learn effectively. There is a wealth of literature suggesting that computer games have been effective in teaching a variety of different subjects including: cancer related knowledge (Beale, Kato, Marin-Bowling, Guthrie, and Cole, 2007), science and mathematics (Adamo-Villani and Wright, 2007), language education (Rankin, Gold and Gooch, 2006), musical education (Avery, 2008), and software engineering (Jain and Boehm, 2006). Despite this wealth of literature on computer games for education there is a dearth of empirical evidence supporting the approach (de Freitas, 2007; Connolly, Stansfield and Hainey, 2007)

This paper will contribute to empirical evidence in the games-based learning literature by analysing the results of a current survey (study 3) performed in March 2009 and comparing the results with two previous studies: one in March 2005 (study 1) and one in March 2007 (study 2). The purpose of this is to investigate if the results from the three studies are consistent in terms of game playing habits, the types of games played, reasons, motivations, attitudes and demographics. Following this we discuss the methods and procedure used to collect the survey data and provide and analysis and discussion of the most recent survey results. While performing the analysis comparisons will be made between the current study 3 and study 1 and 2, focusing on: game playing habits, reasons for playing computer games, reasons for playing computer games when difficulty increases, the kind of games played, use of computer games for learning in HE, reasons for playing computer games in HE, skills obtainable in HE and attitudes to computer games. Following this there will be a discussion of the overall results addressing consistency over a four year period.

2. Previous work

Computer games are just one of the contributing technologies to have a transformational effect on how we spend our leisure time over the past 40 years. The Entertainment Software Association (2009) reported that "U.S. computer and video game software sales grew six percent in 2007 to $9.5 billion – more than tripling industry software sales since 1996." Other contributing factors are the proliferation of the internet, advancement of computer technology and the advancement of MMORPGs. The development of the early computer games in the late 1960s was swiftly followed by the development of educational computer games. In recent years games-based learning/serious games has been used in different, innovative ways to support learning and teaching (Whitton, 2007).

To gain an appreciation of what makes computer games engaging it is necessary to understand the reasons behind why people play computer games. In recent years motivation theorists have made progress in trying to explain why people behave the way they do and since Malsow's hierarchy of needs (1970) have explained bahaviour in terms of desires and needs. Self-determination theory (Ryan and Deci, 2000) suggests that every individual has three innate psychological requirements that have to be met to sustain prolonged participation in an activity which are autonomy, competence and fulfillment. The most basic distinction made is between intrinsic and extrinsic motivation, where intrinsic motivation is participating in an activity because it is interesting or enjoyable and extrinsic is participating in an activity to gain some separable outcome. Self-efficacy theory (Bandura, 1986) refers to personal judgement of how well a person can perform a course of action to complete a given task. How long people will persevere in the face of failure will depend on individual self-efficacy level. Individuals with a low self-efficacy level will not focus their attention or apply nearly as much effort as individuals with a high self-efficacy level. Higher levels of self-efficacy will lead to intrinsic motivation. Attribution goal theory (Nicholls, 1984) hypothesises that an individual's behaviour is dependent on the goal orientation and individual perception of the motivational climate. There are two different goal orientations that influence an individual's emotions, thoughts and actions, namely: task oriented – assessing competence on either previous personal standards or self reflective criteria and ego oriented – assessing competence through normative comparison with others and other referenced criteria. With regards to the individual perception of the motivational climate there are two different types of climate namely: a mastery-oriented climate that encourages life-time skills, promotes a willingness to learn from practise and promotes a desire to persist in the activity and a performance-oriented climate that facilitates feelings of satisfaction through the demonstration of superiority relative to opponents. Csikszentmihalyi (1990) refers to flow theory as the optimal state that occurs when there is a balance between perceived challenges of a situation and a person's skills or capabilities for action. The flow state is "the state in which the people are so involved in an activity that nothing else seems to matter". People who experience the flow state can experience a transformation of time, being in control of their lives at a given point in time, being highly focused and optimally challenged. Malone and Lepper (1987) provided a more detailed account of important aspects of intrinsic motivation in the design of educational computer games. They suggest that intrinsic motivation is created by four individual factors: challenge, fantasy, curiosity and control and three interpersonal factors: cooperation, competition, and recognition. Interestingly these factors also describe what makes a good game, irrespective of its educational qualities.

There has been a number of previous questionnaire/survey studies performed to find out peoples, reasons and motivations for playing computer games. Gibson, Halverson and Riedel (2007) performed a survey of 228 "pre-service" students to ascertain perceptions and attitudes in relation to simulations and games. 80% of respondents were white females. 46% believed that simulations and games could be a very important learning tool and 19% believed that they could be an important learning tool. Only 7% believed that they were of little or no importance. Males were more negative about the potential of games in learning. 53% or males were positive where 70% of females were positive. There was no notable generation gap between the respondents. Whitton (2007) performed a study with 200 participants to examine gaming preferences, attitudes towards games in HE and motivations. 63.1% reported that they would find games positively motivating for learning, 28.3% not motivating either way and 8.6% demotivating. Eglesz, Fekete, Kiss, and Izsó (2005) performed a study with two surveys, one online survey with 843 participants and a second with 102 participants. The studies found that woman play computer games significantly less than men and prefer RPG games while men prefer action, adventure simulation and sports games. Yee (2006) performed a study of 30,000 participants over a 3 year period particularly focusing on motivations and experiences of users of MMORPGs and found significant differences between males and females in relation to relationship, manipulation, immersion, escapism and achievement factors. The results of this study were later used to formulate an empirical model of player motivations in online games (Yee, 2007).

Two identical previous studies have been performed on motivations for playing computer games in HE at the University of the West of Scotland in 2005 (Connolly, Boyle, Stansfield and Hainey, 2007; Connolly, Boyle and Hainey, submitted; Connolly, Boyle, Stansfield and Hainey, 2006; Connolly, Boyle and Hainey, 2006) and 2007 (Connolly, Boyle and Hainey, 2007). The results of these two studies proved to be broadly consistent. This study addresses whether the current study will be consistent two years later in the same context and thusly whether motivations, game playing habits, preferred game types and attitudes have remained broadly consistent over the 4 year period.

3. Methods used to collect data in study 3

3.1 Participants

All undergraduate and post-graduate students at the University of the West of Scotland were emailed to tell them about the computer games questionnaire. Out of approximately 18,000 students surveyed, there were 704 respondents; 1 was deleted, as the questionnaire had not been completed properly. Of the remaining 703, 376 (53.5%) were female and 327 (46.5%) were male. This compares with a gender breakdown in the University as a whole of 37% males and 63% females.

The mean age was 25.91 (SD = 8.82) with a range from 17 to 77, which is consistent with an overall average student age of 25. 700 respondents specified whether they were full time or part time, 606 were full-time students and 94 were part-time students.

3.2 Materials

Questionnaire: As well as demographic questions, computer games specific questions included: whether or not participants played computer games; how many hours per week and how many years they had been playing for.

Reasons for playing games: Malone and Lepper's (1987) framework was used to examine the reasons for playing computer games (challenge, fantasy, curiosity, control, cooperation, competition, and recognition). Leisure, pleasure and relaxation were also included as reasons. Participants were required to consider each possible reason for playing computer games and rate how important it was for them using the categories: very unimportant; unimportant; neutral; important; very important; don't know.

Reasons for using computer games for learning in University: In addition students' ratings of the importance of these reasons for using computer games for learning in University were examined. Participants were required to respond to the question: "If you had the opportunity to use computer games for learning in your programme at University, how would you rate each of the following reasons in terms of importance in learning?" Rating categories were similar to before.

Games played: Students were also asked which games they played from the following categories - strategy, fighting, racing, shooting, platform, role playing (RPG), simulation, adventure and sport. Students were asked to indicate with a 0 games that they do not play. For games that they do play they were asked to rank the games they played most frequently where 1 indicated most frequent and 9 least.

3.3 Procedure

The questionnaire was made available through the online questionnaire package, SurveyMonkey, for a two-week period during March 2009. Participation was voluntary and participants were notified of the availability of the questionnaire through email and a login notice posted in the BlackBoard Virtual Learning Environment (which the majority of students use). Notices were also posted across the University. Respondents completed the questionnaire online at their convenience during this period. Access to the questionnaire was controlled using the students' BlackBoard username and password, and the students' unique banner identification number was used to ensure a student only completed the questionnaire once.

4. Results

4.1 Game playing habits

78.4% of students in study 3 played computer games, which was lower than study 1 where 85.6% played and higher than study 2 where 69.2% played. 77.7% is the mean of all three studies.

90.8% of male students in study 3 played computers games, which is consistent with the findings of study 1 and 2 where 91.8% and 89% of male students played respectively. 66.4% of female students in study 3 played computer games, this is broadly consistent with the findings of study 1 and 2 where 80.7% of females played and 55.8% of females played. This was mainly attributable to the relatively low number of female students in study 2 who played.

To calculate the mean time spent playing games the time bands used as responses were recoded with their mean value (e.g. 1-5 hours was recoded as 3, while less than 1 was coded as 1 and more than 25 was coded as 21). Using this recoded data the average number of hours played per week in study 3 was 7.57 hours (SD = 6.17) which is consistent with study 1 and 2 where the average number of hours was 7.54 hours (SD = 5.70) and 7.72 hours (SD = 7.14) respectively.

Males in study 3 played games for significantly longer per week (9.35 hours, SD = 6.57) than females (5.25 hours; SD = 4.68), ($t(411) = 7.085$, $p < 0.001$) and a significantly higher percentage of men (37.2%) than women (10.6%) played for more than 6-10 hours per week. This was consistent with study 1 and 2. Males in study 1 played for significantly longer (9.34 hours; SD = 6.13) than females (5.93 hours; SD = 4.73); ($t(827) = 9.03$, $p<0.001$) and a significantly higher percentage of men (35%) than women (9%) played for more than 6-10 hours per week. Males in study 2 played games for significantly longer per week (10.11 hours; SD = 7.78) than females (4.78 hours; SD = 4.88), ($t(306) = 7.01$, $p<0.001$) and a significantly higher percentage of men (40.6%) than women (11%) played for more than 6-10 hours per week.

49.8% of the students participated in online gaming in study 3, compared with 37% in study 1 and 40.3% in study 2. 56.7% of online gamers were male and 43.3% were female which is consistent with the game player data of the ESA (2009).

There was a significant relationship between gender and participation in online gaming in study 3 ($\chi^2(1) = 60.087$, $p < 0.001$) with men (66.4%) more likely to take part than women (27.9%). This is consistent with study 2 where there was a significant relationship between gender and participation in online gaming ($\chi^2(1) = 11.487$, $p<0.001$) with men (49.1%) more likely than women (30%) to take part.

Students taking part in online gaming played for significantly more hours per week (10.21) than those who did not (4.95), ($t(363.450) = 9.550$, $p<0.001$) which is consistent with study 2 where students taking part in online gaming played for significantly more hours per week (11.5 hours) than those who did not (5.05 hours), ($t(297) = -8.581$, $p<0.001$). This was not a significant finding in study 1 reinforcing the influence of the increasing popularity of online games.

The majority of students (58.2%) in study 3 preferred single player to multiplayer games which is consistent with study 1 and 2 which were 78% and 59.7% respectively. There was a significant relationship between gender and preference for single or multiplayer games ($\chi^2(1) = 8.027$, $p < 0.005$). A higher percentage of males (47.8%) than females (33.9%) preferred multiplayer games which is consistent with study 2. 71.8% of those who do not play online prefer single user games in study 3 which again is consistent with study 2 where 73.9% of those who do not play online prefer single player games.

On average in study 3 participants had been playing computer games for 12.73 years (SD = 5.36) with a range of 0 to 30 years. This result is consistent with the findings from study 1 (11.55 years, SD = 4.08, range 2 to 29 years) and study 2 (12.98 years, SD = 5.59, range 0 to 30 years). The average participant from all three studies taking into account the average age (study 1: 26.6, SD = 9.71, range 17 to 58; study 2: 27.15, SD = 9.53, range 17 to 63; study 3: 25.91, SD = 8.82, range 17 to 77) had been playing computer games for just under half of their life. In all three studies male respondents had been playing computer games for significantly longer than females (study 1: males = 12.82 years, females = 10.40 years, ($t(847) = 8.84$, $p<0.001$); study 2: males = 14.4 years, females = 11.1 years, ($t(259) = 4.923$, $p<0.001$); study 3: males = 13.4 years, females = 11.8 years, ($t(399) = 2.95$), $p < 0.003$)).

4.2 Reasons for playing computer games

Table 1 shows the mean ratings for each reason for playing computer games, along with the order of importance of its rating for study 1, 2 and 3. Three of the four highest rated reasons for playing games in all three studies were pleasure, relaxation and leisure, confirming that games are being played primarily for relaxation and enjoyment. Challenge was rated as the third most important reason for playing games in studies 1 and 2, but is ranked 4th in study 3. Fantasy and curiosity were rated less important with recognition rated the least important reason for playing computer games in study 1 and 2 and rated 9th in study 3. The biggest difference between study 1 and 2 was for ratings of competition, which were rated as more important in study 2 (3.30) than in study 1 (2.74). The biggest difference between study 2 and 3 was the rating for cooperation and was rated more important in study 2 (3.17) then study 3 (2.94). Online players rated all reasons as more important reasons for playing games in study 3, suggesting they derive more challenge, competition and enjoyment from playing games. This was also consistent with study 2 with the exception of curiosity and leisure.

Table 1: Reasons for playing computer games

	Study 1			Study 2			Study 3		
Reasons	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD
Relaxation	1st	4.32	0.829	2nd	4.12	0.975	2nd	4.07	0.863
Pleasure	2nd	4.25	0.727	1st	4.21	0.821	1st	4.14	0.785
Challenge	3rd	3.93	0.766	3rd	4.05	0.925	4th	3.85	0.986
Leisure	4th	3.79	0.787	4th	3.95	1.071	3rd	3.86	0.971
Curiosity	5th	3.32	0.845	5th	3.68	1.061	5th	3.42	1.169
Fantasy	6th	3.13	0.928	6th	3.38	1.255	7th	3.11	1.405
Cooperation	7th	3.03	0.950	8th	3.17	1.094	8th	2.94	1.169
Control	8th	2.96	1.067	9th	2.92	1.150	10th	2.20	0.964
Competition	9th	2.74	0.963	7th	3.30	1.188	6th	3.13	1.196
Recognition	10th	2.30	0.806	10th	2.53	1.126	9th	2.39	1.154

4.3 Reasons for playing computer games when they get more difficult

374 respondents in study 3 answered an open-ended question about what stimulates them to keep playing a game when it gets progressively more difficult. 7 of these responses were deleted leaving 367. The responses were grouped into 9 broad categories. It should be noted that students' answers to this question could mention more than one of the categories. The results are presented in Table 2.

Table 2: Reasons for playing computer games when they get more difficult

Category	Numbers/ Percentages
Challenge of completing the game	125 (34%)
Completion of the entire game	86 (23%)
Achievement from completion of the game	64 (17%)
Determination – persevering with the game regardless of difficulty	46 (12.5%)
Competition with others or oneself	40 (10.9%)
Story/narrative experienced while playing	34 (9%)
Advancement in the game or in game skills or character development	32 (8.7%)
Fun experienced while playing the game	10 (2.7%)
Curiosity while playing a game	9 (2.4%)

In comparison with study 1 and 2: challenge and completion still remain the two highest-ranking motivations for prolonged participation. Table 3 shows the rankings of most important motivations for all three studies. There is an increase of the importance of advancement in study 3 in comparison with study 2 and a decrease in the importance of competition.

Table 3: Rankings of most important motivations for prolonged participation

	Study 1 Importance	**Study 2 Importance**	**Study 3 Importance**
Challenge	1st	1st	1st
Completion	2nd	2nd	2nd
Achievement	3rd	4th	3rd
Determination	4th	6th	4th

	Study 1 Importance	Study 2 Importance	Study 3 Importance
Advancement	5th	8th	7th
Fun	6th	9th	8th
Competition	***	3rd	5th
Story/Narrative	***	5th	6th
Curiosity	***	7th	9th

4.4 The kinds of games played

The analyses of the kinds of games played compared game preference of male and female students. The first analysis examined whether or not students played each type of game. All rankings of games from 1 to 9 were recoded as 1 to indicate simply that the student plays that game. Summing the number of games ranked by participants showed that male students play a greater variety of games than female students ($t(710) = 7.264$, $p<0.001$). On average males ranked 5.21 games and females 3.07. The comparable figures for study 1 was 6.34 for males and 4.67 for females and study 2 for males ranked 6.15 games and females 5.00.

Table 4 shows the numbers and percentages of males and females who played each kind of game. For each game there were more males who played that games than did not, while for women there were many more women who did not play the game than who did. Chi-square tests revealed highly significant differences between males and females in game-playing, with a significantly higher proportion of males than females playing each game.

Table 4: Numbers and percentages of students playing different types of game, mean rank and order of preferences of games split by gender

		Males				Females			
		n	percent	Mean rank	Order	N	percent	Mean rank	Order
Strategy	Yes	190	58.1%	4.49	2	148	39.3%	3.61	1
	No	137				228			
Fighting	Yes	183	55.9%	5.38	7	119	31.6%	6.50	9
	No	144				257			
Racing	Yes	189	57.7%	5.14	5	125	33.2%	5.20	6
	No	138				251			
Shootemup	Yes	203	62%	3.58	1	108	28.7%	6.33	8
	No	124				268			
Platform	Yes	175	53.5%	5.67	8	124	32.9%	4.83	5
	No	152				252			
RPG	Yes	185	56.5%	4.86	3	129	34.3%	4.25	3
	No	142				247			
Simulation	Yes	177	54.1%	5.97	9	126	33.5%	4.79	4
	No	150				250			
Adventure	Yes	191	58.4%	5.03	4	141	37.5%	4.12	2
	No	136				235			
Sports	Yes	202	61.7%	5.19	6	136	36.1%	5.45	7
	No	125				240			

Table 4 also shows the mean ranking of games for male and female students where a lower mean represents a stronger preference. To compare gender differences in game preference, the order of preference was compared. For male students shooting, strategy and role-playing games were the games ranked as the type of game played most frequently, while the lowest ranked were simulations, platforms and sports and racing. Shooting, strategy and adventure were the most popular with males in study 1 and 2. In the current study, females rated strategy, role-playing and adventure games as those played most frequently with fighting, shooting and sport played least often. Strategy, platform and adventure were most popular with females in study 1 and 2. In all three studies male students ranked shootemups as the game they play most frequently and females ranked them as one of the games they play least.

4.5 Use of computer games for learning in HE

There were 338 responses to the open-ended question: Do you believe that computer games can be used to learn in a Higher Education environment? Each response was categorized as "Yes", agreeing that computer games could be used, "No", claiming that computer games did not have a role to play in learning or "Possibly" where the respondent was unsure about whether computer games would be useful in learning.

198 (58.5%) of students thought that computer games did have the potential to be used in HE, 66 (19.5%) said no and 74 (22%) said possibly. This result is consistent with study 2 where 173 (69%) of students thought that computer games did have the potential to be used in HE, 40 (16%) said no and 37 (14.8%) said possibly.

Those who did not agree that computer games were useful in learning in HE gave a number of reasons including that they already spent long enough looking at computer screens, that computer games would be distracting and that games would lead to poorer quality learning.

4.6 Reasons for playing computer games in HE

Table 5 shows the students' mean ratings of the different reasons for playing games from study 1, 2, and 3. The top three rated reasons for all three studies were challenge, curiosity and cooperation, which were all rated as important. Fantasy, leisure and recognition were rated least important. Pleasure and relaxation, which were omitted from study 1, were rated as important reasons for playing games in HE in study 2 and 3 suggesting that students see no contradiction in thinking of these features as being associated with learning. Students who play games gave substantially higher ratings of the importance to all characteristics suggesting that game players will be persuaded more easily of the benefits of games in learning. Males rated challenge, competition, curiosity and pleasure as significantly more important as reasons than females in study 2; however no significant differences between males and females were detected on any characteristics in study 3.

Table 5: Students' ratings of the importance of reasons for using games in HE for study 1, 2 and 3

	Study 1		Study 2		Study 3	
Reasons	Mean rating	Importance	Mean Rating	Importance	Mean rating	Importance
Challenge	4.04	1st	3.87	1st	3.86	1st
Curiosity	3.57	2nd	3.69	2nd	3.53	3rd
Cooperation	3.39	3rd	3.59	3rd	3.61	2nd
Leisure	3.11	4th	2.80	9th	2.61	9th
Competition	3.11	5th	3.06	6th	3.22	6th
Control	2.89	6th	3.06	6th	3.04	7th
Recognition	2.74	7th	2.97	8th	3.02	8th
Fantasy	2.64	8th	2.52	10th	2.56	10th
Pleasure			3.32	5th	3.47	4th
Relaxation			3.50	4th	3.38	5th

4.7 Skills in HE

Table 6 shows responses to the question "What types of skills do you think can be obtained from computer games that would be relevant to Higher Education?" The most frequently chosen skills were problem solving, critical thinking, analysis and classifying and creativity. The least popular were reflection and management. The results are consistent in all three studies.

Table 6: Skills that can be obtained from computer games

	Study 1		Study 2		Study 3	
Types of skills	**N**	**Percentage**	**N**	**Percentage**	**N**	**Percentage**
Problem solving	771	93.1%	323	92.1%	392	93.1%
Reflection	294	35.5%	121	34.3%	141	33.4%
Analysis and classifying	417	50.3%	228	65.2%	259	61.5%
Collaboration and teamwork	495	59.7%	215	61.2%	264	62.7%
Leading and motivating	269	32.4%	134	38.5%	165	39.1%
Critical thinking	589	71.1%	247	70.5%	290	68.8%
Management	262	31.6%	119	34.0%	154	36.5%
Creativity	483	58.3%	223	63.7%	289	68.6%
Recollection	242	29.2%	151	43.1%	151	35.8%

4.8 Attitudes to computer games

The questionnaire was altered for study 2 to collect information on basic attitudes towards computer games and remained consistent for study 3. As a result comparisons can only be made for attitudes between study 2 and 3. Table 7 shows the attitudes to computer games split by gender and study. An independent sample t-test indicated no significant changes in overall attitudes between study 2 and 3. In study 2 there were significant differences between male and females regarding attitudes towards games being a social activity, enjoyable, interesting and worthwhile. The results of study 2 suggest that males consider playing games to be more of a social activity than females ($t(352) = 3.571$, $p < 0.001$). The results also indicate that males consider playing games to be more interesting ($t(352) = 3.569$, $p < 0.001$), more enjoyable ($t(351) = 3.289$, $p < 0.001$), and a more worthwhile activity ($t(350) = 2.832$, $p < 0.005$) than females. Study 3 supports the results of study 2, but in addition, the results show a significant difference between male and female attitudes towards whether playing games is exciting. The results suggest that males consider playing games more exciting than females ($t(416) = 4.983$, $p < 0.001$) which was not a significant finding in study 2. People who played computer games had significantly more positive attitudes towards games than people who did not play computer games. The only exception to this was the playing games is time consuming category.

Table 7: Attitudes to computer games split by gender and study

	Males				Females			
	Study 2		Study 3		Study 2		Study 3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Playing games is a sociable activity	3.77	1.10	3.85	1.07	3.34	1.15	3.29	1.06
Playing games is a waste of time	2.07	0.96	2.11	1.07	2.33	1.03	2.34	0.89
Playing games helps to develop useful skills	3.80	0.88	3.59	0.85	3.62	0.86	3.61	0.73
Playing games is time consuming	3.96	0.83	3.98	0.83	3.94	0.37	3.83	0.84
Playing games is interesting	4.16	0.79	4.15	0.70	3.83	0.87	3.81	0.82
Playing games is a worthwhile activity	3.75	0.94	3.75	0.85	3.46	0.92	3.43	0.85
Playing games is an enjoyable activity	4.31	0.74	4.39	0.70	4.02	0.86	4.05	0.76
Playing games is a lonely activity	2.83	1.10	2.44	1.05	2.80	1.14	2.88	0.93
Playing games is a valuable activity	3.39	0.90	3.35	0.91	3.20	0.91	3.20	0.81
Playing games is exciting	4.04	0.94	4.13	0.75	3.78	0.90	3.72	0.89

5. Discussion

Study 3 broadly confirmed and supported those found in study 1 and 2. Computer games consistently play and important role in the lives of University students with students playing an average of 7.61 hours per week when all 3 studies are brought into account. Generally more males play computer games than females. Online male players played for substantially longer than females and those who do not play online. Reasons for playing computer games are also broadly consistent across the three studies with relaxation, pleasure and challenge rated as the top reasons.

The studies have shown a high level of acceptance that games could play a role in learning in HE. Challenge, curiosity and cooperation are regarded as important features of games for learning in HE with students who play games rating all reasons as more important than those who don't in study 3.

Strategy, adventure and role playing games were amongst the most popular for both male and female students and it seems likely that these kinds of game provide an ideal vehicle for supporting the problem solving and interaction skills increasingly demanded in HE and the workplace.
The increasing trend to online gaming was evident in the transition from study 1 to 2 and has gradually increased by 9.5% in study 3 to 49.8%. The value of the global online games market has increased to a projected 9.8 billion US dollars in 2009 from 670 million dollars in 2003 (Hsu and Lu, 2007).

Challenge and completion were cited as the most important reasons for continuing to play games when they become more difficult in both studies. However competition and story/narrative were also important in the 2nd and 3rd surveys. One possible explanation for this is again, the increased popularity of Massively Multiplayer Online Role Playing Games (MMORPGs). In 2006, 25 million people were playing MMORPGs (Riegel and Matejka, 2006). World of Warcraft is the worlds most popular MMORPG and had 11.5 million subscribers (Blizzard Entertainment, 2009), a fact substantiated by survey 2 and 3.

In conclusion the three surveys of computer games in HE were broadly consistent in showing the popularity of playing computer games as a leisure time activity for students, especially male students. There was also a high level of acceptance amongst students that games could be used for learning in HE. However fewer female students played games, those who did play played less and played a less varied selection of games than males. This suggests that there may still be some way to go in persuading female students of the value of computer games in learning.

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Arguing for Multilingual Motivation in Web 2.0: an Evaluation of a Large-Scale European Pilot

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Abstract: While there are some teachers who are dubious about the benefits of gaming in education, language teachers make great use of simulation/gaming methodologies and there are many supporting textbooks. While many of the simulations/games used are non-computer based, during recent years the computer game has become an important development in popular culture. During the same period there has been an appreciation that computer games can play a significant role in education. In this paper, we explore the use of one particular type of computer game called an Alternate Reality Game (ARG), a form of interactive narrative, often involving multiple media and game elements. We have developed an ARG to motivate secondary school students to learn a modern foreign language and have piloted this game across Europe in 2009. This paper presents a framework for evaluating games-based learning and provides both a quantitative and qualitative analysis of student performance in the pilot using this framework. The paper reflects on this analysis and provides directions for future research.

Keywords: ARGs, collaboration, social networks, modern foreign languages, evaluation

1. Introduction

As noted by Crookall (2007), language teachers make great use of simulation/gaming methodologies and there are many supporting textbooks and research papers that present various forms of role-play, games, simulations, and other exercises. (eg. Gaudart, 1999; Garcia-Carbonell, Rising, Montero, and Watts, 2001; Halleck, 2007). While many of the simulations/games used are non-computer based, during recent years the computer game has become an important development in popular culture. During the same period there has been an appreciation that computer games can play a significant role in education. In this paper, we explore the use of one particular type of computer game called an Alternate Reality Game (ARG), a form of interactive narrative, often involving multiple media and game elements, to tell a story that may be affected by participants' ideas or actions (Connolly *et al*, 2008). We have developed an ARG to motivate secondary school students to learn a modern foreign language and have piloted this game across Europe in 2009. However, two of the current issues with games-based learning are the dearth of empirical evidence to support the approach and the lack of frameworks to use for evaluating games-based learning applications. We were very conscious of these problems at the outset of the project and carried out research to ensure that we had an appropriate framework for evaluating the ARG with secondary schools students.

This paper presents the framework we used for evaluating the *Tower of Babel* ARG that was piloted from 22 April to 30 April 2009 involving 328 students and 95 teachers from 28 schools across 17 countries and provides both a quantitative and qualitative analysis of student performance in the pilot using this framework. In the next section, we review the literature on frameworks for the evaluation of games-based learning applications. In the subsequent section, we present the results of the evaluation and complete the paper with a discussion of the findings and directions for future research.

2. Previous research

2.1 Lack of empirical evidence and evaluation frameworks in GBL

One of the primary concerns associated with the GBL literature is the dearth of empirical evidence supporting the validity of the approach (Connolly, Stansfield and Hainey, 2007; de Freitas, 2006). O'Neil, Wainess and Baker (2005) believe that an essential element missing is the ability to properly evaluate games for education and training purposes. If games are not properly evaluated and concrete empirical evidence is not obtained in individual learning scenarios that can produce generalisable results, then the potential of games in learning can always be dismissed as unsubstantiated optimism. In the O'Neil study, a large amount of literature was collected and analysed from the PsycINFO, EducationAbs, and SocialAciAbs information systems. Out of several thousand articles, 19 met the specified criteria for inclusion and had some kind of empirical information that was either qualitative, quantitative or both. The literature was then viewed through Kirkpatrick's four levels for evaluating training and the augmented CRESST model. The majority of the studies reviewed analysed performance on game measurements. Other studies included observation of military tactics used, observation, time to complete the game, transfer test of position location, flight performance and a variety of questionnaires including exit, stress and motivation questionnaires. The review of empirical evidence on the benefit of games and simulations for educational purposes is a recurring theme in the literature and can be traced even further back. For example, Randel, Morris, Wetzel, and Whitehill (1992) examined 68 studies from 1963 comparing simulations/games approaches and conventional instruction in direct relation to student performance. Some of the following main discoveries were made:

- 38 (56%) of the studies found no difference; 22 (32%) of the studies found a difference that favoured simulations/games; 5 (7%) of studies favoured simulations/games however control was questionable; 3 (5%) found differences that favoured conventional instruction.
- With regards to retention simulations/games induced greater retention over time than conventional techniques.
- With regards to interest, out of 14 (21%) studies, 12 (86%) showed a greater interest in games and simulations over conventional approaches.

Dempsey, Rasmassen and Lucassen (1994) performed a literature review ranging (but was not limited to) 1982 to 1994 and discovered 91 sources (most of them journal papers). The main findings of this study were that majority of the articles discovered were discussion articles (n = 43) i.e. "articles which state or describe experiences or opinions with no empirical or systematically presented evidence." Thirty-three research articles were discovered, nine literature review, seven theoretical articles and a very small number of development articles (n = 4). The study acknowledges that it has unsystematically sampled a very small amount of the literature as a whole but expects the literature to follow the trend of being dominated by discussion articles. The current state of the literature certainly follows this trend as discussion articles are simpler to write than research or empirical articles. Although lack of empirical evidence supporting GBL is not a new issue, the growing popularity of computer games in conjunction with recent advances in games and hardware technology, the emergence of virtual worlds and massively multiplayer online games (MMOGs), reinforces the need for the generation of empirical evidence. The following section will review some of the games in education and will critically evaluate the associated empirical evidence.

2.2 Previous evaluation frameworks

When developing an evaluation framework for GBL, it seems logical to design the framework from a pedagogical perspective as the entire ideology of GBL is using games/simulations to motivate and engage learners, resulting in more effective learning even at a supplementary level. There are very few evaluation frameworks in the literature that specifically address the effectiveness of GBL from this perspective and ask questions such as: Does the GBL environment increase knowledge acquisition? Does it improve learner performance? Does it assist in the formation of metacognitive strategies? The majority of available frameworks are focused on either e-Learning or commercial games such as World of Warcraft. Two examples of these frameworks are based on Nielsen's Heuristic Evaluation developed in 1990 (Nielsen and Molich, 1990). Heuristic Evaluation consists of ten recommended heuristics and is supposed to be performed by a small team of evaluators. It is a Human Computer Interaction (HCI) technique that focuses on finding interface usability problems and has been extended with additional heuristics to encompass website specific criteria. The technique has also been expanded and developed to produce a framework for web-based learning (Ssemugabi and de Villiers, 2007) and a framework for heuristic evaluation of Massively Multi-player On-Line Role Playing Games (MMORPGs) (Song and Lee, 2007). One of the main difficulties associated with frameworks developed from Heuristic Evaluation is that the quality of a Heuristic Evaluation is dependent on the knowledge of the expert reviewer. By extending frameworks to encompass web-based learning and MMORPGs, suitable reviewers would have to have sufficient knowledge of HCI and games to perform a high-quality evaluation. In addition, from a GBL perspective the main difficulty is that these frameworks do not specifically focus on pedagogy.

Tan, Ling, and Ting (2007) reviewed four GBL frameworks and models including: the design framework for edutainment environments, the adopted interaction cycle for games, the engaging multimedia design model for children and the game object model. According to their results one framework significantly addressed pedagogy and game design: the game object model developed to allow identification of suitable game elements to be supported by valid pedagogical elements (Amory, Naicker, Vincent, and Adams*,* 1999). The game object model (GOM) has been further developed using theoretical constructs and developments in the literature to become the game object model version II framework (GOM II) (Amory, 2006). This particular framework can be used from both a game design perspective and an evaluation perspective. Kirkpatrick's four level framework (1994) takes pedagogy into account. It was originally developed in 1994 as a framework for evaluating training but it has been also been proposed for the evaluation of business simulations as educational tools (Schumann, Anderson, Scott, and Lawton*,* 2001). The CRESST model of learning is composed of five families of cognitive demands and can be used in a motivational learning view for the evaluation of games and simulations (Baker and Mayer, 1999). Each family in the CRESST model is composed of a task that can be used as a skeletal design for testing and instruction. The CRESST model is divided into content specific and content independent variables. Content specific variables include: content understanding and problem solving. Content independent variables include: collaboration/teamwork, communication and self-regulation. A further framework specifically for games and simulations that addresses pedagogy is the Four Dimensional Framework (FDF) (de Freitas and Oliver, 2006). The FDF is "*designed to aid tutors selecting and using games in their practice. The framework includes: context, learner specification, pedagogy used and representation as four key aspects for selecting the correct game for use in learning practice*" (de Freitas, 2006).

2.3 New framework for GBL evaluation

Connolly, Stansfield and Hainey (2009) reviewed the literature and formulated a new evaluation framework for GBL (Figure 1). The purpose of the framework is to identify the main potential evaluation categories of games-based learning available in the scientific literature. The categories do not necessarily have to be viewed in isolation but as a collective whole depending on what is to be evaluated. The framework can be used in both a developmental sense to inform design during the implementation and embedding a games-based learning environment into curricula in a formative evaluation sense and also points to examples of individual analytical measurements already present in the literature for focusing on an evaluation at the end of development in a summative evaluation sense.

A brief description will be provided of each category: *Learner Performance* **–** Encompasses pedagogy from the perspective of the learner and is to evaluate aspects of learner performance. It is primarily concerned with whether there is an improvement in learner performance. *Motivation* **–** The particular motivations of the learner using the intervention, the level of interest in participating in the intervention, participation over a period of time and determining what particular motivations are most important. *Perceptions* – Encompasses perceptions associated with the learner such as overview of time, how real the game is, it's correspondence with reality, whether the games-based learning intervention represents a holistic view of a particular organization or process, game complexity, advice quality and level of self reported proficiency at playing games etc. *Attitudes* **–** Learner and instructor attitudes towards various elements that may alter the effectiveness of the games-based learning intervention. Elements include: learner attitudes towards the taught subject, learner attitudes towards games, instructor attitudes towards the incorporation of games into the curricula etc. *Preferences* – This category is designed to consider learner and instructor preferences during a games-based learning intervention. There are different learning styles (Kolb, 1984) therefore it stands to reason that different learners have different preferences, for example, preference for medium used when teaching the material. *Collaboration* – Collaboration is optional when considering games-based learning as it is dictated by whether the game is played on an individual level, cooperative group level, competitive group level etc. The main ways of evaluating collaboration are through log files monitoring interaction, mapping team aspects to learner comments, measuring the regularity and level of collaboration and learner group reflection essays. *Games-Based Learning Environment category* – This category encompasses all aspects that could potentially be evaluated about the games-based learning environment. It is one of the most complicated categories as it can be divided into five subcategories: environment, scaffolding, usability, level of social presence and deployment. The framework was highly instrumental in formulating the pre-tests and post-tests for the evaluation of the ARG.

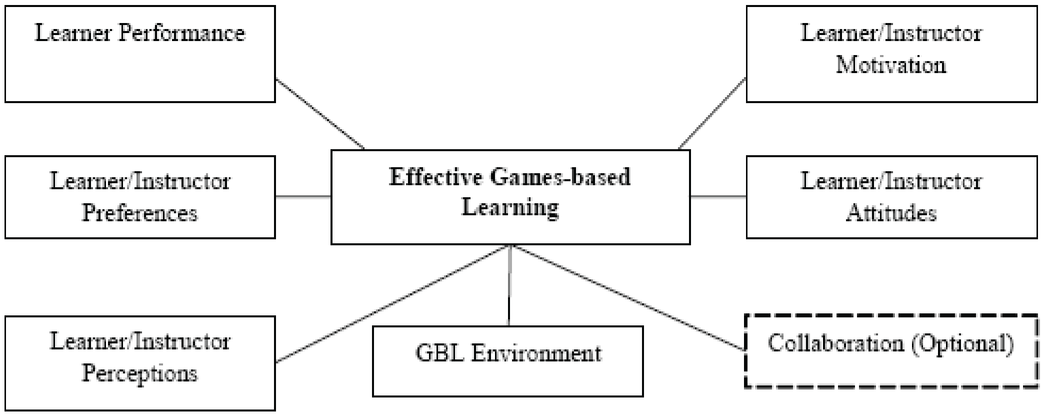

Figure 1: Evaluation framework for effective games-based learning

3. Evaluation of the Alternate Reality Game (ARG) and validation of the evaluation framework

This section will discuss the evaluation of the ARG in terms of methodology selected, particular categories of the evaluation framework used, procedure and an initial results discussion.

3.1 Methodology

The general experimental designs of studies evaluating games-based learning are experimental as opposed to quasi-experimental and are typically based on the pre-test/post-test approach (Maguire et al, 2006). Despite the fact that the most impressive pedagogical results in the literature have a pre-test/post-test experimental/control group design it should be noted that a control group is not always producible or appropriate. In the case of the distributed nature of the ARG study, multiple control groups would be required which is not realistic. Also if the game is designed to assist learning which is the case in this study then there is no requirement for a control group. The ARG study is primarily interested in student motivation, engagement, skills, technical aspects and attitudes. Therefore the experimental design selected for this study is pre-test → ARG intervention → post-test. The particular categories of interest from the devised evaluation framework are learner motivations, learner attitudes, learner preferences, perceptions and a section from the GBL environment category concerned with the technical aspects of the ARG. Learner motivations were adapted from Malone and Lepper's (1987) framework on intrinsic motivation.

3.2 Procedure

Each participant was sent a pre-test designed to: collect some demographic and learner type information, information on foreign languages being learned, skills that participants' believe can be obtained from computer games, how important reasons and motivations are for playing computer games, how important technical aspects of a game are and general attitudes towards playing computer games. Participants were then given the opportunity to play The Tower of Babel Alternate Reality Game in classroom situations and at home for a period of approximately 10 days. Participants were then sent a post-test collecting information on how much time they got to play the game in class, how much time they played the game in their own time, how reliable internet access was to the game, what particular motivations were present in the game that was important to the player, technical aspects, skills acquired from the game and attitudes. Additional questions were asked about realism, confusion and complexity. The two questionnaires were developed and sent through SurveyMonkey.com and all initial results obtained were transferred into SPSS version 15 for further detailed analysis.

3.3 Results

105 of the participants completed the pre-test, 90 participants completed the post-test and 43 completed both the pre-test and the post-test. As a result of this the pre-test and post-test results can be analysed in isolation and comparisons can be made between the two tests with the 43 participants. This section will firstly discuss the pre-test results, the post-test results and then perform a comparison between the pre and post-tests.

3.3.1 Pre-test results

Of the 105 participants who completed the pre-test, 34.3% of the respondents were male and 65.7% were female with a mean age of 14.22 (SD = 0.85) with a range of 12 to 15. Participants spent an average of 4.58 hours (SD = 5.47) a week playing computer games which is significantly different from computer game participation observed in a higher education institution were participants played games for approximately 7.72 hours a week (Connolly, Boyle and Hainey, in press). The foreign languages being studied by participants were: 94 (89.5%) learning English, 27 (25.7%) learning German, 25 (24%) studying French, 12 (11.4%) studying Russian, 8 (7.6%) studying Spanish, 8 (7.6%) studying Italian and 7 (6.6%) Bulgarian. Other languages mentioned were Polish, Latin and Portuguese.

In terms of skills that participants believed could be obtained from computer games: 66 (63.8%) creativity, 54 (51.4%) collaboration/teamwork, 51 (49%) problem solving, 39 (37.1%) reflection, 37 (35.2%) critical thinking, analyzing/classifying, leading/motivating and 30 (28.5%) management skills. The majority of the participants (66.7%) preferred cooperative learning – learning by working with other students. Due to the collaborative nature of the ARG game, this particular learning preference was expected. Table 1 shows the mean rating for each reason for playing computer games along with the order of importance for its rating and Table 2 shows the mean rating for the importance of aspects in a game with the order of importance of its rating.

Table 1: Reasons for playing computer games

Reasons	**Rank**	**Mean**	**SD**
Challenge	1st	3.74	1.08
Cooperate	2nd	3.64	1.24
Fantasy	3rd	3.60	1.30
Curiosity	4th	3.51	1.30
Pleasure	4th	3.51	1.20
Compete	5th	3.48	1.10
Feel Good	6th	3.38	1.17
Prevented Boredom	7th	3.38	1.28
Relax	8th	3.27	1.47
Escape Stresses of Life	9th	3.24	1.31
Leisure	10th	3.23	1.38
Release tension	11th	3.12	1.37
Control	12th	3.11	1.50
Avoid Other Activities	13th	2.85	1.43
Recognition	14th	2.85	1.38
Emotional Stimulation	15th	2.79	1.38

Table 2: Importance of aspects of computer games

Aspect	**Rank**	**Mean**	**SD**
Narrative	1st	4.08	0.99
Help and Support	2nd	3.97	1.03
Story	3rd	3.95	1.18

Aspect	Rank	Mean	SD
Solving Quests	4th	3.88	1.14
Realism	5th	3.84	1.09
Characters	6th	3.80	1.02
Collaboration	7th	3.70	1.31

3.3.2 Post-test results

90 participants completed the post-test. The mean amount of time that participants got to play the game in class was 2.07 hours a week (SD = 2.57) with a range of 0 to 10.33 hours indicating that different time allowances for playing the game in class may have been a factor. Participants played the game for a greater amount of time in their own time (3.21 hours, SD = 3.88, range 0 to 17.5) possibly indicating that the game was more intrinsically enjoyable outside of a classroom structure. The reliability of Internet access to the game was generally good with 33 (36.7%) of participants indicating that it was very good, 44 (48.8%) of students indicating that it was good and 12 (13%) indicating that it was medium. 77% of the participants indicated that the game was what they expected. Those who indicated that the game was not what they expected gave some of the following reasons:

> *"I was expecting it to be more interesting and for more people to take part in the game facilities."*

> *"It was more like a website and forum than a 'game' in 3d."*

> *"The story of the game wasn't much connected with the quizzes."*

> *"It was much better than I was expected!"*

61% of participants indicated that they did not experience confusion will playing the game. Those who did gave a number of reasons why that was the case including:

> *"There were some misunderstandings on my side as I skipped some instructions in order to save more time on playing the game."*

> *"I found some of the quests hard to understand. I mean the questions were unclear."*

> *"I was confused when I couldn't find where those diaries of the characters were and I didn't know where to look for information on their personalities."*

78% of participants indicated that the level of realism and the level of complexity of the ARG were appropriate. Table 3 shows the mean ratings of motivations for playing the ARG game along with the order of importance while Table 4 shows the mean rating for the importance of aspects in the ARG with the order of importance of its rating.

Table 3: Reasons for playing the ARG

Reasons	Rank	Mean	SD
Control	1st	3.71	1.28
Curiosity	2nd	3.61	1.19
Fantasy	3rd	3.45	1.18
Pleasure	4th	3.36	1.37
Leisure	5th	3.38	1.28
Cooperate	6th	3.36	1.30
Avoid Other Activities	7th	3.30	1.42
Emotional Stimulation	8th	3.30	1.21
Feel Good	9th	3.19	1.22
Release Tension	10th	3.13	1.28
Escape Stresses of Life	11th	3.13	1.32
Recognition	12th	3.10	1.32
Relax	13th	3.07	1.30
Challenge	14th	3.06	1.35
Compete	15th	2.92	1.35
Prevented Boredom	16th	2.89	1.31

Table 4: Importance of aspects of computer games

Aspect	Rank	Mean	SD
Story	1st	3.73	1.13
Realism	2nd	3.72	1.16
Solving Quests	3rd	3.70	1.10
Collaboration	4th	3.57	1.19
Narrative	5th	3.56	1.42
Help and Support	6th	3.53	1.25
Characters	7th	3.48	1.39

In terms of skills that students believed they obtained from the ARG, 48.8% believed that they obtained problem solving skills, 37.7% believed they obtained reflection skills, 44% analyzing and classifying skills, 55% collaborative and team work skills, 41% leading and motivating skills, 32% critical thinking skills, 32% management skills and 54% creativity.

3.3.3 Comparison between the pre and post-tests

Due to the fact that 43 participants completed both the pre and post tests the data can be analysed in two different ways. Within sample tests can be performed for the 43 participants as one group and between sample tests can be performed on the remaining participants as independent groups i.e. 62 participants remaining in the pre-test group and 47 remaining in the post-test group.

In terms of motivations the pre-test asked the participants what motivations they considered to be important in games and the post-test asked them what motivations they considered to be important in the *Tower of Babel.* This means that we can assess if important motivations have been sufficiently incorporated into the ARG. A paired sample t-test between the 43 pre and post test participants only showed a significant difference with regards to fantasy ($t(39) = 3.088$, $p = 0.04$). The mean score for fantasy in the pre-test (3.78, SD = 1.25) was greater for fantasy in the post-test (3.13, SD = 1.28). The lower mean suggests that while fantasy is considered important in games in general, it can be an area of improvement in the ARG. The important aspect of the results is that out of 16 motivations only 1 had a significant reduction and indicates that the ARG is acceptably motivational for the participants.

In the independent groups comparison, the only motivation that had a significant difference was recognition ($t(97) = -2.513$, $p = 0.014$). The mean in the pre-test is significantly lower than the mean in the post-test indicating that the ARG provided participants with more recognition than they initially expected from computer games in general. Although the groups are treated as independent, the fact that the majority of the motivations for playing games and the motivations for playing the ARG are not significantly different indicates that the ARG is sufficiently motivating.

In terms of technical aspects of the ARG, the independent groups showed no significant differences with the exception of Story ($t(97) = 2.368$, $p = 0.020$). The mean in the pre-test is significantly higher than the post-test indicating that the ARG story did not meet the participants' expectations. In the group of 43 who completed both the pre and post-tests a paired samples t-test showed that there was no significant differences with regards to narrative, collaboration and solving quests, however there was a significant reduction with regards to story, characters, help and support and realism. This indicates that the ARG did not meet the participants' expectations of these technical aspects in comparison to what they expect of computer games in general.

4. Discussion

This paper has discussed the evaluation of a pilot of the *Tower of Babel* ARG that ran from 22 April to 30 April 2009 involving 328 students and 95 teachers from 28 schools across 17 countries. Overall, the students' reaction to the ARG was very positive. Expected motivations in general computer games and motivations for playing the ARG were on the whole not statistically different indicating that the ARG has managed to deliver the motivational experience expected by the students. In terms of the technical aspects the results indicate that the ARG managed to exceed student expectations with regards to narrative (a key component) and adhere to student expectations in all other components.

Challenge, curiosity, cooperation, pleasure and competition were rated as important expected motivations for playing computer games and for playing the ARG - a finding which is consistent with three studies performed in Higher Education (Connolly, Boyle and Hainey, in press) indicating that the expectations of using computer games in education are similar regardless of age group and educational context.

The majority of the students who completed the post test either agreed or strongly agreed that they would be willing to play the game over a prolonged period of time and that they would play it as part of a foreign language course. Again the majority of students reported that they game was engaging and that it motivated them to learn and use foreign languages. Interestingly participants played the game for a greater amount of time in their own time (3.21 hours, SD = 3.88, range 0 to 17.5) possibly indicating that the game was more intrinsically enjoyable or more suitable and accessible in a home environment.

The students believed that they obtained a number of skills from playing the ARG and the results suggest that the ARG is very encouraging in terms of cooperation, collaboration and team work. Cooperation was ranked the highest motivation for playing the ARG after the intervention and replaced Challenge as the most important motivation. Also a higher percentage of students believed that they obtained collaborative skills from the ARG than would have been expected from the pre-test results. The obtained skills result was more than 10% higher.

While the results are very encouraging, we have identified a number of enhancements that we would like to make to the game. We would like make these changes and then repeat the pilot across Europe, potentially with more students and teachers than the pilot. We would use a similar evaluation framework to determine whether the results of the pilot still hold. After that, we would like to use the underlying ARG platform but produce a different narrative and quests to evaluate the ARG in a different subject area, for example, history, modern studies or personal and social education (PSE) and again determine whether the results from the pilot still apply.

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A Critical Reflection on the Potential of Mobile Device Based Tools to Assist in the Professional Evaluation and Assessment of Observable Aspects of Learning or (Game) Playing

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Abstract: In the past few years a large amount of work has been done in the field of games based learning, mainly with respect to computer based applications. However there have been other, much older and traditional areas of (or related to) games based learning that have also received drastically increased attention from the research community in recent years. The public interest in matters concerning paedagogics has literally exploded, an observation reflected in the coverage by the mainstream media. In previous work the authors have reported on practical hands on studies from the classroom (J. Hildmann) or proposed a formalism designed to represent unambiguous descriptions of observable aspects of learning or (game) playing (H. Hildmann). In this paper aforementioned formal approach is linked to innovative approaches for behavioural evaluation of children and experiential paedagogics, in specific to initiative games. The background of the authors allows the merger of the theoretical contribution from the field of computing with the practical considerations, criticism and requirements of an expert "in the field", i.e. one of those professions that will ultimately be using these new approaches as well as judging and evaluating them.

Keywords: Adventure/initiative games, experiential education, behavioural psychology, social skills, mobile devices, computer based assessment and evaluation

1. Introduction

The term experiential education refers to a modern approach in education which deviates from the old fashioned paradigm of a hierarchical one-way delivery of content. It aims to combine multi sensor stimuli with practical learning as well as making use of emotional incentives and learning strategies in order to facilitate development. It focuses for a large part on making the participants aware of their already existing competences and abilities before working to enhance them. There is a large amount of literature and research demonstrating the positive outcome of experiential education programmes mainly in respect to social skills, self-esteem and problem solving (cf. Rehm, 1999). Although these programmes are originally, and even now primarily, set in an outdoor and/or adventure context, in the past years a field or nature-independent activities have emerged and is by now well established, e.g. as *City Bound* (Deubzer & Feige, 2004) or initiative games that can also be practiced indoors. They always pose a practical challenge that needs to be mastered with creativity, problem solving skills and physical action. Usually they are designed for groups, thus also requiring and promoting cooperation, effective communication strategies and team spirit. Common examples are crossing a stream (real or imaginative), transporting an object without touching it or finding a path while blindfolded and / or forbidden to speak (Rohnke, 1989).

Just recently, this approach has also been introduced into regular school lessons in Germany to promote social skills in pupils while at the same time transporting the academic curriculum (Hildmann, in review). To achieve this, a number of working principles of experiential education were employed in conducting the lessons, such as giving the pupils as much self responsibility as possible and designing the tasks in a manner such that several approaches are possible to reach a satisfactory solution.

A qualitative experiment conducted with four classes of eighth formers over two six months periods has proven this approach to be very successful in terms of promoting social and personal competence.

2. Observable aspects of behaviour

2.1 A model for human behaviour choice

In 1985 Ajzen proposed the *Theory of Planned Behavior* (ToPB) as extension to his *Theory of Reasoned Action*. This theory stipulates that human decision-making (with respect to actions and behaviour) is guided by three conceptually different considerations and beliefs (Ajzen, 1985):

- *Behavioural beliefs*: The expectations about the likely outcome of one's actions, paired with one's subjective view on these outcomes.
- *Normative beliefs*: The opinion of others regarding the outcomes of one's actions, combined with the intention to adhere to the standards of others and to live up to the expectations of one's peers.
- *Control beliefs*: One's confidence towards all factors relevant to bringing about an outcome and the subjective belief of control over these factors.

2.2 A distinction of observable aspects

With respect to observable aspects of behaviour we continue to use the works of Ajzen as reference point, specifically the TACT (Target, Action, Context and Time) paradigm that was suggested for the design and the evaluation of questionnaires (within the context of ToPB related research). In this work, Ajzen (2002) argues that in order to define behaviour sufficiently the above mentioned four aspects have to be distinguished and identified in (introspective) statements regarding behaviour. His running example is *"walking on a treadmill in a physical fitness centre for at least 30 minutes each day in the forthcoming month"*. It is not always clear how to distinguish between the four aspects, a matter to which we will return further below. The labelling of behaviour as well as the distinction of which of the four aspects to assign to a part of a statement describing behaviour is subjective and therefore has to be decided upon by the trainer or the researcher. This opens the door for ambiguity. However, since we are not making any claims towards providing an objective way to assess behaviour this is not of much impact. We merely provide well-defined and consistent means to the assess behaviour. The classification, just like the eventual interpretation of the collected data, will remain the task of the person investigating the behaviour.

Ajzen himself points out that there is this ambiguity and that there are many possible additions to the basic TACT paradigm as proposed by him originally (e.g. *"within next month"* can include *"next Tuesday"*). The aim of the paper is to illustrate our suggested approach and as such it is bound to be rather general. The specifics of the project for which it is used will determine the extent to which a finer grained distinction is required; one of the first tasks in the design stage of a project is for the programmer and the trainer to liaise on that matter and to reach a consensus. Furthermore, complicated extensions will complicate the matter without adding value to the conceptual approach and are therefore omitted here. The scope and the intended audience of this article do not warrant a lengthy discourse on this matter.

2.3 Experiential education, initiative games

In experiential education the used games are often called *exercise* rather than *games*, because in the context of a professional training setting, playing games is often regarded not only as a children's activity but, if done by adults, as childish and is therefore met with resentment (Hildmann, 2008).

With respect to the 3 types of belief mentioned above in the section on behavioural psychology we briefly elaborate which of them is target and if then to which extent. Recall that Ajzen distinguishes 3 beliefs:

Behavioural beliefs:

Experiential education and initiative games can target these beliefs in two different ways:

a) In an exercise the player can face new, previously unknown actions and choices and thus gather experience related to the outcome of these actions as well as providing feedback on their desirability.

b) The game can be designed to place the player in the position to perform a known action that is normally performed by others and thus provide feedback on an otherwise merely observed action.

Normative beliefs:

These are strongly dependant on the scenario and probably the least commonly targeted beliefs of the three in experiential education. There are famous examples of experiments like the Stanford Prison Experiment (Haney, C., Banks, W. C. & Zimbardo, P. G, 1973) which were designed to investigate the extent to which these beliefs can be changed, often with horrific results. In the context of teaching these are normally continuously targeted by the trainer in the effort to make up for the increasing lack of parental influence evidenced by today's youth, yet they are not as commonly found as the stated primary target of initiative games.

Control beliefs:

Though not necessarily the most important beliefs, these are the first that come to mind when talking about initiative games. The personal confidence towards being able to bring about something is boosted or even created, simply by placing a player in a position where a certain outcome has to be achieved and the (ideally successful) attempt to do so provides the feedback that might not normally be experienced in the everyday life of the player.

The observable aspects with respect to initiative games or experiential education in general (and within the scope of this paper!) are then e.g. the participation in group activities and efforts, individual actions, communication and the content of the communication, consideration of oneself and the other group members (social skills) cooperation (as a high level description) and creativity. This is a non exhaustive list and the actual observable aspects are of course dependant on the exercise.

We now introduce a formal language alike the one used in previous research. This language is designed to unambiguously describe relevant observable aspects of behaviour and learning. This is necessary when implementing evaluation tools for initiative exercises which are intended to function automatically.

3. A formalism for observable aspects of behaviour and learning in games

As described by Hildmann & Livingstone (2007), the language described in the following sections is standard classical propositional logic (PL) as introduced in van Benthem, van Ditmarsch, Ketting & Meyer-Viol (1991) (page 11-23); for advanced reading see Blackburn, deRijke & Venema (2001). It is explained here only to the extent required to understand the approach.

3.1 A formal language $\mathcal{L}^*$

We use a formal language, which we will call $\mathcal{L}^*$ (Hildmann & Livingstone, 2007). By formal language we mean a formally defined language that has both syntax (clearly defined structure) as well as a semantic (meaning). That language is, unlike most natural languages, unambiguous; a quality we require for our application in order to provide us with data which can be processed automatically.

The language $\mathcal{L}^*$ is constructed over a vocabulary. These *"words"* of the language are its smallest building blocks from all sentences are constructed; we can deconstruct any however complex sentence, and, using the semantic rules, propagate the truth values of the vocabulary upwards to determine for any sentence whether it is true or false. To make this language understandable to any non technically inclined person we make use of the fact that we can (mechanically) translate any sentence of this language into a natural language, for example into English. This gives us a language at our disposal that is both formal (and thus unambiguous) as well as intuitively understandable (Hildmann & Livingstone, 2007).

Motivation

We justify this section and the introduction of a formal language by our aim to provide the reader with a straight forward means to represent, implement and eventually assess behavioural statements, because:

- It gives us a well defined and unambiguous way to make statements regarding behaviour. Since the language is semi-natural a trainer can intuitively understand and verify the validity of statements in the context of the specific application, and, therefore, make use of our tool.
- Implementing a rigid evaluation method for any aspect expressed in the language allows the game designer or the trainer to amend certain behavioural aspects of the game or the tool without having to change the whole system.
- There are algorithms that allow us to automatically cerate new behavioural statements that are consistent with existing ones. Furthermore, application specific modules can be implemented that use artificial intelligence to suggest useful and meaningful statements to the user during the game or the project and while the program is running.

3.2 Behavioural psychology

Above we introduced the conceptual approach of TACT proposed by Ajzen (2002). In this section we will illustrate how this is incorporated into games. As a running example we will use the game "Glasgow SoxWars" (Hildmann & Boyle, 2009) designed to investigate cooperative and competitive behaviour.

We start by designing the game around the vocabulary of our formal language, which (as described in the sections above) is a collection of statements which at any given moment can be evaluated to be either true or false. What we intend to do is to construct statements regarding the player's behaviour such that:

- The four concepts *Time*, *Action*, *Context* and *Target* are unambiguously defined in each statement.
- Given a state of the game we can evaluate any such statement to either true (**T**) or false (**F**).
- Each statement is assigned a behavioural label (e.g. *cooperative*, *competitive*).

The last point is quite vague as it will be based on the opinion of the researcher alone. This however cannot be avoided; furthermore it is a problem that is present when constructing a questionnaire as well. In what follows we will use some insight into the example game to decide subjectively whether a stated behaviour should be seen as *cooperative* or *competitive*. It is important to remember that these labels are used to illustrate the approach, not as definitions of the two behaviours. In the next few sections we will express behaviour of a player, which we will call *Subject* and use the abbreviation **B** and **B'** which stand for either *cooperative* or *competitive* behaviour. Since we, as the researchers, define for any behaviour whether it equates to one of these two we can investigate at any moment whether a player is playing cooperatively or competitively. Using the complex statements further down below this allows us to investigate the behaviour of the player *in response* to the opponent's actions.

In our game the players have the option to offer their resources to other players. When doing so the price they can ask for this is fixed. This is to keep things simple. If price varied, the number of statements as well as their complexity would increase drastically. The player can choose from offering resources to: a single player, all players, all but one player, all players of lower rank and all players of higher rank.

<u>Cooperative</u>

- Subject offers trading with a single player **P** who is ranked lower than Subject.
- Subject offers trading with a single player who plays **B** against Subject.
- Subject offers trading with all players that are ranked lower than Subject.

<u>Competitive</u>

- Subject offers trading with a single player **P** who is ranked higher than Subject
- Subject offers trading with all players ranked higher than subject.
- Subject offers trading with all players but player **P** who is ranked higher than Subject.

The TACT labels are (omitting *Time* for now, see below):

Action :	Subject offers to trade resources …
Target :	… with player **P** / all players / all players but player **P**…
Context :	… of higher / lower rank than the subject.

In the above statements we have ignored the temporal aspect. We now add three operators to the game: *for n rounds*, *until* and *while*. In the following sentences, provide to illustrate the usage of these temporal operators, cooperative and competitive statements like the ones given above are abbreviated **A** and **B**:

<u>Simple temporal statements</u>

- Subject plays **A** for n rounds.

<u>Until statements</u>

- Subject plays **B** / **A** until player **P** plays **B'** / **A'** against Subject.
- Subject plays **B** / **A** until all other player plays **B'** / **A'** against Subject.

- Subject plays **B** / **A** until some other player plays **B'** / **A'** against Subject.

While statements

- Subject plays **B** / **A** while player **P** plays **B'** / **A'** against Subject.
- Subject plays **B** / **A** while n other player plays **B'** / **A'** against Subject.
- Subject plays **B** / **A** while at least n other players play **B'** / **A'** against Subject.
- Subject plays **B** / **A** while at most n other players play **B'** / **A'** against Subject.

Now the latter two statement types *until* and *while* are more complex than the first one. For all three types of statements we are deriving the *Target*, *Action* and *Context* from the behaviour **B** but the *until* and *while* statements allow us to use time not only in relation to the number of turns but to measure behaviour in relation to the behaviour of others as well. The Repeated Prisoners Dilemma (Binmore, 2007) is a good example of a setup where exactly this type of behaviour is investigated.

The above listed are merely examples. Many more combinations are possible. We argue that the above suffices to illustrate the complexity and expressiveness of $\mathcal{L}^*$. One can imagine that there are, in theory, statements of almost infinite length possible (restricted only by the number of temporal connectives like *until* and *while* and the upper bound of semantically different statements). Longer statements are of little use for psychological experiments or our initiative games; we are content with statements given above.

3.3 Experiential education

As above, we will assume a less than general exercise as a running example. In this case we simply assume an initiative game that makes use of mobile devices carried by each player and used for interaction and communication. This could be because the players are acting in different locations too far apart to communicate personally, because the mobile devices allow the exchange of a game currency (thereby forcing the player to effectively log all interactions that require currency exchange) or by providing information in a format that can not be communicated otherwise (e.g. providing many images as clues, which the players can share). We now consider the previously listed observable aspects of initiative game exercises, making use of the TACT paradigm wherever possible:

The participation in group activities and efforts

Assuming there is a predefined list of actions that can be performed in the exercise any activity undertaken is the ***Action*** element of that behaviour. The ***Target*** is depending on the activity but is required in order to relate one player's action to the other players'. The *Context* of the activity will define whether the player is partaking in a group effort or whether the activity is cooperative at all.

Individual actions

This is the same as above with the difference that it might not be possible to evaluate the activity right away as belonging to either a constructive group effort or a (potentially counterproductive) individual action. This can be evaluated over time in relation to other activities.

Content of communication

Clearly the *Action* here is the act of communicating; the *Target* is the player or players with which the communication is taking place. The *Context* is determined either by previous and subsequent communication and / or content that is communicated. The degree to which information is relevant is not always immediately obvious as the player might have a subjective understanding that changes this; however the relevance of transmitted information as well as the completeness are important and normally understood easily. As above this can be re-evaluated after some time.

Consideration of oneself and the other group members / Social skills

From the observation on the group members we should be able to infer at which stage in the exercise they are (or think that they are) are at any moment. Using this inferred information, we can deduce an importance of specific abilities and expertises of individual players and then monitor the extent to which this is both understood by the other players as well as incorporated into their decisions. This is only *Context* dependant as the actions performed will themselves have *Action*- and *Target*- elements.

Cooperation

We can formally define which behaviour we are considering to be cooperative and competitive, but that will be a decision made by the trainer or researcher and will be stated in terms of the vocabulary of the formal language. We intentionally kept this part general; the previous section uses the example from (Hildmann & Boyle, 2009) which should suffice to give the reader an idea.

Creativity

This last one is going to very hard and probably impossible to formally define. This is partly due to the fact that the very understanding we have of creativity includes the notion of using previously not considered means and approaches when attempting to solve a problem. In a fully controlled setting this can easily be implemented by classifying a subset of all possible actions as *creative*, however this is almost never going to be possible in an initiative exercise scenario which is not purely conducted using the mobile device. This none withstanding there is of course the ability to closely monitor and record the actions taken by individuals and for the trainer to evaluate them separately or after the exercise is concluded.

By the above we hint that a well designed and implemented initiative exercise can very well be cast into the TACT paradigm. We will now briefly cover the functionality to evaluate and assess statements on our language by a fully automated process and then discuss the use of mobile electronic devices for experiential education and initiative games.

3.4 Automated verification mechanisms

The automatic process of evaluating sentences in the language is straight forward. Given the formally defined semantic (van Benthem, van Ditmarsch, Ketting & Meyer-Viol, 1991) we can rewrite any sentence as a conjunction of statements and negated statements. Such sentences are called the *normal form*; they can then be automatically evaluated to be either true or false on the basis of the individual truth values of the propositions which we can determine unambiguously at any stage during or after a game. The algorithms for this are standard and can be found in most textbooks on propositional logic.

4. Mobile device based evaluation and assessment tools

We conclude that with respect to the identified requirements for electronic devices in the context of this particular research, the current standard of mobile phones or laptops can surely boast a subtle inclusion of the required technologies into their design as well as a multitude of by now very user friendly interfaces. Furthermore we refer to recent work of the first author (Hildmann, Uhlemann & Livingstone, 2008 and Hildmann, Branki, Pardavila & Livingstone, 2008) where a variety of complex implementations have been reported on as being achievable as well as computationally feasible. With respect to the objective recording of social and personal skills and behaviour, the work presented in Hildmann & Boyle (2009) indicate that the results obtained are less prone to criticism from the fields of behavioural psychology and education. Nevertheless this is a matter of specific application and implementation and there is certainly yet work to be done to bridge the gap between computing sciences and these fields.

We argue that the appropriate use of mobile devices or new technologies in general can be of great benefit to educationalists of many types, as long as they are designed as supporting tools and in accordance with the requirements of the intended users. With respect to mobile devices as platform for lessons targeting behaviour or social skills and awareness, we first isolate the areas where these devices have a clear benefit they can bring to the collaboration. In the scope of this paper two aspects emerge:

Support the game scenario and enrich the environment

Mobile devices can be used to support the scenario set by the trainer. These devices have the ability to store large amounts of data, provide a controllable communication interface, provide an audio-visual interpretation of elements of the game and interact with other devices, all of which can be used very effectively to enrich the physical environment to reflect the scenario more closely. To illustrate what is meant by this, consider the use of die or event / activity cards, which can be done in much greater variety through an electronic device. In addition, large amounts of both game relevant (to drive the game) and irrelevant (to add to the gaming experience) information can be stored and provided on the basis of certain cues (e.g. GPS determination of position or proximity detection of (specific) other players). Finally they can be used to provide hints and clues in a variety of formats (e.g. sound, image) which are much less obvious then a statement from the tutor.

<u>Assess and evaluate actions even during the game</u>

Every action that is performed with such a device can be recorded and stored without the knowledge of the player. Such information can be used for a post exercise evaluation but also interpreted immediately and used either as feedback to the trainer or to intervene in the normal course of the game (e.g. the absence of a player causes the game to start a side event that requires this player to be included in the group again). If properly designed it allows the trainer to initiate a game that is not fully determined in its course yet. According to the performance of the players it can be steered one way or another. This can facilitate the targeting of multiple lessons and objectives. Finally and simply, we can view any device in the game as additional eyes and ears for the trainer, allowing a closer interaction with the game as well as adding security and accountability to the exercise (calling for e.g. medical assistance as well as locating the person in need of assistance is easily supported).

5. Critical considerations and practical concerns

This article's parallel publication (Hildmann & Hildmann, 2009) lists a number of potential advantages for the use of electronic devices in general and mobile phones in particular. Before we provide a critical view we first briefly list those positive aspects here:

- <u>Data integrity:</u> Electronic devices allow the individual monitoring of players or students. The gathered data can then be used to create a user specific profile that is based on the observed actions and not on introspective statements (which are traditionally unreliable due to their introspective nature).

- <u>Data authenticity:</u> There is a variety of mechanisms to ensure the authenticity of the data, ranging from using devices that the user will not likely share, over automatic cross-checking and comparing of answers and answering behaviour to authentication mechanisms as key cards or biometric scanners.

- <u>Data protection laws and data security:</u> Electronic data collection allows for a variety of levels of data security that can be controlled centrally and in manners that require a number of people to give their consent for the release of data before it can be accessed. In addition the data can be analysed automatically and the results can remain undisclosed and protected by the same mechanisms.

- <u>Unobtrusive recording devices:</u> High-performance recording devices are already embedded in standard mobile technologies (e.g. mobile phones or laptops). Using e.g. a 6 Megapixel camera in an up to date mobile phone to record the eye movement or facial expressions is not a difficult task.

- <u>Individual recording devices:</u> Being able to give the recording device into the hands of the subject has the psychological effect that the subject feels more in control and less observed. The surrendering of the physical ownership over the device to the subject is the key issue here.

As stated by Hildmann, Uhlemann & Livingstone (in press), the shortcomings of serious games are not unknown to the field; one of the dominant noted drawbacks for serious games is the lack of guidelines or means to assess and evaluate the performance of the player; therefore efforts have been made to use the aforementioned formalism and mobile devices to assess the progress of the player, both during game play as well as after the game is finished. Previous / recent work has showcased the work done on a game called “Glasgow SoxWars”. The approach described in this paper follows adheres to earlier work, using the formal description of player behaviour in initiative games or other educational settings.

Both authors have been active in their fields long enough to be aware of bias found in educationalists against new technologies when these are introduced in their field of practice. The approach of digital games based learning is still suffering from this bias as innovations are often immediately rejected by educational practitioners. This reluctance can be traced to a number of (valid) core problems:

- These new techniques are developed by technicians without practical experience in educational settings. Therefore, their tools work in theory but fail to engage the pupils or are loaded with negative side effects that outweigh the benefits.

- Educationalists, by nature of their trade, will tend to reject technical devices advertising to achieve pedagogic goals. Their professional training and practical experience has taught them the vital role of personal interaction, which – so far – no computer can truly replace.

- Furthermore, when it come to approaching and handling difficult or demanding situations and issues in their classroom or respective context, practitioners are far more likely to follow their experience based intuition than the instructions of a technical device.

- Children and teenagers nowadays have a far superior understanding of new technologies than most adults, which forces the latter to give up the traditional position of authority that they have held in the past; and loss of authority often results directly in loss of respect, and subsequently, sub ordinance. Thus at least is their fear. Modern educationalists know that these assumptions are faulty.

- Additionally, each device can be used and misused. And unfortunately, many youngsters are incredibly eager to tamper with new hard and software in legal as well as illegal ways.

- Finally, some of the technologies which are used of are often financially unattainable in the required numbers, hard to maintain, not sturdy enough or too difficult to protect against theft.

The authors believe that on many occasions a good idea is rejected or failing simply because it is applied too directly or without considerations for the environment in which it is supposed to perform. Any digital or electronic device and programme which is intended to aid in the instruction and/or assessment of social skills – as in the study presented above – requires the expertise of a computer scientist and many cycles of design and implementation. This has to be undertaken in close collaboration with the end user, namely trainers, social care takers and the like to ensure the required functionality, usability and applicability.

6. Conclusion and future work

We have outlined how the TACT approach can be used to extend the language (propositional logic) used to formally state behaviour within a bounded context. Due to this extension we can make statements regarding behaviour (within the well defined terms of the game or exercise) that live up to the standards suggested by experts in the field of psychology. These statements can be assembled and deconstructed in an unambiguous manner, allowing for an interface within the game to enable the social practitioner or researcher to define the behaviour of interest for the game or the experiment; as well as being evaluated and assessed automatically. Due to this we can claim that we have presented an outline of how to implement a digital device based tool for educationalists to enrich their exercises and game scenarios. We took a critical view on the applicability and usefulness of employing digital devices in education, specifically in experiential education and initiative games and identified a number of issues and problems.

The authors of this paper agree that the design and implementation of digital or electronic tools has to be undertaken in cooperation with the intended users. The technology has to be a tool and as such one that is hand carved to meet the exact needs of the experts expected to use them. The providers of these tools are not equals to the educationalists in this decision process as their competence lies in the creation of the tools, but to the specific wishes and needs of the trainers.

More research will be necessary on the practical applicability of such programmed devices. Field experiments with children and teen-agers in school-related and out of school settings – such as social clubs, trainings for troubled youth or delinquents, and others – are equally possible as an evaluation of team trainings or other experiential education programmes designed for adults. Assessment might focus on which types of activities – initiative games, orienteering, trekking tours or the like – are most prone to profit from such devices and which same or others are best feasible to be adopted for assessment of participant behaviour.

Independent of contents of a study, all research endeavours should be conducted in cooperation of both fields of expertise, educationalists doing the 'real life base work' and computer scientists capable of designing and programming electronic devices such as mobile phones or GPS-computers used in outdoor activities for orienteering. Both groups of experts would have to be willing to cooperate in such a joint venture and adapt their professional language to achieve successful communication amongst each other – thus proving themselves worthy of assessing other people's will and skill to cooperate.

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Promoting Social Skills Through Initiative Games in the Classroom and Assessing Their Effects

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Abstract: *Adventure* or *initiative games* are one of the methods frequently applied in experiential education, a holistic approach to facilitate personality growth, which has established itself in various educational contexts. The main goal of initiative games is to promote social and personal skills. Generally, a group of participants is presented with some kind of problem or challenge that needs to be mastered. This can take place in an outdoor or indoor setting and usually requires effective group interaction and creative thinking to be completed successfully. The lead author has examined the impact of initiative games in regular school lessons on the growth of social and personal competence in students over a period of three years. The aim was to test the efficiency of the approach within the restricting conditions of a classroom setting. The evaluation of the intervention was conducted with a combination of quantitative and qualitative methods. The findings suggest that the presented approach does in fact promote social and personal skills already after a brief intervention phase. Some of the methods chosen created certain difficulties in regard to the experimental setting. These difficulties are presented and we suggest ideas how computer based methods could be a valuable alternative for the evaluation of social skills and behavioural development in comparable settings.

Keywords: Adventure initiative games, experiential education, problem solving, social skills, personality growth

1. Experiential education

Experiential education is a holistic approach in pedagogics, which has established itself in various educational contexts, from drug and violence prevention for youngsters to professional team trainings and therapeutic sessions (Heckmair/Michl 2004, Gass 1993; and others). Its main objective is to help participants discover and/or enhance personality growth, namely social and personal skills such as creative thinking, problem solving, or effective team behaviour (see section *2.2.* below for details).
Experiential education differentiates itself from other educational concepts through a number of underlying principles, that are also proven to be the key stone to this approach's success (compare Rehm 1999):

- *Learning with Head, Heart and Hand*: a combination of cognitive, emotional and practical or multi-sensorical learning techniques is employed to convey learning contents.
- *Challenge by Choice:* each participant is allowed to decide which challenge s/he wants to take on and to what extent.
- *Full Value Contract*: the group members agree to certain rules, such as respecting each other and being open to change.
- *Self responsibility & self regulation of group dynamics*: Participants are given as much responsibility for themselves, the course of the activities and group decisions as possible.

Although frequently combined with outdoor activities such as climbing, hiking or canoeing, the principles and basics of experiential education can also be implemented in activities with little or no requirements towards technical gadgets or locality. Next to the aforementioned outdoor sports are among the methods used in this approach a wide range of trust activities, ropes courses and the broad field of *adventure* (and/or) *initiative games*.

2. Adventure initiative games

In variation to this term, several others are found in the standard literature, such as *cooperative adventure games*, *initiative problems* or plain *initiatives* (Rohnke 1989; Rohnke/Butler 1995; Sonntag 2002; Reiners 2003; Gilsdorf/Kistner 2003). Trainers tend to use the term *exercise* rather than *games* when presenting them to participants, since playing games is often regarded not only as a childrens' activity but – in adults – as childish and is therefore often met with resentment in professional trainings (Hildmann 2008a).

The technical task that is the core of an initiative game is often embedded in an adventurous story such as getting lost in a desert storm or finding oneself in a tropical jungle after a plane crash. The purpose of this is to enhance the game aspect of the activity and aid the participants to unleash their creativity for the problem solving process (CEP 2009). Also, it helps being at ease, because not rarely, a certain amount of playful silliness is required to complete the task within the story compounds (Rohnke 1989).

Figure 1: Plastic cups and string make an adventurous team challenge

2.1 Structure

The general structure of initiative games is quite simple and reoccurring in most examples:

- A situation and setting is created by the facilitator by telling a frame story and/or arranging a real situation (blocking a path, tying a rope across a stream, etc.).
- The group is given all (safety) instructions and rules for the challenge. Ideally, this includes that the group members decide when they as a team are content with the result and inform the trainer that the activity is now terminated (nota bene: this can be the case without being completed successfully in terms of the original rules!).
- The trainer retreats a few steps to not distract the attention of the group. Until the end of the activity, s/he only interferes when the physical or emotional safety of one or more persons seems in danger or when addressed by the group with safety questions. The trainer does *not* give hints on how to solve the problem! This is an essential part of the social learning process!
- When the activity is ended, the trainer will resume his/her leading function and engage activities for reflection or transference of the learning increase, if appropriate.

Several variations are possible:

- The group is asked to verbally work out a strategy before they are allowed to start the actual activity.
- Some or all members of the group are 'handicapped' (blind-folded, legs or hands tied together, etc.)
- Verbal communication is prohibited.
- The game entails several rounds or phases of increasing difficulty.
- And others, depending on group parameters as well as creativity of the facilitator.

In many cases, strings of initiative games are arranged, with one activity following the other in an action–reflection pattern (see *Project Adventure*, USA). Naturally, other factors such as developmental stages of social groups have to be taken into account as well.

By principle, initiative games can also be constructed for single persons (obviously then not-cooperative), for example for therapeutical purposes (Gass 1993; Hildmann 2008b). But they are very rarely use in that way, since the vast majority of experiential education programmes simply is designed for groups.

2.2 Goals

Initiative games can be considered as 'serious games', since their objective is to facilitate team development and personality growth. Amongst others the following are goals commonly found (e.g. Rohnke 1989; Rohnke/Butler 1995; Gilsdorf/Kistner 2003):

- Developing team spirit (i.e. identifying with the team and its rules, values and goals)
- Increasing the effectiveness of communication
- Finding out about individual roles and their particular assets
- Putting individual strengths to the best possible use for the team
- Effective cooperation (i.e. reaching decisions, strategies and agreements fast, goal-oriented and in a socially agreeable manner)
- Team work, attributing individually to reach a shared goal
- Offering and accepting help
- Achieving a team goal even with
- simultaneous parallel tasks
- restricted means
- missing pieces of vital information
- hindered communication
- time pressure
- or other interference factors or handicaps.
- creative problem solving (which can be an individual as well as a team objective).

Which of these goals can be set and the extent to which they can be achieved, depends on a variety of parameters: number and age of group members, their usual working or social context, shared background, possible handicaps or psycho-social interference factors, such as open or hidden conflicts. In addition, duration and other components of the programme, skills and abilities of the facilitator(s), even weather conditions can have a distinctive positive or negative effect on the progress and outcome of a programme(CEP 2009).

The lead author, being an outdoor & social competence trainer as well as a school teacher, developed a teaching approach combining elements of experiential education with regular lesson contents, to implicitly promote social and personal competences in the class room. This concept, the *Experiential Teaching Approach* (ETA), is considered an *approach* rather than a teaching *method*, since it functions on a higher level than they do: It aims for half-abstract goals such as social competence, it is based on a humanistic and systemic view on the learner and employs a number of different methods itself, adventure initiative games being the most prominent of them.

3. Study design

Following the research question to what extent initiative games could be effectively transferred into an everyday classroom setting and deliver regular curriculum contents, a qualitative experiment was designed using a mixed-method setup. Additionally, ten single case studies were conducted, aiming at a more in-depth look at the strengths and weaknesses of this approach.

Figure 2: Virtually any topic can be turned into an initiative game

The findings and implications were supposed to achieve the highest possible level of practical applicability. Thus, the intervention was tested with a high proximity to everyday conditions, including a few restricting factors many teachers and lecturers are faced with: rigid timetables, an overboarding curriculum, restricted means and locations, reluctant parents, students with various special needs and/or no interest in their academic career, and so on. The idea was that if the approach could prove itself under deplorable – albeit unfortunately realistic – conditions, it should easily be implementable in the majority of schools and advocational training centres.

The test group consisted of 34 eighth graders (19m, 15f) at a specialized school for hard-of-hearing and d/Deaf students. Many of them attended the school not due to a hearing impairment but because of other special needs, mainly behavioural or emotional challenges. This is not an uncommon practise in Germany, where the study was conducted.

Two control groups were gathered, consisting of (a) students at schools for special needs (N= 115) and (b) regular school students (N= 194). Both control groups did not receive any kind of intervention and merely filled in the questionnaires needed for a base line comparison of the groups.

4. Intervention

An intervention phase with four eighth grade classes of different performance levels was conducted over a six month period. During this time, the lead author instructed the classes for 90 to 180 min per week, following the curriculum in the subjects History, Vocational Preparation, Art and Physical Education. The usual topics were covered in this period, but with the following adaptations:

- At least one adventure initiative game was conducted per lesson.
- The working principles of experiential education as listed in chapter 1 were followed consequently, e.g. by getting students physically engaged instead of having them merely sit, talk and read.
- Several subjects were combined (e.g. History and Art).
- Where applicable, the school yard or gym was used instead of the classroom.

Table 1 provides a detailed example of one intervention unit (consisting of two 90 min lessons) to illustrate the practical application of these parameters:

Table 1: Detailed example of one intervention unit

Topic:	Castles
Location:	Art room
Lesson outline:	*Arriving* marking on a prepared chart (ritual at the start of every intervention unit). topics: (a) My mood right now and (b) My feeling towards this group today. *Active acquisition of theory* Browsing preselected books for pictures of castles. Each pupil writes down at least eight features of castles (e.g. crenelations, draw bridge) Reading out to each other and demonstrating features with pictures *Initiative game I* students divided into small groups.

	instruction: "build a castle" criteria: it has to fit onto your desk you are free to use whatever material you find no material may be destroyed (torn, cut, broken or the like) time allowed: 10min Remember to include the features you collected. When completed, you will present your castles to the class in a 'castle tour'. *Presenting* Constructors give 'castle tours' to fellow students, present and – where needed – explain their work. Each castle is photographed. *Creating ones own work sheet* Instruction: Make a rough draft of your castle. Include only the important details. Afterwards, make a legend explaining the features. Teacher is double-checking for mistakes. *Cleaning up* The groups sort away their own material and clean their desks. When finished, they help others. *Reflection* Just briefly. Creating link to following lesson (see below).
Topic:	**Castles**
Material:	books about the Middle Ages Chart "My mood right now" & "My feeling towards this group today" Random material at hand Blank sheets of paper Pens and pencils
after a brief recess, a second 90 min lesson is conducted:	
Location:	Gym
Lesson outline:	*Initiative game II* instruction: again, "build a castle". Two groups □ two castles With whatever material you find Big enough for the group to sit or stand in 15 min time *Sociometric reflection* Answers are given by positioning oneself on an imaginary scale between the two castles. Questions: (a) How much did you contribute to the progress? (b) How content are you with your group's result? *Enacting castle life* Students 'move into' their castles. Two scenes are enacted: (a) Royal reception (incl. banquet, jesters,...), (b) battle (possibly conquest, definitely reconciliation. Caution: harmless weapons only!) *Cleaning up* The groups sort away their own material. When finished, they help others. *Evaluation* Marking on a prepared chart (ritual at the end of every intervention unit). Evaluated competences: cooperation, problem solving, self organisation and endurance. Brief discussion.
Material:	Various sports instruments found in a gym. Evaluation chart

Figure 3: Castles in the art room

Figure 4: Castles in the gym

In the unit presented here, the two initiative games happen to follow the same instruction and principle (i.e. build a castle with whatever material you find). This was not the case in all units, but it demonstrates the great variability of initiative games, because the two games in this unit vary in a number of factors, such as size of groups, size of resulting objects, employed material and consecutive activity.

5. Methods

The evaluation of the intervention was conducted with a combination of quantitative and qualitative methods. All of them were administered to the experimental group, but only the questionnaires included the control groups as well.

5.1 Teacher interviews

Half-standardised interviews were conducted with seven teachers at the end of the intervention phase (Interview-I) and with three of these teachers again after another six months as follow-up (Interview-II). The other four teachers were not available for Interview-II because of long-term illness, pregnancy or because they were no longer teaching this class.

In Interview-I, the teachers were asked

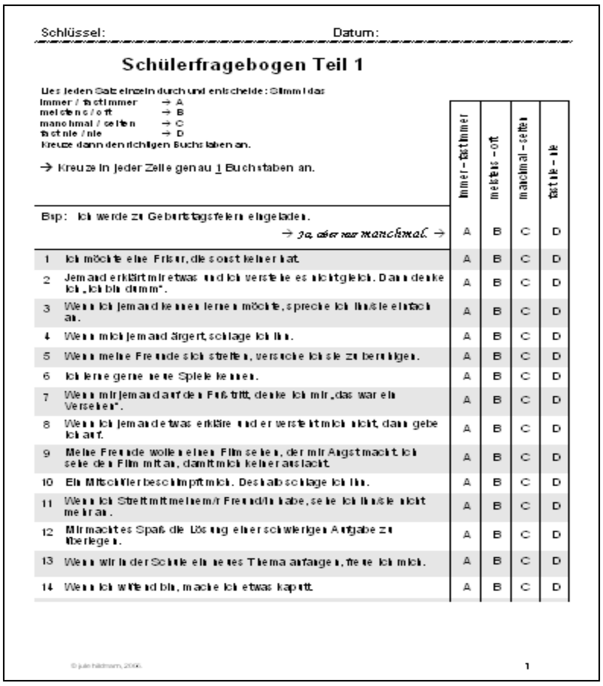
- about intervention related changes in the students as a group.
- about intervention related changes in the students as individuals.
- about the strengths and weaknesses of the approach from the teachers' point of view.
- what they deemed necessary for the approach to be spread and implemented broadly.

Interview-II investigated

- what became of the changes reported in Interview-I.
- whether the teachers continued to practise the approach, and if they did not,
- the reasons that kept them from doing so.

All interviews were recorded either on audio or video tape, transcribed and evaluated with the *qualitative contents analysis* technique by Mayring (1995).

5.2 Questionnaires



Schlüssel: Datum:

Schülerfragebogen Teil 1

Lies jeden Satz einzeln durch und entscheide: Stimmt das
immer / fast immer → A
meistens / oft → B
manchmal / selten → C
fast nie / nie → D
Kreuze dann den richtigen Buchstaben an.

→ Kreuze in jeder Zeile genau 1 Buchstaben an.

		immer – fast immer	meistens – oft	manchmal – selten	fast nie – nie
Bsp:	Ich werde zu Geburtstagsfeiern eingeladen. → Ja, aber nur manchmal. →	A	B	C	D
1	Ich möchte eine Frisur, die sonst keiner hat.	A	B	C	D
2	Jemand erklärt mir etwas und ich verstehe es nicht gleich. Dann denke ich „Ich bin dumm".	A	B	C	D
3	Wenn ich jemand kennen lernen möchte, spreche ich ihn/sie einfach an.	A	B	C	D
4	Wenn mich jemand ärgert, schlage ich ihn.	A	B	C	D
5	Wenn meine Freunde sich streiten, versuche ich sie zu beruhigen.	A	B	C	D
6	Ich lerne gerne neue Spiele kennen.	A	B	C	D
7	Wenn mir jemand auf den Fuß tritt, denke ich mir „das war ein Versehen".	A	B	C	D
8	Wenn ich jemand etwas erkläre und er versteht mich nicht, dann gebe ich auf.	A	B	C	D
9	Meine Freunde wollen einen Film sehen, der mir Angst macht. Ich sehe den Film mit an, damit mich keiner auslacht.	A	B	C	D
10	Ein Mitschüler beschimpft mich. Deshalb schlage ich ihn.	A	B	C	D
11	Wenn ich Streit mit meinem/r Freund/in habe, sehe ich ihn/sie nicht mehr an.	A	B	C	D
12	Mir macht es Spaß die Lösung einer schwierigen Aufgabe zu überlegen.	A	B	C	D
13	Wenn wir in der Schule ein neues Thema anfangen, freue ich mich.	A	B	C	D
14	Wenn ich wütend bin, mache ich etwas kaputt.	A	B	C	D

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Figure 5: Questionnaire on social and personal skills

Several standardizes questionnaires were considered for use, but none matched the specific needs of this study – especially regarding the poor level of language comprehension of the participants. Therefore, multiple choice questionnaires were newly designed for the sub-groups (a) students, (b) parents and (c) teachers, separately. The main indices measured were *Problem Solving Ability* (PSA) and *Positive Self-Concept* (PSC). The questionnaires were filled in by each participant at three points of time: At the start of the intervention phase (in the case of the experimental group as pre-test), at the end of the intervention phase six months later (post-test) and a third time after another five to six months (as follow-up).

5.3 Parents' feed back

In a letter following the end of the intervention phase, parents were kindly asked to state any changes they have observed in their child over the past six months. Also, they were encouraged to give any additional feed back about the project, if they desired. A fill-in form with return envelope was enclosed.

5.4 Students' feed back

At the end of the final lesson in each class, students were asked to reflect on (a) what they have learned in this project and (b) whether lessons should be conducted like this more frequently. Answers were recorded on tape, transcribed and also subjected to a qualitative contents analysis, although on a smaller scale than the teacher interviews.

5.5 Individual goals

The teachers were free to define individual goals for any student they chose. These were written down and handed to the examiner. Students were not informed about these goals to prevent resistance or self-fulfilling prophecies.

After completion of the intervention phase, teachers were asked to rate the progress of their students in regard to the goals set for them. Rating options were:

- (0) 'no significant improvement'
- (1) 'significant improvement in intervention units *without* generalisation of effect to other teachers lessons'
- (2) 'significant improvement in intervention units *and* considerable generalisation of effect to other teachers' lessons'.

5.6 Additional methods

A number of additional methods were employed in the evaluation process. Among these were a daily self-evaluation of the students (see unit outline in table 1) and comments on social behaviour and work attitude in the report cards. Video recordings intended for behavioural analysis were also collected but turned out to be an unsuitable method for this experiment (see section 8), and were therefore discarded during the intervention phase.

Further details on the additional methods shall be omitted in this publication due to restricted space.

6. Results

The total number (N) of participants can be found in table2. Percentage is shown in brackets.

Table.2: Number of participants (N), percentage in brackets

	experimental group	Control groups		total total
		Special Ed students	regular school students	
students	34 (9,9)	115 (33,5)	194 (56,5)	343 (100)
parents	34 (15,7)	91 (42,1)	91 (42,1)	216 (100)
teachers	7	11	6	21
classes	4	11	9	24

Again, only the questionnaires were conducted with all groups, all other methods were only used on the experimental group.

6.1 Interviews

Due to restricted space, only a representative selection of statements can be included in this paper.

Outcome of interview-I:

Intervention related changes in the students as a group and as individuals

- Students became more active and involved in the lessons.
- Attention span and motivation grew.
- Cooperative interaction increased.
- Group communication became more effective and orderly.
- Quiet students contributed more to the class action and shared their ideas.
- Endurance and frustration tolerance improved in most students.

Strengths of the approach

- It is actually fun and at the same time effective.
- Literally *every* pupil – and even their teachers and parents – can profit from it.
- It does not require special material, locations, extra lesson time or other conditions a school would have trouble providing.

Weaknesses of the approach

- The structure of the activities needs to be transparent for students. Else, they 'get lost' in a freedom of choice and space they are not used to – and create chaos.
- Interested teachers will need theoretical and practical training to master the approach effectively.

For a broad implementation of the approach, teachers rated the following as vital:

- A certain amount of theoretical and practical instruction for those teachers interested
- The support of the school administration

In addition, the following were considered helpful albeit not truly essential:

- A network of active colleagues
- Written out instructions for the activities
- A somewhat flexible time schedule

Outcome of Interview-II:

Further development of the changes reported in Interview-I

- The general social climate among the students improved.
- Communication is more open and positive.
- The project's positive effects remained at a constant level.

Did teachers continue to practise the approach?

> *"No, I didn't know how to".*
>
> *"Yes, in physics and sports. The approach suits me, so I found it quite easy".*

6.2 Questionnaires

A total of 1157 questionnaires were returned, digitalised and statistically evaluated using Excel and SPSS.

In neither sub group (students, parents or teachers) within the experimental group did the comparison between t1, t2 and t3 reach a significant level. Equally small were the differences between the experimental and the two control groups, although in one index (PSA) in the teachers' questionnaire, the experimental group had a tendency (p=,091) towards higher results than the control group b with regular school students.

6.3 Parents' feed back

Of the 34 parents who were sent the letters after the end of the intervention, only 15 returned them, some of them left blank.

Have you observed any changes in your child during the past six months? If yes, please state of what kind.

Table 3a: Parents' feed back, question 1

Parents' answers	Counts of answers
Sometimes	1
Not really. S/he was just as always.	2
No.	7
No answer	5

Do you have any other feed back to this project?

Table 3b: Parents' feed back, question 2

Parents' answers	Counts of answers
We always welcome activities and projects that improve the social climate.	1
It was a lot of fun.	1
The assignments were sometimes difficult.	1
No.	7
No answer	5

6.4 Students' feed back

To question (a), what students have learned in this project, answers of 31 students were collected. Following are the answers in summary and how often they were stated (max. 1 count per topic and student):

Table 4a: Students' feed back, question 1

Students' answers	Counts of answers
I / We...	
did [certain adventure initiative game].	14
learned a lot about [the subject].	12
had fun.	10
experienced and saw the benefit of team work.	7
helped each other.	5
did team exercises.	2
took responsibility for each another.	2
practised working independently.	2
learned a lot [without further specification].	2
were allowed to experiment a lot.	2
were allowed to make our own decisions.	1
interact more respectful.	1
learned a lot about our behaviour in class.	1
learned to be open to new experiences without being scared.	1

Question (b): Should lessons be conducted like this more frequently?

Table 4b: Students' feed back, question 2

Students' answers	Counts of answers
Yes	28
No.	2
Don't know.	4

6.5 Individual goals

Table 5 provides a list of the 13 individual goals set by the teachers for selected students, as well as their ratings.

Table 5: Individual goals and teacher ratings

Student + individual goals	0	1	2	Comment
Student A				
improve concentration span	X			For this reason, student A has been in behavioural therapy for quite some time.
increase endurance			X	
reduce lack of sense for personal space and boundaries		X		
Student B				
develope initiative			X	Student B is an autist.
learn to share ideas	X			
reduce oppositional behaviour			X	
Student C				
mehr Selbstbewusstsein, seine eigenen Ideen bzw. Vorstellungen zu artikulieren			X	Student C has a strong case of dyslexia.
reduce lethargy and increase level of activity and initiative			X	
Student D				
develop more team spirit		X		Student D shows a high level of aggressive social behaviour, physical restlessness and a short attention span.
improve ability to concentrate	X			
increase endurance		X		
Student E				
improve frustration tolerance		X		
Student F				
improve frustration tolerance		X		

0 = no significant improvement

1 = significant improvement in intervention units *without* generalisation of effect to other teachers' lessons

2 = significant improvement in intervention units *and* significant generalisation of effect to other teachers' lessons.

Of 13 goals, three were rated as *no significant improvement*, five showed *significant improvement in intervention units* but no general effect, while in another five goals, students had shown *significant improvement in intervention units* and *significant generalisation of effect to other teachers' lessons.*

A full report and unabbreviated results of all methods can be obtained from the authors or in Hildmann (in review).

7. Implications

The evaluation of the interviews indicate clearly that employing adventure initiative games in regular school lessons has a positive effect on several social and personal competences in students –

cooperation skills, effective group communication, endurance and frustration tolerance, to name but a few. This covers short term as well as medium term (six months follow-up) improvement.

Not all students were capable of reflecting on their own development, but those who were, made statements that supported the teachers' judgement.

Considering the choice of particularly 'difficult' students for the *individual goals*, the ratio of improvement is satisfying.

In the teachers' point of view, initiative games can be connected to curriculum contents with little or no demand to material, locality or time budget. Also, all teachers agreed that the approach should be implemented more broadly in schools. Yet, to achieve this, some practical and institutional conditions would have to be met as well as suitable training courses administered.

According to their feed back sheets, parents did not take much notice of their kids' development. This may have a simple reason: It could be argued that the students' increase in competences is *context based*, i.e. restricted to school lessons and interactions. This hypothesis might be supported by the fact that this is where the external influence (i.e. the intervention) took place while the students' family life was deliberately left untouched. This question however would have to be investigated in further research.

8. Methodological considerations and proposition

It is unfortunate, that the questionnaires did not yield any better results, but considering the following factors, this is not surprising:

- Many participants of the study (students *and* parents!) have a poor level of written language comprehension. So, it has to be expected that an uncertain number answers are more or less faulty.
- The items in the questionnaire had to be relevant to the students' lives and able to alter significantly within six month of regular life and school year. Arguably, this was not achieved.
- The intervention reached the students at minimum level, within regular lessons and without fancy material or spectacular outdoor activities commonly associated with experiential education.

We therefore conclude that questionnaires, multiple-choice or other, were an inefficient and inadequate method for this study.

Figure 6: Mobile device based games can be used to assess attitude and behavior

As mentioned in section 5.6., the video recordings intended for behavioural analysis also turned out to be a poor method for this experiment: The video camera could not sufficiently be moved and turned during lessons, thus missing relevant parts of the students' actions. Also, its presence was not received well by the students and induced interference behaviour such as posing in front of or hiding from the camera. For these reasons it was decided to discard this method in later intervention methods.

The authors suggest that the identified shortcomings could be partially circumvented by the use of electronic assessment mechanisms. The second author has recently presented work that uses mobile device based games to assess and evaluate the players (Bitterberg/Hildmann/Branki 2008;

Hildmann/Boyle 2009) without having to rely on rigid and intrusive observation devices such as a sturdy video camera used in the study described above. Nowadays, high-performance recording devices are embedded in standard mobile technologies like mobile phones or laptops. While user consent for this recording is of course required, the inconspicuous inclusion of the camera into the phone removes the reported uneasiness of the subjects during the recorded initiative games. Additionally, the quality (especially for audio recordings) as well as the identificability of individual subjects is much easier as the dominant recording will be of the person carrying the device.

The methods would have to be hand tailored to meet the specific needs of the actual needs of the practitioners – teachers, social care takers and the like – and the study they are needed for. This requires a close cooperation of a computer scientist and the practitioner. If this is respected, a variety of complex implementations are achievable, as has been demonstrated recently by the second author (Hildmann/Uhlemann/Livingstone 2008 and 2009).

9. Conclusion and outlook

The findings suggest that the examined approach does in fact promote social and personal skills in students already after a brief intervention phase and despite restraining conditions. We therefore conclude that it is (a) possible and (b) successful to use adventure initiative games in a regular classroom setting in order to promote social and personal competence. A broad implementation in schools is possible if certain organisational conditions are met.

Further research might investigate long term effects as well as the influence of teacher personality and other factors constituting the Experimental Teaching Approach rather than 'plain' adventure initiative games. The attempt to draw a straight line between these two will have to be made.

Regarding study methods, future scientists investigating social skills and behaviour might be advised to make use of the presented by technological innovations in the electronic sector.

From a practitioner's point of view and to aid the implementation of adventure initiative games in the classroom, a teacher training course needs to be designed, a compact handout written and a selection of activities and lessons made available for easy copying. All of these have already been accomplished by the authors. What interested teachers might need to do in addition to completing a training is to create a platform for exchange of thoughts, experiences and successfully conducted lesson outlines.

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Videogames and Education: a First Empirical Research in the Basque Country

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Abstract: In this paper we will present the main results of a research project about "videogames and education" carried out in the Basque Country in 2007-2008. In the first part of the paper, we present the results taken from the first research project carried out in the Basque Country in order to analyze the use of videogames. 435 teenagers from six different schools between 11 and 18 took part in the survey in June 2008. In the second part of the study we put forward a suggestion to work with videogames at school. We have tested this suggestion in autumn 2008 in two schools from the Basque Country. We have worked on a few games (*GTA-Vice City*, *Bully*, *GTA-San Andreas* and *Contra viento y marea*) with two main aims: to show teenagers to do a reflexive-critical reading of the screens that have become so important in their everyday life, and to explore the positive potential of videogames (especially serious ones). This paper also presents the outcomes of these experiments.

Keywords: Videogames, education, research project, Basque Country

1. Introduction

Taking into account the research projects about "videogames and education" (Gee 2003, Gros 1998, 2004 and 2008, Prensky 2001 and 2006, Shaffer 2008) an empiric research to analyze the phenomenon of the videogames has been developed during 2007-2008 in the Basque Country, the first one like this in this country. The research has got the financial assistance from the University of the Basque Country, the Basque Studies Society and the Basque Government. The research had two main aims: on the on hand, to carry out a survey on the use of videogames; and on the other hand, to make a proposal to develop video games at school and to prove that proposal.

2. The first Basque survey to analyze the use of videogames

The first goal of our research has been to make a first sociological-quantitative approach to the phenomenon of videogames in the Basque Country. For that, we prepared a survey that 435 teenagers between the ages of 11 and 18, answered in six different schools in June 2008. The main questions of the survey were: how many teenagers play video games in the Basque Country?; what age do they start playing at?; how often and how long do they play?; what are their favourite video games?; what is the relation between playing video games and other factors such as school results, leisure...? The main characteristics of the sample are in Table 1 (since the sample is not random, we will not present the significance level).

Table 1: Main characteristics of the sample

	In public schools	In private schools	Total
Boys	133	76	209
Girls	135	89	224
Total	268	165	433

According to this research, most young people in the Basque Country use video games, almost 80% (79.1). This fact is similar in the rest of industrial and post-industrial countries. Among boys, 97% have answered that they use video games, for just 62% of girls. Therefore, there are genre differences in this matter as well, as it has been stated in the rest of researches. In terms of age, the very young people are the ones who use them most (every 11 year-old kids play video games!). The use of videogames goes down as these youngsters are getting older. Several reasons have been mentioned to explain this. It might be because older teenagers have less spare time to spend on video games (a hypothesis mentioned in other researches) or it may be because this phenomenon is stronger among new generations, and consequently, these generations may keep on playing when they are 20 years old... We will have to observe what the tendency is in the years to come.

On average they start playing at the age of eight, the boys a bit earlier (when they are seven years old) and the girls a bit later (when they are nine years old).

In terms of frequency, the distribution of the answers is quite different and regular: those who play once a month, once a week, two or three times a week and everyday are divided in a quite similar way. Indeed, as it happens with most of the questions, there are differences between boys and girls; boys play more often. And the age is also a discriminatory factor, since the youngest are the ones who play the most as we have mentioned before (anyway, there are more 18 year-old youngsters who play everyday than 11 year-old kids).

Table 2: Frequency of the use of videogames

	Once a month	Once a week	2-3 times a week	Everyday	
Girls	47.7%	25.8%	16.1%	10.3%	100%
Boys	11.2%	22.8%	37.9%	28.2%	100%
11 year-old	17.1%	19.5%	48.8%	14.6%	100%
18 year-old	40.5%	4.8%	26.2%	28.6%	100%
Total	27%	24%	28.7%	20.4%	100%

When we ask them how often they play, the great majority has answered that they play between 0-2 hours on school days. On holidays, however, a big group has answered that they play between two and four hours, and a small but significant group more than four hours (90% of these youngsters that can be defined as “compulsive players” are boys).

Table 3: How much they play

	0-2 hours	2-4 hours	More than 4 hours	
School days	96.3%	3.4%	0.3%	100%
Holidays	61.5%	28.8%	9.8%	100%

When asking about their favourite video game, they have chosen *Pro Evolution Soccer*, one of the best-known football simulators. *Grand Theft Auto* (*GTA*) was in second position (it is remarkable that this game is meant for people over 18 and teenagers between 11 and 17 have chosen it in second position as their favourite video game). These are the rest of the video games chosen by the youngsters successively: *Mario Bros* (platform-labyrinth), *Sims* (simulation), *FIFA* (football), *NBA* (basketball), *Need for Speed* (races), *Sing Star* (simulation-music), *Gran Turismo* (races), *F1* (races), *Pressing Catch, Tekken, Counter Strike, Medal of Honour, WWE, Call of Duty, Dragon Ball, Good of War* (fight-war-shoot), *Eye Toy Play, Wii Sports* (sport)...

We have also asked them if they use videogames meant for people over 18, and, as the answers to the previous question showed, nearly the half (46%) has answered yes (73% of boys and 20% of girls). Among 11-12 year-old kids, one out of three (27%) admits using videogames, such as Grand Theft Auto, meant for people over 18.

In the second part of the survey, we have analyzed whether there are differences or not between video game players and non-players in several aspects: school results, interest and use of new technologies, leisure habits... In terms of school results, there are no significant differences between players and non-players, and if there are, they are slightly favourable to players (they get better results). The average of bad results goes up with the 10% that play more than four hours on holidays.

Table 4: How would you evaluate your school results?

	Non-players	Players	Heavy players
Very bad	1.2%	1.5%	2.9%
Bad	6.2%	5.3%	14.7%
Regular	30.9%	27.2%	26.5%
Good	37%	41.4%	35.3%
Very good	24.7%	24.6%	20.6%
	100%	100%	100%

Regarding to leisure, against people’s thoughts, video game players practice sports more often than non-players. But, on the other hand, they share less time with friends and they read less. In this case, the prejudices are confirmed, although we must know that the differences are not too big.

Table 5: What do you do in your free time?

	Sport			Stay with friends		
	Non-players (N-P)	Players (P)	Heavy players (H-P)	N-P	P	H-P
Never	10.1%	4.1%	2.9%		0.6%	
Seldom	21.5%	15.1%	5.7%		3%	
Sometimes	34.2%	29.3%	34.3%	16.5%	22.8%	31.4%
Often	34.2%	51.5%	57.1%	83.5%	73.7%	68.6%
	100%	100%	100%	100%	100%	100%

Table 6: What do you do in your free time?

	Read			Be in front of the computer (Internet, messenger, chat etc.)		
	N-P	P	C-P	N-P	P	H-P
Never	15.9%	22.6%	25.7%	1.2%	6%	2.9%
Seldom	41.5%	42.3%	42.9%	12.3%	22.9%	5.7%
Sometimes	35.4%	28%	22.9%	42%	35.8%	40%
Often	7.3%	7.1%	8.6%	44.4%	35.2%	51.4%
	100%	100%	100%	100%	100%	100%

In the case of compulsive players, they do more sport than any other, but they share less time with their friends, they read less and they use more the computer.

In terms of the interest in computer science and new technologies, in a scale from 1 to 4 (1 meaning I do not find them interesting and 4 meaning I am very interested), the interest rate is 3.11 for non-players (between 3-quite and 4-very interested), 3.37 for video game players and 3.60 for compulsive players.

Regarding to the use of new technologies, the data from our survey do not confirm the prejudice or myth: the video game player is not a freak who is addicted to new technologies, at least not more than other youngsters from the same age that do not play video games. Anyway, there are some exceptions. For instance, compulsive players use more internet than the rest.

Table 7: Which technologies do you use from this list?

	Internet			Film videos and hang on YouTube or similar web pages		
	Non-Player (N-P)	Player (P)	Heavy Player (H-P)	N-P	P	H-P
Never		3.8%		33.3%	38.5%	25.7%
Seldom	4.8%	10.6%	5.7%	21%	19.7%	25.7%
Sometimes	27.4%	22%	11.4%	32.1%	21. 8%	25.7%
Often	67.9%	63.6%	82.4%	13.6%	20%	22.9%
	100%	100%	100%	100%	100%	100%

Table 8: Which technologies do you use from this list?

	A web page, create, hang and keep a blog or a fotolog			Electronic mail (email)		
	N-P	P	H-P	N-P	P	H-P
Never	36.1%	44.8%	40%	9.8%	25.4%	17.1%
Seldom	15.7%	19%	20%	26.8%	27.5%	31.4%
Sometimes	18.1%	18.4%	17.1%	31.7%	28.7%	25.7%
Often	30.1%	17.8%	22.9%	31.7%	18.3%	25.7%
	100%	100%	100%	100%	100%	100%

3. A suggestion to work with videogames at school

As the second empiric purpose of our research, we wanted to raise and test an experiment-workshop in order to use and work on video games at school. These are the aims of the attempt:

- To get over the division between the new generations and the school. In our case, we wanted to suggest a little attempt to introduce the "screens" (basic elements in the everyday lives of kids, teenagers and youngsters) at school.

- To start developing a reflexive and critical look of video games ("learn to watch the screens"). In fact, we have learnt how to read, analyze and value the best written texts in the last centuries, and now it also seems necessary to learn to analyze these new "texts". As the cinema and/or television have been used to learn in the audiovisual society (in two senses: "learn to watch the screens" or "use the screens to learn"), the same thing should be done now with the video games, since they can help to achieve the digital alphabetization.
- To show that interesting things can be learned thanks to the new technologies, the screens and, in our case, the video games ("use the screens to learn"). For instance, taking into account that motivating students is one of the main challenges that education has to face up, we wanted to prove how video games can help achieving or growing the motivation (by promoting students´ participation, by using images, by focusing on the game, by making use of a resource which is usual in their everyday life out of school, by giving the chance to try and simulate different roles, by developing the imagination…).
- In order to achieve these purposes, we began preparing attempts focusing on the patterns mentioned before. We first prepared an outline for ourselves:

1. A thinking about controversial video games that promote counter values such as violence, sexism, racism, etc.
2. Play "serious video games", to see that there are different types of games, as there are also different types of films or TV programs.
3. Discuss about what has been done.

Figure 1: Video games at school. the outline for the experiment

After getting this outline ready, the next step was to choose the games. For the first part, we chose *Grand Theft Auto* (*GTA*) and *Bully*, because in our opinion they fulfilled very well our objectives: in the game *GTA* the player has to carry out some "missions" ordered by the video game and we can define most of those duties at least as "polemic; the video game *Bully* is located in a school, and the main character will have to use violence against the rest of students, so it is an excellent game to talk about bullying.

But at the same time, we realized that we could not fully take advantage of one of the main attractiveness of video games, the interaction and players' participation. In fact, the last version of the game *GTA* (*GTA-4*) and *Bully* can only be played with game consoles by now and there are no consoles at schools. Therefore, we decided to use videos in the first part of the experiment (a video recording of us playing or records taken from *YouTube*) and for the second part we chose games that could be played with computers: *GTA-San Andreas* (a video game classified as polemic), *Against the odds*, *Contra Viento y Marea* in the Spanish version (a serious game prepared by UN that gives the chance to experience the immigrants' situation), and *McDonalds* (a serious and critical video game that aims to raise a reflexion about rubbish food and companies). So this is the last outline:

1. Introduction.
2.To watch parts of the video games.
    2.1.The video game *Grand Theft Auto-4*
The video game *Bully*
3. To play video games.
    3.1.The video game *Grand Theft Auto–San Andreas*.
    3.2.The video game *Contra Viento y Marea*.
    3.3.The video game *McDonalds*.
4. To discuss, first in small groups and in big groups afterwards, what we have done.

Figure 2: Video games at school. the outline for the experiment

With this outline, we have carried out four sessions in the autumn 2008. In the first two, we spent an hour in each one; with a class coursing Primary (14 years old) and another one in the High School (16 years old). Taking into account the time we had at our disposal, we recorded a five minutes long video of the videogame *GTA-4* with some parts that we found interesting: car thefts, fights, sexist treatment of women... We used *YouTube* to watch another five-minutes-long video of the game Bully. Indeed, players hang many games on the net and they can be useful to get a first idea of the video games. After watching the videos, we started the unit of games with *GTA–San Andrea*s (you must previously load the game in all the computers) and next we played through Internet the other two (contravientoymarea.org and molleindustria.org/mcdonalds).

In general, it was very successful, as we expected: the pupils were very motivated with the experiment and it was useful to talk about video games (polemic attitudes and values shown in some video games, the differences among video games...). We asked three short questions to the teachers and the ICT manager that watched the experiments: 1. What do you think of the experiment? 2. In your opinion, what are the opportunities and advantages of this sort of experiments? 3. And what are the difficulties? And the appraisal was very positive; they found it a very interesting suggestion to "work on ethics, talk about values, think of what they see..." For coming sessions, teachers, ICT managers and we noticed the need to reconsider two matters: on the one hand, and regarding to the age, we realized that the experiment had better results with older students in terms of the goals, methodologies and games suggested by us; on the other hand, and in terms of time, one hour was too short to do everything we wanted to do.

That is why, in the third and fourth sessions we worked with students from the High School (16 and 17 years old) and we got to have two hours for each session (that was our aim for the first sessions, but we did not get it). Thus, we could prepare the experiments better and more at ease. The students, for example, answered the following questionnaire after watching and playing each video game:

.1. What do you think of the first video (*GTA-4*)? What kind of attitudes, people and values are shown? How are the women treated? (what subject is the woman related to?)
2. What can you say about the second video we have seen (*Bully*)? Have you noticed any contradiction between what school and family say about bullying and this video game's discourse?
3. The video game *GTA-San Andreas*. What would you say about this video game? What kind of attitudes, people and values are shown?
4. What is your opinion about the game *Contra Viento y Marea*? What is the subject? And the last goal of the game? Have you enjoyed it? Do you think it is has something to do with what happens in real life?
5. What is your opinion about the video game *McDonalds*? What is the subject? And the last goal of the game? Have you enjoyed it? Playing the role of the boss of the company, what difficulties have you found? And how have you solved those problems? What is the aim of the company?
6. Do you notice any difference between these games that we have seen or played? What are those differences?

Figure 3: Video games at school. the experiment. the questionnaire for students

At the end of these third and fourth sessions, we also played a role-playing game about the opportunities and risks of video games. Half of the class had to play "the role of the parents that only see the bad side of the video games", and the other half, "the role of the parents who think that the video games can also have their good side". Each group had to find ten arguments to reason their position. These are some arguments that came out against the video games: "it is addictive; they are often violent; they throw us out from reality; there is business behind, they create stereotypes; it is bad for the sight; they show what they want". These are some other arguments that came out in defence of the use of the video games: "they are good pastimes; they can function as nurseries (parents can use video games to keep their children amused instead of being with them); some video games are educative; it is a way to spend time with friends".

4. Conclusions

The "screens" (with video games, but also Internet, television, mobile phones, cinema…) have a big importance in the socializing process of the new generations, and it is necessary to analyze in a reflexive, critical and scientific way what is happening in that relation.

The first goal of our research has been to study how the Basque adolescents are using digital games. We can say that according to our survey, at least in the field of electronic games (and probably in most of the fields) the Basque Country is completely integrated into the Global Consumer Society of our times. Most of youngsters between 11 and 18 play video games (80%). They start at the age of eight. Boys play more than girls and 11 year-old kids play more than 18 year-olds. Their favourite video games are those chosen by kids, teenagers and youngsters all over the world: *Pro Evolution Soccer, Grand Theft Auto* (a game meant for people over 18), *Mario Bros, Sims, FIFA, NBA*... (related to this list of favourite video games, we have to mention the risk of homogenization or cultural similarity that this and other similar phenomena mean). Regarding to the addiction risks that video games can create, only 10% of the participants are part of the group that play video games maybe too much (that is the percentage of the students who have admitted to playing more than four hours a day without school). But, in general, the stereotype of a freak as "a weird young boy who shuts himself in the bedroom all day" is not confirmed. Most video game players have similar school results to those who do not play, similar leisure habits, a similar use of new technologies... Anyway this is logical, since the great majority (80%) has answered that they play video games. The only noticeable differences are between compulsive players and the rest; the first group gets worse school results, they read less, they share less time with their friends...

Therefore, the simple act of playing video games can not be considered the source of all problems, since it has become an important and usual phenomenon in the leisure of our times. Determine the researches and analysis, taking into account and distinguishing how much and what games they play, is what should be done. In fact, we can not say whether playing video games is good or bad. It is clear that we can not talk in general about television, because there are programs to just pass the time, programs that are inappropriate for kids, and educative programs. And, the same way, there are "good" video games; video games that promote some values defined by the society as counter values and therefore not recommendable for youngsters, etc. And the same thing can be said about the time spent on playing video games. We can not over generalize and think that the time spent on playing video games is wasted time. To begin with, some people, especially kids and teenagers, have the opportunity (or, at least, they had until not so long ago) to "waste their time" (ideologies such as "time is gold" and "time can not be wasted" grew stronger with the industrial modernism and, as any other ideologies, they can be questioned). Secondly, it is not the same playing an hour or playing four hours a day. Thirdly, we have to take into account what the kids would be doing otherwise; it may be better playing an educative video game than watching rubbish television. And finally, as we have seen, playing video games is not a mere entertainment or pastime.

The second goal of our research has been to design and to check some sessions to work this phenomenon from a educational point of view. In our opinion, they have been useful to prove that these sorts of activities can function well. The teenagers that have taken part in the experiments have had the chance to talk and think about video games. They have also been able to see that there are different kinds of video games: they promote those defined as "counter values" by the society; and those that, apart from offering pastime and entertainment, are useful to think and learn about problems of our times. Precisely, the discussion about "sexism" worked out very well in these four sessions: after watching a visit to a striptease local in the game *GTA-4*, especially girls criticized very hard the games that show girls as "sex-machines"; interesting and burning arguments about this subject rose among boys and girls. Apart from that, students who took part in these experiments thanks to the video games have also spoken about violence, globalization, the difference between the real and virtual world… And we have also been able to see through these experiments how serious video games are not always boring: although students who took part in the experiments have said that commercial games are better in terms of graphics and fun, they have admitted that the serious video games we suggested (*Contra Viento y Marea* and *McDonalds*) were good and amusing. We have noticed that what they said was really true, since we have seen them fully motivated in the sessions, and many of them have asked us the Internet address to be able to keep playing at home.

In terms of difficulties, we would remark these ones: (1) The youngest did not understand the goal of the experiment with the video games and methodologies we suggested. There is the risk that some students take these experiments as a break. We see two solutions to the problem: on the one hand, to reconsider the proposal (the games, methodology…) to work with younger students. On the other hand, as we did in the third and fourth session, make clear before starting that "although these experiments are not theoretical, they are not mere pastime and entertainment either. The goal is to analyze the phenomenon of the video games. Therefore, students will need a notebook or a paper sheet and a pencil or a pen in order to write". Moreover, after watching each video or after playing each video game, we gave them some time in order to answer individually the questions we handed out (they had also read the questions before watching the video or playing the video game in order to know what they had to focus on). In the last part of the session, they first discussed those questions among them in small groups, and then in big groups with us coordinating. (2) We think that the school, as an institution, is not ready to suggest this kind of experiences yet. One problem, for example, lies in the infrastructure: having two computer rooms (each of them with 20 computers) in a school with 1,000 students is not probably enough; moreover, in one of the schools the computers did not have a DVD reader, and instead of playing the game *GTA-San Andreas*, we had to show it in video. Another problem lies in the teachers. In general, we have seen lack of interest on their part; some of them preferred to do other things instead of watching the experiment. And only two out of five teachers answered the questions we raised in order to discuss the experiment. One reason may be lack of preparation: because they probably find themselves far from that reality (one teacher admitted that he did not use the electronic mail), because they have not seen the advantages of working on this kind of matters… Related to this, the organization of the schools and the education system may be another problem: a school calendar that is already quite overcharged from before, old-fashioned curriculums, demanding too much to the school and teachers (now they must be knowledgeable in thousands of new fields: emotional intelligence, new technologies, values, sex, drugs, sustainable development…), etc.

Anyway, the research project offer us a first radiography about the “digital games phenomenon” in the Basque Country, and it is useful to understand that it can be very interesting to think about the possible educational work with electronic games in the two senses we have mentioned: “learn to see the screens” and “use the screens to learn”.

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The Motivational Power of Mini-Games for the Learning of Mathematics

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Abstract: Computer games are part of many children's daily life. Playing computer games is done in leisure time. Nevertheless, there is also a growing interest in serious games, games that are made to learn or to train a skill that is useful outside the game. In this paper we describe the results from a six-week pilot-study on the use of the mini-game 'Crack the Number Safe' that is designed for exploring divisibility. We address the following questions: What are characteristics of mini-games like 'Crack the Number Safe' that motivate students to play? How gamelike are these games? What do individual students do and learn when they play 'Crack the Number Safe'? Outcomes show that children experience 'Crack the Number Safe' as a game. Most children like to play this game more than once. They play the game in leisure time. From the analysis of the 'think aloud' protocols recorded during game-play it is clear that children are able to use their prior knowledge about division and that in some cases they discover new division rules.

Keywords: Game-based learning, mini-games, mathematics education, division

1. Introduction

Numerous studies show that games can engage students in learning activities. These studies mostly focus on 'big' games, like MMOG (massively multiplayer online games, e.g. see Copier 2007) and less on the use of online casual games or mini-games (Juul 2007). Online computer games have gained in popularity along with the increase in public access to broadband networks. It is known that especially younger students (aged 8-12) often play online casual games on game portals like addictinggames.com and funnygames.com (ISFE 2008; Rohrl 2009; McFarlane 2002). For all types of educational games 'big' or 'mini' we can state that for these to be successful in realizing learning effects it is important that the player is and stays motivated to play. The motivation is influenced by what is called the 'flow' of the game (Csikszentmihalyi 1990). This is the balance between skills and challenge. If this balance exists the player will get better and better and will be able to meet bigger challenges and in this way get more and more involved in the game and reach a state of 'flow'.

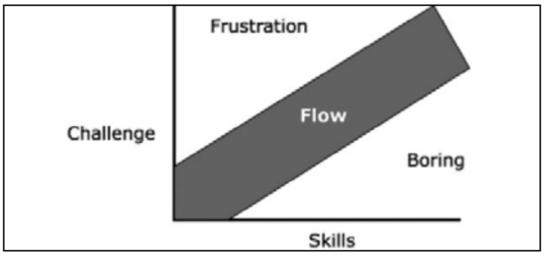

Figure 1: The flow according to Csikszentmihalyi (1990)

From research (Zagal and Bruckman 2008; Salen and Zimmerman 2004) we know that characteristics like goals, rules, narrative, game level(s) and the possibility of user-generated content have a strong influence on the gameplay and the motivation of players. These characteristics will therefore determine whether or not players keep playing and – for educational games – whether or not players will learn something.

We discuss a small scale qualitative study on motivation and learning effects of playing an educational mini-game 'Crack the Number Safe' that is designed for exploring division.
In the game research we conduct we address the following three questions:

- What are characteristics of mini-games like 'Crack the Number Safe' that motivate students to play? How gamelike are these games?
- What do individual students do and learn when they play 'Crack the Number Safe'?
- How can a teacher profit from the use of mini-games and integrate these in their regular math lessons?

In this paper we focus on the first and second research question.

2. Mini-games

Large games like MMORPG (role playing), games like Simcity or the Tycoon series and games like Civilization provide a rich environment in which players learn and use skills to solve complex tasks. Players analyse, plan, collaborate and emerge themselves in the rules and community of the virtual worlds of the game. Numerous research shows that this contributes to learning in general (Squire 2002; Copier 2007; Kafai 1996).

Some authors like Prensky (Prensky 2000; Prensky 2005) have argued that only this type of large games is valuable for learning. We don't agree with this point of view. Mini-games can contribute to learning as well, but – and in this respect we do agree with Prensky – they contribute to other types of learning, they address other skills. Some studies for example show opportunities for learning with mini-games in the area of mathematics education (Alexopoulou 2006; Barmby 2009)
With respect to their use in education mini-games have the advantage that they are 'everywhere', they are online and often for free, their use only requires a computer or any handheld device with an internet connection. Furthermore there is an advantage in that they are 'mini'. Mini' in this context means three things:

- *Dimensions*. The mini-games fit within the window of a browser like Internet Explorer, Firefox, etc. The dimensions are less than 1500 pixels wide and less than 1000 pixels high. Sometimes the whole screen is used for the mini-game. It is questionable if a fullscreen game must still be called a mini-game;
- *One episode*. The mini-game is restricted to one episode, scene or image, with a restricted 'rule-set'. This does not mean that there is no animation or that the game does not contain a certain amount of sub scenes or even levels. Having one episode within the game means that the user easily grasps how to play the game. There is no steep learning curve, neither does learning to play require an investment of many hours. This is an important motivation for playing mini-games and it makes them easier to use in education;
- *Short period of playing*. The playing time is restricted. Often a mini-game can be played within a maximum of about 10 to 15 minutes. This means that the player can replay the same game often (or play a number of levels) . It is also possible and easy to switch from mini-game to mini-game within one session. In educational settings the restricted playing time is an advantage.

3. Mathematics education

In Realistic Mathematics Education (RME) the focus is on learning with understanding, rather than on learning to follow procedures (Gravemeijer 2004; Drijvers 2004). In a process of 'guided reinvention' (Freudenthal 1983) students construct a meaningful and coherent network of mathematical concepts, procedures strategies and their relations. Construction of knowledge is not merely an individual process, it is part of what happens in the classroom as a community of practice (Wenger 1998). Interaction is therefore an important aspect of RME. Besides social interaction, interaction with tools – models, representations, simulations etc. – is crucial for the learning of mathematics (Van den Heuvel Panhuizen 2003; Treffers 1987; Gravemeijer 1994). Tools that allow students to generate their own productions and constructions contribute to students deeper understanding (Gravemeijer and Drijvers 2004). This type of tools can often be designed as games. A large collection of mini-games dedicated to the learning of mathematics and fitting the RME principles has been designed over the past 10 years (Jonker and Wijers 2008). These mini-games (also called Th!nklets) are presented online on a dedicated free game-portal (http:// www.thinklets.nl). Web statistics show that Th!nklets are played outside of classroom settings as well as during school hours. We see the most frequent use during after school hours between 4 and 8 pm (see Figure 2) .

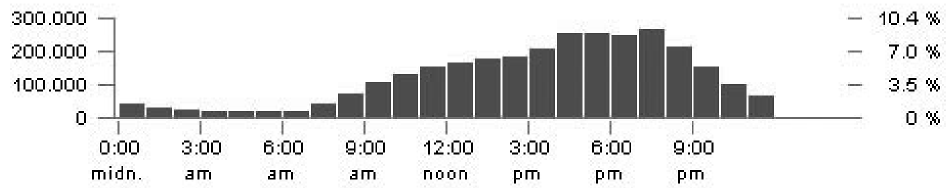

Figure 2: Average distribution of visitors of the dutch Th!nklets.nl over the day, recorded from 3 July 2008 to 7 May 2009

For quite a large number of Th!nklets we also have data from online surveys (Jonker and Van Galen 2004). These data give insight in the facts and figures of the players: their average age is 11 years; most players play the mini-games on their own; an online session has a mean duration of about 10 minutes. These data combined lead us to believe that Th!nklets are seen as enough fun by students to play after school and in this respect can be compared to casual mini-games on other web-portals.

3.1 Division

In mathematics education in primary school multiplication and division are important topics. Multiplication and division are part of the mathematics curricula all over the world. The way these topics are addressed as well as the subtopics that are included will differ. In the Netherlands multiplication and division tables as well as written calculation procedures for multiplication and long division are being taught. Factorisation and rules for divisibility are not part of the regular core curriculum for primary schools .

It is evident that automated and flexible use of knowledge of basic facts and skills in the domain of multiplication and division contribute to a better understanding of other, related, mathematical topics. Flexible knowledge can only be formed when the learning process focuses on understanding instead of on memorizing facts and procedures.

We are interested in finding out whether students are able to use their knowledge of multiplication and division in a flexible way in order to factorize numbers and whether they are able to discover or become aware of certain divisibility rules while playing a mini-game specifically designed to address divisibility.

4. The mini-game ‘Crack the Number Safe’

To address division a set of mini-games was created, as part of the bigger collection of Th!nklets. The mini-game 'Crack the Number Safe' is part of this collection. We chose ‘Crack the Number Safe’ to be studied more thoroughly for two main reason. The first reason is that this mini-game is an example of a typical division task that is accessible for students in a range of grade levels (see description in Figure 3).

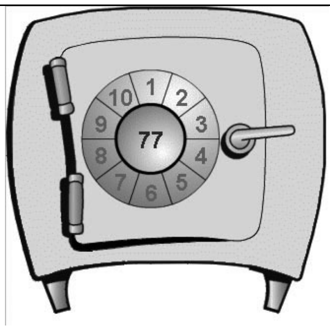	The task of this mini-game: Which numbers along the circle can be used to divide (factor) the central number? Highlight all the possible numbers by clicking on each of them. When you are ready you can click on the handle. The safe will open when you have selected all factors correctly. You can chose to play with a number below or above 100 in the middle

Figure 3: Th!nklet ‘Crack the Number Safe

A second reason for choosing this specific mini-game is its popularity as a game. Web statistics show that it ranks second in the Top 5 of the most popular Th!nklets that deal with divisibility.

5. The mathematics in 'Crack the Number Safe'

As described in Figure 3 the task in the mini-game is identifying all factors between 1 and 10 of a given number. The given number (The Safe Number) is either between 1 and 100 or between 101 and 999. This can be selected at any moment in the game. Numbers are chosen at random from the selected range. Students identify the factors by clicking on them so they get highlighted. This action can always be undone.

Two 'support' mechanisms are provided in the game: students can click the handle of the safe to get feedback on the numbers they have selected so far. If all factors are correctly identified the safe opens. If not, the number of factors that is correctly identified is given. Students have to interpret this feedback. For example "7 out of 10 factors correct' means that 3 mistakes have been made: either a number is incorrectly identified as factor or a proper factor has been overlooked. A calculator is available at all times. It is a special calculator that does not have a button for division. It can be used to multiply or to subtract.

Crack the safe is a suitable task for division since the following strategies may be used by the students to identify the factors of a given number are:

- using theirknowledge of the Multiplication Tables between 1 x 1 and 10 x 10;
- using divisibility rules;
- using other calculation strategies.

We expect students to use their knowledge of multiplications between 1 x 1 and 10 x10 to identify pairs of factors of numbers below 100. . If the number is the result of 6 x 8 then 6 and 8 are both factors.

We expect students to know and use divisibility rules for 5 and 10 (the products will end in a 5 or a zero) and maybe the rule for 2 (products ending in 0, 2, 4, 6, 8) including the names 'odd' and 'even'. Since divisibility rules are not part of the curriculum we do not expect students to know rules for the factors 3, 4 and 9. Of course 1 as a factor is a special case.

Furthermore we expect them to use other calculation strategies especially for the number > 100. They may use trial and error or a more systematic way of 'adding on' from a known produc. Splitting the number is also an effective strategy if it is done correctly (see examples in Table 1). We expect that not all students will know how to do this.

Table 1: Three examples of Safe Numbers with their possible solution: 42 and 81

42	We expect students to easily find 6 and 7 as a pair. They may know that 2 is a factor since 42 is even because it ends in a 2; they may not easily find 3 because 42 is 3 times 14 and 14 is bigger than 10. Adding on from 10 x 3 = 30 using 33, 36, 39, or splitting 42 in 30 + 12 and concluding that both 30 and 12 can divided by 3 are other foreseeable strategies.
81	Students may reason like this: 20 x 3 = 60, the remainder is 21, is this divisible by 3? Yes 20 x 4 = 80, the remainder is 1. So 81 is not divisible by 4. 10 x 7 = 70, the remainder is 11. So 81 is not divisible by 7.

We expect some students will discover and learn some new rules while playing the game. This could be rules like:

- If 9 is a factor of a number, then also is 3.
- If 8 is a factor of a number, then also are 2 and 4
- If 6 is a factor of a number, then also are 2 and 3 and the other way around.
- Even factors 2, 4, 6, 8 have only even numbers as multiples.

The observations will reveal what students actually do, which of these strategies they use, whether they use other strategies as well and how successful they are.

6. Research method

The research is a small-scale qualitative study. During a six-week period 18 students of grades 4 and 6 of a primary school in Utrecht (the Netherlands) were observed while playing 'Crack the Number Safe'. These students worked individually or in pairs outside their classroom with one researcher/observer present. The screen capture software 'iShowU' was used to tape all sessions. All mouse movements and clicks as well as all keyboard actions were captured, the webcam above the screen recorded audio and video of the player. All recordings combined can be reviewed in the same screen (see Figure 4).

The observer/researcher prompted the students to 'think aloud' and guided the process only if necessary Sessions had an average duration of about 15 minutes. During one session 2 to 6 different Safe Numbers were played. Background data on the players age, gender, grade level, average math grade, was collected as well.

Figure 4: Review screen of the tool iShowU (screen capture software)

6.1 Method of analysis

We follow the methodological ideas of developing a 'humble theory' (diSessa and Cobb 2004; Parnafes 2008), conducting a moment-by-moment analysis, zooming in on the fine details of the studied processes, rather than proving or applying a theory, the objective is to make theoretical innovations (see also Glaser and Strauss 1956).

Data were organised and analysed in two ways:

By student. In the analysis per student we focused on what students do and if they are motivated to play and on the math students used and learned (strategy use). The 'what students do' is related to the interaction with the game; The focus on the math shows the use and development of strategies and of understanding division. In this analysis we take into account their average math grade and also compare the data of the students from grade 4 with students from grade 6.

By Safe Number. Three groups can be distinguished:

- Numbers below 100 with only factors below 10
- Numbers below 100 with also factors above 10 (for example 84, 99 but also 72)
- Numbers between 100 and 1000

In the analysis we focused on which characteristics of each number students used, the results for that number (which factors were found and in what order, solution correct/incorrect) etc.

7. Results

We analysed the data of 18 playing sessions with individual students (see Table 2).

Table 2: Summarized data of eighteen sessions of playing 'Crack the Number Safe'.

Number of Safe Numbers per session	4.5 numbers
Mean playing time	16 minutes
Mean time per Safe Number	3.50 minutes
Mean time Low Number (0-100)	2.50 minutes
Mean time High Number (101-999)	4 minutes
Mean number of Handle actions per Safe Number	1.6 times

7.1 Results of students: game perpection and strategy use

A remarkable observation is that children showed a lot of mathematical activity that in many standard mathematics lessons would lead to remarks like 'stupid' and 'boring', but with 'Crack the Number Safe' we observed that children enjoyed the game. They all liked to keep on playing more numbers. The observers had to end the session in each case.. When asked afterwards if they liked the game all students said they did, of course this can be partly based on politeness.

In this mini-game it is important to work systematically. Otherwise students loose track of which factors they already checked. When we look at the data per student we notice that several ways of working systematically have been used:

- Checking factors in the order from 1 to 10. (A)

- First checking ‘easy’ factors: (1), 2, 5 and 10 (B) or pairs of factors below 10 (C). Then check the other factors either in order (A) or at random.
- No system (D)

From the data we conclude that which strategy is used, not only depends on the student, but also on the SafeNumber (see section 7.2). Very few students (3 out of 18) systematically check all factors in order. This are all boys from grade 6. The large majority of students use a mix of strategies B and C. Some of the students develop a more systematic way only after they have played 2 or 3 SafeNumbers. Only a small number of students (3 out of 18) seem to use no systematic strategy at all.

For checking whether a number is a factor of the Safe Number several strategies were used. Some of which are incorrectly expanded to numbers it doesn’t hold for.

- *‘Table jumping’*. Some children easily ‘jump’ through the products of Multiplication Tables to check for a factor. For example to check if 4 is a factor they jump along 4, 8, 12, 16. Sometimes they use bigger jumps like in 16, 32, 48, 64.
- *Check the last digit*. The strategy to make a decision depending on the last digit of the safe number works for 0, 5 and even numbers, but it does not work in all cases. For example '78 not divisible by 3 because 8 cannot be divided by 3' is not correct.
- *Remove the last 0*. This works with some numbers: ‘80 can be divided by 4 because 8 can’, but it gives a problem with other numbers, for example some children reason that 100 cannot be divided by 4 because 4 is not a factor of 10..
- *Splitting the number.* Splitting a number and check if a factor holds for both parts is an effective strategy. Although a number of mistakes can be made if the number is not split in an approriate way.
- *Using base10*. Especially for numbers below 100 (but sometimes also for the larger numbers) the base10 facts are used to split the numbers. 78 divided by 6 -> 10 x 6 = 60, and then check the remainder (28 divided by 6)
- *Middle 0*. Numbers with a middle 0 (e.g. 603) sometimes provoke the often incorrect strategy of splitting the number in the first two digits and the last one. For example in 603 finding factors for 60 and then reason they can be taken 'times 10' and trying to divide the remainder.
- *Taking apart the Hundred digit*. Numbers with 3 digits are split up in hundreds and the rest (e.g. 687 is split up in 600 and 87). A problem is that some children only check the divisibility of the remainder (87 in this case) and exclude the hunderds.This strategy only holds for factors of 100 which are 1, 2, 4, 5 and 10.

A final observation about what students did is that they all worked through the game by reasoning and calculating without using any support. They did not use the calculator provided in the game, neither did they use paper and pencil. Even for larger numbers and difficult factors they made all calculations mentally. We conclude this section with an example of a protocol (Figure 5).

John, grade 4. Age 10. Safe Number: 96
He starts with 1: 'that's one that always fits'
2, because 96 is even
3, is possible (3 x 30 = 90 and 2 x 3 = 6)
4: 40 and another 40 makes 80 and then 4 x 4 makes 16
6: 60 and 36, both in the Multiplication Table of 6
He clicks the handle. One number is not correct.
John is silent for a minute
Then he says: 10 does not fit
9 does not fit (10 x 9 and then it does not fit)
So it is 7 or 8. After some hesitation he chooses 8 (he split up 96 in 80 and 16)

Figure 5: Example of a protocol

7.2 Results per Safe Number

In the 18 sessions 81 Safe Numbers have been played, including some numbers that occur more than once. These are distributed as shown in Table 3.

Table 3: Distribution of Safe Numbers played

Below 100: Number from 1x 1 till 10 x 10	31 numbers
Below 100: Other numbers	29 numbers
Between 100 and 1000	21 numbers

In general the factors most easily identified correctly are 5 and 10. All students know the division rules of numbers ending in 5 or 0. Identifying 1 as a factor is initially problematic for 5 of the 18 students, in the beginning they don't select the button with the 1. They need the feedback of the handle to 'reinvent' the fact that 1 is always a factor of the Safe Number.

For Safe Numbers between 1x1 and 10x10 almost all students use their knowledge of the multiplication tables to find some of the factors. The prevailing strategy for 18 of the 31 (57%) of this type of numbers is first identifying pairs of factors both below 10. For the squares, 4 of the 31 Safe Numbers (14%) students started with the factor 1.

For the remaining 9 numbers the order in which factors are identified is not based on how they occur in the multiplication tables, but for example on their numerical order. For 19 of the 31 numbers the answer is found without using the feedback option.

For Safe Numbers below 100 that are not in the multiplication tables between 1x1 and 10x10, the strategies and the order in which factors are identified differ from student to student. For 10 of the 29 numbers 1 is the first factor identified. In case of an even number the first factor identified is often 2.

Identifying 2 as a factor is done in several ways. Some students know that they only have to check if the last digit is 0, 2, 4, 6 or 8. Other students know the term 'even' and implicitly use the last digit rule. Still a remarkable number of four students don't click the 2 while dealing with their first (even) Safe Number.

For Safe Numbers between 100 and 1000 we see that the solution process takes more time. More often students struggle with finding the factors, they go back and forth selecting and deselecting factors. For 17 of the 21 numbers the first factor identified is 1. This can be explained by the fact that the larger Safe Numbers are played after the lower ones: by then all students know that 1 is always a factor.

8. Conclusion and discussion

Children experience 'Crack the Number Safe' as being fun. This can be concluded in general from the data of online use where we notice that Crack the Number Safe is mainly played online in leisure time, more specific we conclude that children enjoy playing the mini-game from the data in the 18 protocols. Despite the fact that playing the game mainly asks for doing mental calculations, children are concentrated and like to play several Safe Numbers in one session, they seem to experience some kind of flow. They use the feedback option in a thoughtful way to check how far they have come in identifying factors and like to 'get the money from the safe' when all factors are correctly identified. The fact that the Safe is filled with coins when it is opened, contributes to the children's experience that they are playing a game.

From a designers point of view, however, we conclude that 'Crack the Number Safe' is missing some essential game aspects and that the goal of the game and the math goals are not fully aligned. There are no levels (Safe Numbers come at random), the game has limited feedback and there is no scoring mechanism. Of course the option to choose between easy (below 100) or difficult (between 100 and 1000) Safe Numbers is an alternative way to choose your own level, but this is primitive and not game-like. The feedback that follows the click on the handle is primitive and children have difficulty to interpret the message. The game is not supportive for specific strategy use, there are long periods in which the children are thinking and reasoning mentally without being able to interact with the game. Although a calculator is avalable on screen the children do not use this tool.

It is remarkable that despite these flaws children experience Crack the Number Safe as a gama and seem to enjoy playing it.

In answer to the second question: What do children *learn* when they play 'Crack the Number Safe'? we conclude that while playing the game students do indeed reason about divisibility. The game gives children the opportunity to use their knowledge on Multiplication Tables in a new environment. In this new and non-standard situation that has not been 'trained' in the classroom all students use this knowledge. Some students developed strategies on how to deal adequately with finding factors of 'large' numbers (>100). The two most common strategies that students developed were: adding on in jumps from a known multiple of the factor they were checking for, or splitting the Safe Number in two parts and check each of these. Sometimes for larger numbers, one of the remaining parts was split again. All students learned that the factor 1 is always a factor of each number and must be included in the final set of factors that divide the Safe Number properly. Some students made discoveries and learned new things about division rules: like for example that it is enough to check if the last digit is even to be sure that the number itself can be divided by 2, or that if a number is divisible by 10 also 2 and 5 are factors. As was shown in the results some of the students also came up with incorrect rules.

In this research we focused on game sessions with individual students outside their classroom. A question that remains is whether and how this mini-game can be used in classroom sessions. We see opportunities for using this mini-game for discussions between students and for classroom discussions orchestrated by the teacher. The embedding of the game in the classroom will be the focus of the next step in this research.

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New Teachership in Game Worlds

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Abstract: It has been argued that we are moving towards a new generation of educational use of games. The third generation educational games stress the meaning of the teacher in game based learning by expanding the scope of the games from just playing to learning and teaching. Although, the shift towards third generation use of educational games has begun, the state of art of educational game research does not offer adequate foundation to design such games. In fact, it has been argued that some teachers are avoiding game based approaches because they are afraid to loose the control on learning process. Thus, the aim of this paper is to uncover the opportunities of third generation educational games and raise discussion about teachers' role in game based learning. The research is basically a meta study about authors' previous research in the area of educational games. In this paper, teachers' role has been approached from two perspectives: The first case is about teacher as a virtual agent in the game world and the second case focuses on how teacher can facilitate reflection both in the real world and in the game world. The cases are very different from a computational intelligence point of view, but the design of both games acknowledges a teacher as an important part of the learning process. The discussed approaches are meant to strengthen and speed up teachers' opportunities to receive detailed information about the learning process. With such solutions, teacher cannot only control the process, but he/she can use received information to master relatively large groups with numerous variances in skills. Finally, we argue that the user-centered design approach paying attention to both the needs of the students and the needs of the teachers would facilitate the diffusion of game based learning approach among teachers.

Keywords: Educational games, teachership, learning, reflection

1. Introduction

In recent years Game Studies has rapidly developed into an important interdisciplinary research field as well as a nascent academic discipline. The rapid growth of the game industry has aroused wide interest, particularly among educational technology researchers as well as digital learning material producers. It is known that the possibilities to use digital games in education have been considered since 70's. Nevertheless, the concrete and scientific ambitions to produce high quality educational games have been quite minor. Actually, the quality of produced games has not met the expectations of the educators and the use of games has not become as general as expected. Probably, the most significant factors that have lowered the quality of educational games have been the lack of a theoretical game design foundation as well as game developers' low yield expectations. In fact, the overall level of educational games indicates that the usefulness and the real power of game-based learning have still not been fully realised.

Apparently, the rapid growth of entertainment game market has reawakened the interest of educational researchers and producers. It seems that games will get another chance to prove their usefulness in computer-assisted learning. At least the starting point for revival is better than before. First of all, researchers have understood the meaning of pedagogical foundation in educational game design (e.g. Kiili 2007, Amory & Seagram 2003; Garris, Ahlers & Driskell, 2002). Secondly, the infrastructure of schools has developed a lot during the last decade. Thirdly, it has been argued that we are moving towards a new generation of educational use of games (e.g. Egenfeldt-Nielsen 2007). According to Egenfeldt-Nielsen (2007) such third generation educational games rely on a socio-cultural approach, where the learning process is seen as being mediated in a social and situated context. Furthermore, third generation educational games focus on the students' engagement with games (Gee 2003) and emphasize the meaning of the teacher as a facilitator that expands the scope of computer games from just playing to learning (Egenfeldt-Nielsen 2007). However, research dealing with third generation educational games has been mainly conceptual and the empirical grounding of the approach is lacking.

In general, game based learning approach has shown its strengths and opportunities from learner point of view (e.g. Sinko & Lehtinen 1999; Mayer 2001; Ketamo 2003; Virvou et al. 2005). However, there are numerous opportunities to support teacher's work with game based approaches. Support is not limited only to on-line game statistics. In fact, game based approaches can extend teachers' role in very meaningful ways. In this article, teachers' role in game based learning is considered through two game examples that can be classified as third generation educational games.

2. Research task

This study is a literature review focusing on two game cases. The games have been studied in detail and the results have been published in more than 20 international publications. Such exhaustive research results make it possible to create summaries about pedagogical use of educational games from a teacher point of view. The main aim of this paper is to uncover the opportunities of third generation educational games from two perspectives: First case is about a teacher as a virtual agent in the game world and a second case focuses on how teacher can facilitate reflection during playing. The cases are very different from computational intelligence point of view. There is no artificial intelligence involved in the first case, but all intelligence is based on narration. In contrast, the second case is based on highly complex AI with teachable software agents and neural computing.

3. The teacher as collaborator and agent provocateur

Media Detective is a learning game for media education. The overall aim of the game is to develop students' media literacy and ability to produce, evaluate and interpret media messages critically. Furthermore, game includes elements that teach copyright issues, safe use of internet services and other data security themes. The learning content is embedded into a realistic story that integrates the challenges and learning tasks into a coherent and harmonious entity. The results described in this section are based on authors' previous studies (e.g. Kiili 2007; Kiili, Ketamo & Lainema 2007) and general feedback that teachers have provided after using the game in teaching.

3.1 Story and learning activities of the game

Following is a superficial description of the story and the game activities. In Media Detective a player takes on the role of an undercover agent working as a journalist who tries to clear up a theft and a related copyright offense. The master disk of the forthcoming movie has been stolen and pirate copies are sold in Internet and streets of Mediaville. The police have reduced the suspects to six persons that are all actors of media industry and they have somehow participated in the production of the stolen movie. In the game the agent (player for now on) interviews suspects, becomes familiarized with their work and does feature stories about them while trying to solve the crime. The player has a partner, an experienced agent, who helps and guides him during the game. The partner called Silva comments the decisions of the player and tries to activate player to think the content more deeply.

The interviews form the core of the game. They include both theoretical content about producing media messages (related to interviewee's work) as well as content needed to solve the crime (Figure 1). When the player has conducted an interview he is allowed to familiarize with suspect's work more deeply by performing a production task. Production tasks allow player to apply the theories that he has learned during interviews in practice. For example, in advertising agency the player is obliged to produce an advertisement for a soft drink company (Figure 2). The use of production tasks is justifiable because several studies have shown that challenging learners as producers of materials increase the learners' understanding of the subject matter (e.g. Kiili 2005; Stern et al. 2003; Hall et al. 1997). Furthermore, the creation of media messages supports also the formation of player's interpreting strategies of media messages. During the game player faces numerous media messages that he has to interpret and analyze in order to solve the game.

Figure 1: Interviewing a suspect

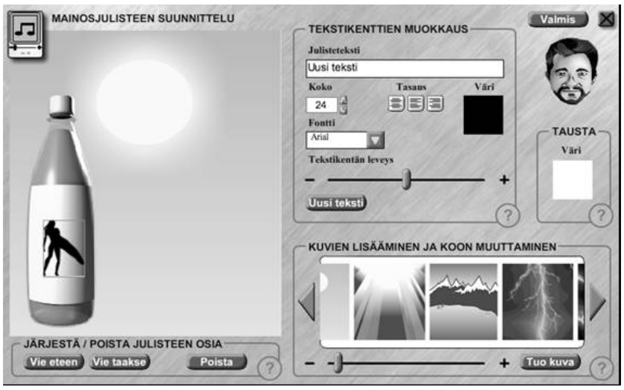


Figure 2: Creating an advertisement

3.2 Teachers' role in media detective

Players demand some intelligence from games due to their prior playing experiences with entertainment games. However, the development of AI-based game elements is expensive and challenging - especially in an educational context where the characters should provide constructive feedback for players. Furthermore, it is extremely challenging to form AI-based game elements that trigger reflection, which is a key process in learning. Therefore, Media Detective uses an alternative method of forming intelligence into the game, in which a teacher has a significant role. This method is called illusion of intelligence (Ketamo & Kiili 2007).

The idea of illusion of intelligence approach is that a teacher can communicate with players through non-player game characters included in the game world. It can be said that a teacher has many faces and identities. In Media Detective a teacher has two ways to communicate with players. Firstly, the teacher can take the role of player's partner, agent Silva. In other words, the teacher can create speech lines for the partner and aim them at a certain player. This kind of tutoring system allows the teacher to give constructive feedback to players and makes differentiation of teaching easier in a game context. The figure 3 shows the way messages are presented to a player. Secondly, the teacher can communicate with players with game's internal e-mail system. The teacher can send e-mails to players from different non-player game characters. This feature was implemented in order to form a feedback channel for tasks requiring creative content producing. Provided speech line templates and e-mail templates support teachers' communication with players. The template messages have been designed to trigger reflection in players and they also facilitate teachers' adoption of the roles of non-player game characters.

Figure 3: Teacher has sent a message to the player

In order to be able to tutor players, the teacher needs to be aware about players' performance and progress in the game. Therefore Media Detective includes also an observing tool. The teacher can for example check players' productions in real-time and publish them into the game world, if they are decently made. The observing tool makes it possible to use player generated content also outside the game world. Such feature supports the integration of game content to other teaching.

The evaluation of Media Detective has indicated that the illusion of intelligence approach is a successful method that can be used to support teachers' work and facilitate players' experiences. In fact, many of the players have been impressed with the artificial intelligence of the game. For example Matti stated that: *"Hey, the artificial intelligence of the game was awesome. The author of the game should work for Remedy"* (Remedy Entertainment is a game company that has published some very successful games). Naturally, Matti's enthusiasm was mainly the merit of the teacher who could create the kinds of messages that did not disturb the harmony of the game - teacher could act like a believable game character. On the other hand, the evaluation studies have showed that messages created by teacher can also ruin the whole game. For, example one teacher used agent Silva to inform players that it was time for a lunch. After that players did not know anymore how to interpret Silva's messages. Thus, the success of illusion of intelligence approach depends on teacher's skills to adapt the roles of different game characters so that the whole game forms a harmonious entity and the teacher-generated content does not stick out from other game content? This phenomenon relates to the concept of *suspension of disbelief*. According to Rollings and Adams (2003) suspension of disbelief reflects a mental state in which a player chooses, for a certain period of time, to believe that this pack of lies (the game) is current reality. It is important to realize that when suspension of disbelief is lost, it is extremely difficult to capture player's attention in such a way again. This is the thing that teachers should realize before they start to teach with games allowing content creation.

Overall, teachers have emphasized that guiding players is quite easy, but the real challenge lays in getting players to think. This is a real challenge also for the game designers. How the performance of the teacher can be supported so that the teacher can provide cognitive feedback for players? One thing is clear, the tempo of the tutoring have to be manageable in order that teachers have enough time to produce effective and constructive messages for players. However, the evaluation studies have revealed that in spite of some delay players seems to like the feedback system of Media Detective. The feedback provided with e-mails has experienced to be very effective, because it is contextualized. For example, one player said that, *"I really liked the way how the game provided feedback from my tasks…It felt powerful because it game from real professionals.".* The player referred to e-mails generated by a teacher and send through non-player game characters. However, as mentioned before the success relays on teachers ability to maintain the suspension disbelief and the harmony of the game. To summarize, the illusion of intelligence seems to be a respectable approach to fulfilling the expectations of students as well as teachers and can be used to support reflection.

4. The teacher's role in supporting reflection

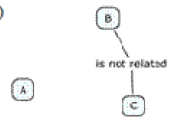
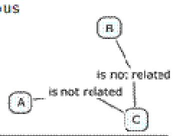
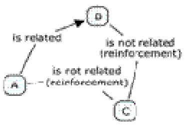
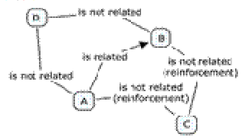
Animal Class is a game series meant for pupils aged 6-12 years. The pedagogical idea of Animal Class is to put a learner (player) into the role of a teacher. The background of the game is in Learning by Doing, Learning by Teaching and Learning by Programming. In Animal Class the player has complete freedom to teach the virtual pet however s/he wants, even wrongly. The results described in this section are based on author's previous studies (e.g. Ketamo & Kiili 2007; Ketamo & Suominen 2008; Ketamo 2009). The positive learning outcome during the gameplay has been explained in details in authors' previous works.

4.1 Learning activities of the game

At the beginning of the game the player got his/her own virtual pet (teachable agent) that does not know anything. Its mind is an empty set of concepts and relations. The pet learns inductively: Each teaching phase increases and strengthens the network of concepts. When the pet achieves a semantic network of a certain structure, it can start to conclude. In Animal Class teaching is always based on statements constructed by the player. The virtual pet answers according to its previous knowledge. If there is no previous knowledge, it will guess. The player then tells the pet if the answer is correct or not, and based on this, the pet forms relations between concepts.

Each teaching phase is recorded in a semantic (conceptual) network within the game AI with one or more 'is (not/option) related to', 'is (not) bigger', 'is (not) equal', etc. relations. In game play these relations are used logically: In a correctly-answered-question situation, the virtual pet accommodates or assimilates concepts and relations into its semantic network in accordance to the types of questions. During gameplay the conceptual structure in the virtual pet's AI develops. The following example (Table 1) describes the teaching and development of a semantic network in AI with a question of 'which one does not belong to the group'. In the following, 'Q' represents a question posed by the learner, 'R' represents answers made by the virtual pet and 'E' represents the evaluation done by the learner.

Table 1: Teaching a semantic network in Animal Class

Phase	Action	Network
1	Q: which one does not belong to the group; A, B or C R: "A" (The pet guesses, because it does not have previous knowledge) E: false	empty 
2	Q: which one does not belong to the group; A, B or C (repeated question) R: "B" (Pet guesses from set [B,C] because of previous teaching) E: false	
3	Q: which one does not belong to the group; A, B or C (repeated question) R: "C" (The pet determines: A is not related to C and B is not related to C, which means that A and B are most likely to be related) E: true	
4	Q: which one does not belong to the group; A, B or D R: D (The pet determines that it had to be D because A is related to B E: true	

In the example, the learning was accompanied by 'is not related to' relations in the beginning. With 'is not related to' relations, the learning takes more time than with 'is related to' relations, that would have taken place if the pet had guessed correctly at learning phase 1. Another note to Table 1 is that, determining the probabilities and answers are based on the state of the network, not on single relations alone. If the overall state of the network is strongly opposite to the shortest relation between concepts, the overall state will override the shortest relation. In terms of contextual learning, we can say that the context affects causes and consequences on the machine learning side of Animal Class. During gameplay, the semantic network will grow up to thousands of relations and a single teaching phase has only a limited effect on areas of the conceptual structure already taught. Understanding this phenomenon is valuable when trying to correct a wrongly taught part of the concept structure. Naturally, the wrong teaching could be corrected by teaching the correct structure enough times. The game AI uses all the taught information to back its decisions, and therefore it takes time to override wrong learning.

An interesting part of teaching is the possibility of teaching wrongly. Sometimes the wrong teaching was not due to low skills: for example at the beginning of geometry game, some pupils tried to teach colors instead of the expected shapes. In order to support reflective thinking, there was a brain icon (Figures 4 and 5) that describes the quality of learning. If the quality increased, the brains got bigger, and if quality of learning decreased, the size of the brains got smaller. If the overall teaching was wrong, the brains were replaced by a cactus to show the player that he was doing something completely wrong. This kind of wrong teaching could be corrected by teaching correctly long enough to override the wrong learning.

The user interface was designed to be easy to use, but it should give enough freedom to make and evaluate complex expressions. In Figure 4 the player has constructed a question which consists of two triangles and one rectangle. When the question is ready, the player asks the octopus by clicking the 'ask' -button (balloon with three question marks). The octopus answers according to its previous knowledge. After the octopus has given its answer by pointing out the shape it thinks does not belong in the group, the player should judge the answer: if the answer is correct, the player should click the green 'correct' -button. If the answer is false, the player should click the red 'wrong' -button. If the player notices that he has posed an impossible question or is uncertain, the question can be cancelled by clicking the yellow 'cancel' -button.

The teaching itself was found to be motivating. Even so, most pupils expected something more than just teaching. Therefore, a quiz challenge called the "Treasure of the Caribbean Pirate" was included into game as a competition between the pets. In the competition the game AI uses the same semantic networks that were taught in the classroom. In the competition a player can challenge his/her friend's octopus to play against him/her. Because all semantic networks are stored in a game server, a player can challenge opponents even if they are not online. The competition (Figure 5) is based on mechanics similar to teaching. The octopus needs to select which of the shapes does not belong in the group. Both octopuses' answer the same questions at the same time according to taught knowledge.

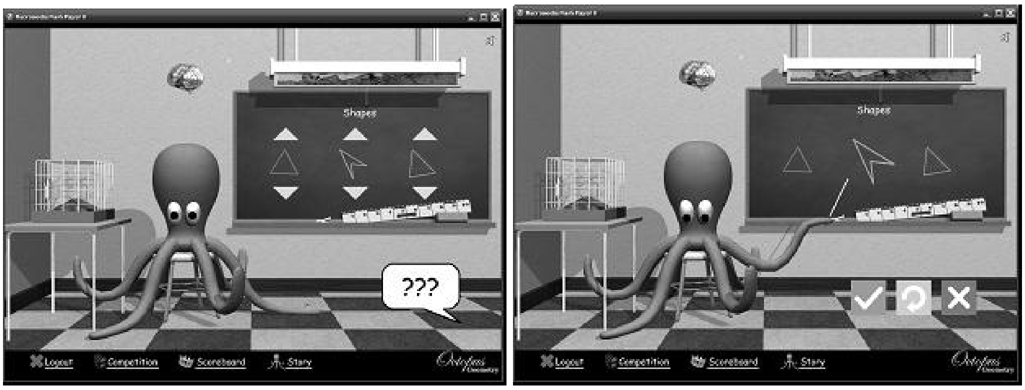


Figure 4: Question construction (left screen) and judging (right screen) in Animal Class, the pre-school geometry game

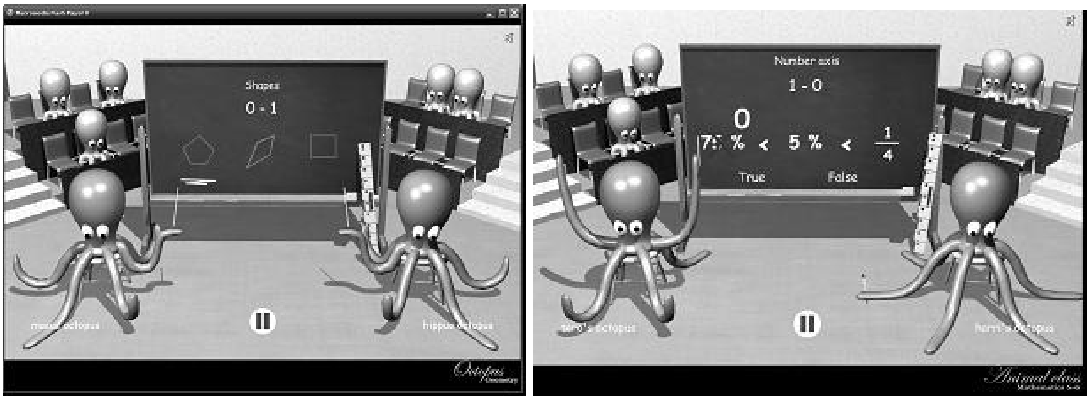


Figure 5: Competition in Animal Class, the pre-school geometry game (left screen) and Animal Class, a 6th grade mathematics game (right screen)

When focusing on dependencies between the quality of conceptual structure and measured variables (e.g. Ketamo 2009; Ketamo & Suominen 2008), we can find out that the quality of the conceptual structure is strongly related to the post-test score ($r=0.457$, $p=0.009$). Because the pre-test and the post-test are dependent ($r=0.707$, $p<0.001$) the quality of the conceptual structure is also related to the pre-test score ($r=0.370$, $p=0.037$). Furthermore, sending the pet into competition predicts that such learner is likely to have a good learning outcome.

4.2 Teacher’s role in the AnimalClass

These results support the idea to mine (in terms of Data Mining) detailed information about learning and gaming process for teacher’s use. The teacher tool (Figure 6 and 7) was designed to be easy and fast to use in classrooms. Therefore the general information (figure 6) focuses on competing statistics and detailed information (figure 7) focuses on conceptual structures, their strengths and weaknesses.

Because the semantic networks are slow to read, the most relevant information is mined and presented at four square. In the beginning, all concepts are on ‘not taught’ –area (figure 7, left screen, circled). After teaching the virtual pet the concepts form a network with multiple relations. This structure is mined and compared to correct structure. According to this analysis, the concepts are presented either as ‘correctly taught’ (figure 7, right screen, upper circled area) or as ‘wrongly taught’ (figure 7, right screen, lower circled area) concepts. If the network is strong, the concepts will be moved into right side of four square. In case illustrated in figure 7 the concepts do not form a strong network and therefore all concepts are presented at the left side of four square.

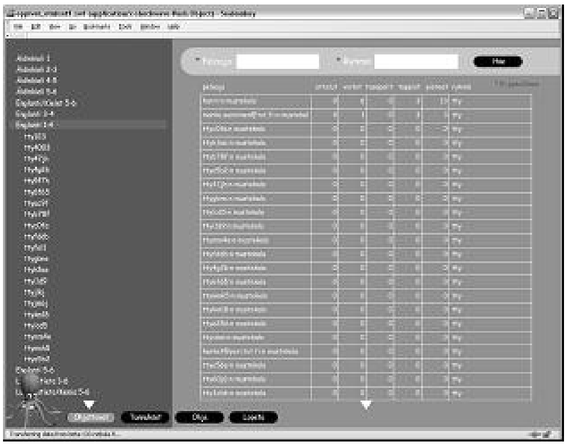


Figure 6: Screen capture about AnimalClass teacher's tool: general information about game play

Figure 7: Detailed information about taught semantic network visualized in AnimalClass teacher's tool

The four square was selected in order to provide easy and fast to understand knowledge about learners' performance. In seconds a teacher can see what is wrong in some pupil's game play and after that teacher can help the pupil by providing some relevant correction suggestions. The idea is that a teacher can encourage pupil to think reflectively and point out problems in pupil's previous teaching. Teacher should not correct pupils' game play, but pupils should do it himself/herself. With this tool, a teacher can manage game play even in large groups such as 20-30 pupils.

The game play can be used to support teacher's work also in terms of social networks: Because competing against classmates tells something about class's real world social networks, it could be useful to give this information to teacher. Formation of social networks is done with similar Data Mining methods than teacher tool's diagnostics. According to previous studies (e.g. Ketamo & Suominen 2008) we can point out 1) two main types of social networks and 2) minor types of social networks.

First major type of social network is formed by the persons at the top of the ranking list and their challengers. The cluster itself was not a surprise, but the clarity of the cluster from a modeling point of view is a bit of a surprise. Nevertheless, there was no hypothesis set in advance; the clusters were expected to be more 'noisy' and not as clear as structures. The second main group of the social networks was formed between, for example, classmates or other friend based groups (Figure 8). In these groups the dominant feature was tightness of the group: There were many considerably strong two-way relations but only a few one-way relations in these groups.

Rare types of social networks (less than 5% of the population) appeared, for example, in groups based around a central person and refer to a situation in which members a,b,c and d establish the group (Figure 9). A has a two-way or one-way relation to members (b,c,d) but other members do not even have one-way relations to one another themselves.

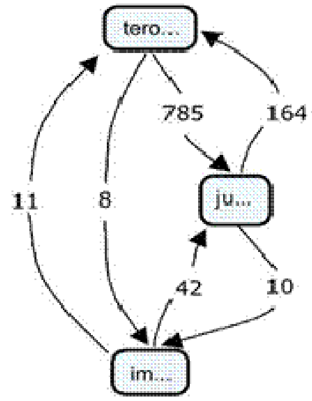


Figure 8: The social network structure of a 'classmates' type of group. The usernames are partially hidden in this figure in order to minimize the possibility of recognizing players

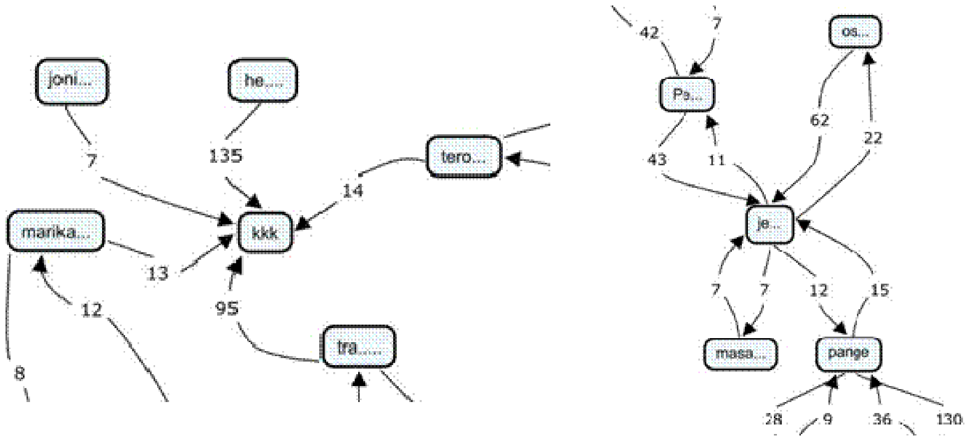


Figure 9: Left network: possibly a case of mobbing? right network: social leadership? The usernames are partially hidden in this figure in order to minimize the possibility of recognizing players

In Figure 9, left network, a central person is challenged by several classmates or friends. This can be explained either as a mobbing or as a leadership. In a case of mobbing, the classmates pick up an opponent that they know is e.g. low-skilled in the game domain. However, if a person is likely to be mobbed, he/she can remain anonymous by not telling his/her username. Classmates cannot figure out a username in the game, but they certainly can force a mobbed pupil to tell his username. In a case of leadership, the classmates pick an opponent that is a central person of the class's real social network. Furthermore, if a person is a social leader of the class, he/she probably challenges his/her friends as in Figure 9 right network. To conclude, the visualization of players' social structures may facilitate the teacher to maintain better control of his/her class also in the virtual game world.

5. Conclusions

Some teacher's are said to avoid game based approaches because they are afraid to loose the control of the learning process. In this paper, the approaches are meant to strengthen and speed up teachers' opportunities to receive detailed information about the learning process. With such solutions, teacher cannot only control the process, but he/she can use this information to master relatively large groups with numerous variances in skills.

In Media Detective game, teacher can communicate with players through non-player game characters included in the game world. With such a feature teacher can guide players and give them feedback of their performance without breaking the harmony of the game down. The results have indicated that in Media Detective case the approach facilitated both the teaching and playing experiences. The method is very useful because it provides a way to give cognitive and contextualized feedback also from players' performance on open and creative production tasks that would be almost impossible to automate. However, the success depends totally on a teacher's skills to adapt different roles in the game world and collaborate with players, which is also a big challenge for game designers – how to support teacher's role in the game world. The features implemented in Media Detective show some solutions that seem to work, but more research and exemplars are needed.

The pedagogical idea of the AnimalClass game is to place a learner in the role of a teacher. In the beginning of the game a player gets a virtual pet that wants to learn natural sciences, mathematics and languages. The player teaches conceptual structures to his/her virtual pet in terms of inductive learning and conceptual learning. Because of the computational methods and game mechanics, the conceptual changes and learning process can be mined in details. The teacher can receive this information in real time with tools that visualizes and pre-analyses the process. The teacher can use the information in classroom in order to highlight the possible points of misconceptions and thus facilitate reflection. Furthermore, teacher can use this mined data for example to uncover mobbing in game world or other significant phenomena that could be difficult to observe without tools designed for the teacher.

In this study, we have shown that there are both computational and non-computational methods to support teachers' work in the game world. So, why teacher is usually neglected when designing educational games? Maybe one of the problems is that when game designers focus on fulfilling the demands of curriculum, they try to make games that simply teach the subject without teacher's 'touch'. When a teacher is forgotten from the concept, we cannot expect that teachers take these games into classrooms, because games do not provide enough added value for them. Finally, we argue that the user centered design approach that pays attention to both the needs of the students and teachers would facilitate the diffusion of game based learning approach among teachers.

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Emergence in Digital Educational Games: a World of Incidents in a Universe of Rules

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Abstract: Using computer games for educational purposes is a compelling idea that is increasingly adopted by researchers, developers, and educators. Still, digital educational games are at an early stage. A crucial factor that must be increasingly addressed by future research is a personalization of learning and gaming experiences in the rich virtual worlds of computer games. In the present paper we introduce an approach to combine frameworks of psycho-pedagogical adaptation, interactive storytelling, and emergent game design in order to provide the individual learners with tailored learning experiences without corrupting the game's storyline and without requiring massive content production.

Keywords: Competitive educational games, adaptation, personalization, interactive storytelling, emergent game design

1. Introduction

Computer games are an outstanding and incredibly successful part of the present entertainment landscape. The compelling technology of leading edge computer games, at least in our opinion, must be considered for teaching and learning also. With the increasing time people of all age groups spend on playing computer games, the idea of utilizing the games' motivational and educational potential becomes more and more convincing and fascinating. Still, today's computer games not only have a tremendous motivational potential, computer games enable realizing elementary and essential pedagogical and didactical principles in a very natural way. Computer games, for instance, provide an emotionally and semantically appealing and meaningful context for learning, rich and immersive possibilities for visualizing contents, or the possibility for self-directed, active learning. In short, computer games do have the potential to make knowledge attractive, important, and meaningful.

For several reasons, the vision that digital educational games (DEGs) become a serious part of educational technology did not come true yet; from today's perspective, the realization of this vision is still in its infancy (Oblinger 2006). This is particularly true if educational games for older children and adolescents are concerned or when considering games related to school curricula. Most existing DEGs are rather small and often simple games, focusing on a limited set of competencies (e.g., basic algebra) or addressing specific skills (e.g., job application trainings). They generally do not related to school curricula or do not attempt to enable learning about school-related subject matter. More importantly, existing games do not provide sound assessment methods and generally there is an imbalance between learning and gaming. Finally, while game intelligence is well developed, educational games do not include adaptation to the learner in terms of knowledge, learning progress, motivation, or individual preferences. Thus, they cannot compete with their commercial counterparts and they cannot utilize the full potential of immersive digital games with respect to learning efficacy and learning experience. In conclusion, a key aspect of the success of an educational game (i.e., effective learning and fun) is an intelligent adaptation to the individual learner.

1.1 Around an Inspiring virtual learning world in eighty days

The psycho-pedagogical personalization in DEGs is in the focus of the European research project 80Days (www.eightydays.eu). Inspired by Jules Verne's novel "Around the world in eighty days", the project aims at developing psycho-pedagogical and technological foundations for intelligent adaptation. Basically, the project's endeavours include melding curriculum-related subject matter with the fun and excitement of an attractive and compelling computer game. In this context, the intrinsic motivational potential of computer games is the key to learning success in the sense of voluntary and maybe hidden learning activities.

In the focus of research and development is an intelligent technology that allows an adaptation to individual learners, their prior knowledge, abilities, preferences, and learning progress, even more, a technology that allows a so important but so fragile dynamic balance between challenge and ability.

Undoubtedly, the motivation to play and therefore to learn is crucial for learning games; only those learners who are perfectly challenged, neither overburdened by too difficult gaming and learning activities nor bored by too simple ones will optimally use the educational potential. In 80Days, this kind of adaptation is realized by providing the learner with adequate psycho-pedagogical interventions (e.g., hints or feedbacks) but also by the adaptation of the entire gaming context and ambience (e.g., the level of difficulty, the mood, the pace, or even the entire storyline). Therefore, in the heart of the project is the fusion of educational adaptation/personalization with interactive storytelling.

Non-Invasive Psycho-Pedagogical Adaptation

Using more or less “intelligent” machines for educational purposes has a long history. It can be traced back to 1926 when Sidney Pressey (1926) tried to build a machine that presented multiple choice questions, their answers, and immediate feedback. The driving force behind intelligent educational systems is to provide individual learners with individual solutions, essentially because a large body of research yielded that meaningful and suitable one-on-one teaching is the most effective way of teaching (Bloom 1984), however, the most expensive way. Over the past decades several methods and frameworks for intelligent (ITS) and adaptive (ATS) tutorial systems were developed. An overview is, for example, provided by Paul De Bra (2008).

For the psycho-pedagogical interventions in DEGs we developed an approach of adaptation on a micro level. The approach is essentially based on *Competence-based Knowledge Space Theory* (Albert & Lukas 1999). This framework allows modelling a knowledge domain as formal structure of admissible and meaningful *competence states* on the basis of *prerequisite relations* among the latent competences. As an example, being able to add two integers is considered a prerequisite to perform multiplications. By this means, the number of meaningful states is significantly reduced in comparison to the power set of all possible combinations of competencies. The basic idea of micro adaptivity is to perform an assessment of knowledge / learning progress by monitoring what the learner is doing in the game (e.g., which objects are manipulated in which way) and to interpret those actions in terms of available and lacking competencies and competence states in a probabilistic sense. To give an example, if a learner closes an electric circuit as a task in the game (e.g. to open a door) we can assume with a certain probability that this learner knows that the task requires electricity. Of course, one observation is not very convincing but by continuously observing the gaming behaviour our picture of the learner’s competence state is getting clearer and clearer. The same principle we can use to make assumptions about other aspects (inner states) of the learner, e.g., assumptions about the motivational state. The probabilistic assumptions are used to provide the learner with suitable interventions, for example, individual feedback or hints that are suited for a specific situation. In this way we can avoid interrupting the gaming flow by inappropriate psycho-pedagogical measures. A more in-depth description of the micro adaptivity concept is given by Kickmeier-Rust and colleagues (Kickmeier-Rust, Albert, Hockemeyer, & Augustin 2007; Kickmeier-Rust, Marte, Linek, Lalonde, & Albert 2008).

1.2 Educational storytelling in DEGs

In the last section we described how micro adaptive assessment contributes to provide the learner with “soft” interventions embedded in the game flow. Important techniques for educational adaptation such as adaptive sequencing of learning units (learning situations in a DEG) or adaptive presentation, however, are difficult. For example, in a game with a fixed story line it is not possible to skip a learning unit because the system concludes that the learner already has the respective knowledge. This would immediately destroy the story’s flow and therefore the gaming experience. To address this problem we aim at merging psycho-pedagogical adaptation with interactive storytelling, essentially to enable an adaptation of the story to the psycho-pedagogical requirements.

A focal aspect of interactive storytelling in an adaptive DEG is to find an appropriate storyline on the basis of a pool of given atomic game elements (these can be viewed as the rooms of a house; each room has a specific goal, for example, to provide the learner with information, to assess internal states, or just to contribute to the story and gameplay). During the game, the single game elements must be adaptively re-combined to a meaningful storyline, which is in accordance with the psycho-pedagogical requirements. By aforementioned example, if the system concludes that a specific learning unit can be skipped, the re-sequencing of game elements must be made in way that skipping a unit does not break the storyline.

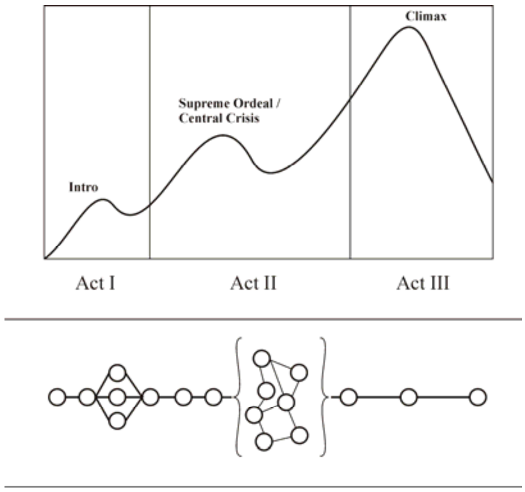

Figure 1: The three act story model and its translation to a sequence of game elements

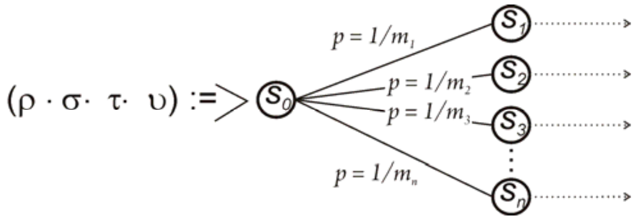

Figure 2: A formal representation of restrictions in the sequencing of story elements

This task is not trivial; it requires not only the adaptive mechanisms described earlier, it requires a formal and computable story model. 80Days relies on the classical three-act structure of Aristotle providing an arc model with 'exposition', 'rising action to climax' and 'denouement' (Figure 1). Thus, we can combine the story and learning by linking competence structures with story plots (Figure 2). This, in turn, generates game paths, possible and meaningful paths through the game accounting for story model, learning objectives, and pedagogical interventions (see Kickmeier-Rust, Göbel, & Albert 2008 for details).

The outlined approach, unfortunately, has an important drawback: the cost factor. A comprehensive adaptation throughout an entire game requires massive content (i.e., game elements) production. However, cost-effectiveness is a crucial factor for a DEG's success on the market. We address this problem by extending the approach of adaptive, educational storytelling with ideas of *emergent game design*.

2. Emergence in (educational) game design

In regular games, a sequence of scripted events occurs throughout the game. According to Smith (2002), however, this bears the downside that the game system has a limited awareness of what is happening and, more importantly, the game is lifelessly determined by what the designers think is exciting and fun. Emergent behavior, on the other hand, occurs when more or less simple rules interact to give rise to behavior that was not specifically intended by the developer of a system. Emergence refers to the process of deriving new but coherent patterns or behaviors in complex systems. Emergent phenomena occur due to a non-trivial interaction of system components with each other and with the user. As Johnnson (2001) pointed out, the collective of such kind of interactions forms novel, complex, and unexpected results. Emergent game design offers a ‚platform' and 'tools' for gaming, however, without any further blueprint; this is comparable to improvisational theatre or giving a kid a box of toy cars. The context is fixed but what happens occurs interactively and incidentally.

One perspective is that emergent gameplay appears due to excellent and comprehensive simulations. Rich virtual worlds enable the player to interact with a large degree of freedom and, more importantly, to interact with game entities that respond in a realistic way. Examples might be *SimCity*, *The Sims*, or the interaction with the people in *Grand Theft Auto*. The key to emergent gameplay and emergent narrative is a meaningful and "intelligent" interaction with the game and within the game. The advantage is that each player receives a very unique and personalized gaming experience, which is potentially enriching the possibilities for educational adaptation/personalization. On the other hand, to create such intelligent and complete game world may require a significant amount of resources, perhaps much more than scripted games need.

There exist several techniques from complex systems, machine learning, and artificial life that potentially enable emergent behavior in games. According to Sweetser (2006a) some examples are flocking (simulating group behavior such as a flock of birds), cellular automata (discrete time models simulating complex systems), neural networks (machine learning techniques inspired by the human brain), or evolutionary algorithms (optimization techniques using concepts from natural selection and evolution to evolve solutions to problems). Some of those principles have already been transferred to real games; for example, *Half-Life* used flocking to give its monsters more lifelike responses. Another example might be *Blade Runner*; but also in this example a pre-defined storyline is only “enriched” or “altered” by accidental aspects, making the game different at each time. Important work in this area comes from Sweetser (2006b) who developed and evaluated a technically sound framework for realizing emergent game design. Several authors claim that emergence is the direction game development is heading, which includes more flexible, realistic, and interactive worlds Sweetser (2006b).

2.1 Gameplay versus narrative

Gameplay and narrative are two fundamental dimensions along each game can be described. The one determines the what and how, the other determines the why. Although both dimensions occur on a continuum, specific games are either predominantly gameplay-based (e.g., role playing games, action adventures, or campaign games) or predominantly narrative-based (e.g., simulation games, management games, or strategy games). Those dimensions also aroused some debate on which a game should focus more: The ludologists say that games should be played and not perceived like interactive movies. The narratologists, instead say, games should follow a red story thread. Both, the gameplay dimension as well as the narrative dimension can be described on a continuum between open/emergent and predefined/scripted.

With respect to emergent approaches on the gameplay side, intelligent characters play a crucial role. The “intelligence” of game characters is a essential factor. Those characters are supposed to behave flexible, challenging, unpredictable, or cunning (Sweetser, Johnson, Sweetser, & Wiles 2003). An intelligent agent can be considered autonomous if it relies on its own precepts and not on the predefined ‘will’ or ‘knowledge’ of the game designer (Russel & Norvig 2003). Being autonomous, in turn, requires situational awareness. An example for such approach in an existing computer game is the agents in Half Life. Those characters “look” and “listen” to what is happening in their neighboring areas (Leonard 2003). Still, the realization is rather simple; pre-defined check scripts are processed. In psychological terms, existing models perform a top-down approach driven by the designers/developers intelligence. The next generation of artificial in-game intelligence will rather purse a bottom-up approach, meaningful responses on changes in the agent’s neighborhood.

2.2 The educational ways

However, aforementioned approaches were developed in the context of entertainment games. Educational computer games cannot simply overtake such ideas since a crucial difference between the two kinds of games is that educational objectives require the learner to pass through certain learning situations (in whatever way they are realized). This means that pedagogical implications limit the degree of freedom and randomness in emergent approaches to game design. It is necessary that a learner is exposed to certain learning situations in a certain sequence.

These limitations contribute to an interactive dilemma (Peinado, Gómez-Martín, & Gómez-Martín 2006) the designers do not want to (and also must not) lose all control and system-only generated story plots are likely not very convincing. Thus, a subtle balance is required between a global idea of the story and emergent aspects; research proposed a dual layer model that separates a narrative layer and an agent/simulation layer (Peinado, Gómez-Martín, & Gómez-Martín 2006). The story generation is based on the interaction with the beholder, a story-ontology, and vectors of story elements and relationships.

In this work we want to present a model for involving emergent game design ideas in educational contexts. This model considers the learning domain, the learner, and it relies on character-based and plot-based foundations.

3. Educational adaptation - interactive storytelling - emergent game design

First, a narrative context model must be generated. This model is based on the characteristics of the hero's journey (Campbell 1993) and the classical three-act story model. It determines a general red thread through the game and it defines the intro act and the closing act. In-between, we have a large number of possible story/game paths (Figure 1). These are associated with educational objectives and pedagogical implications – using the cognitive competence-based knowledge space theory (Kickmeier-Rust & Albert 2008), which establishes a structure of story/game elements that are meaningful in terms of education and in terms of story. The cognitive model reflects the psycho-pedagogical requirements and thus determines the admissible game parameters. Formally, we can summarize the psycho-pedagogical aspects as an "inner state", which constitutes n-tuples, which in turn determine transition probabilities (Figure 2). However, in terms of game development this model is the anti-thesis of cost-effectiveness since it requires massive content production.

As a consequence, we introduce an abstraction layer. On an ontological basis (extending Kickmeier-Rust & Albert 2008) we separate game play features, story features, and educational features. The game progresses through a sequence of generic modules (cells) which are sequenced adaptively and filled with game play, story, and education in real time and system driven.

The theoretical background is similar to the principles of *cellular automata.* Many of today's approaches to modeling real-world phenomena aim to come up with accurate and error-free models. Often such modeling occurs in the context of scientific applications and forecasts. In games this complexity is not necessary. It's all about providing appealing and realistic visual effects (e.g., smoke or fire) – not necessarily accurate but rather credible. Forsyth (2002), for example has described methods with which natural processes (e.g., fluid flow) can be simplified for games using cellular automata.

The game elements are seen as cells of a multi-dimensional grid (Figure 3). Each cell must be in one of a finite set of admissible states (e.g., in terms of story or in terms of knowledge) and each cell has a set of update rules. The state of a cell is a function of the states of the neighboring cells and it is sensitive to the actions of the learner. This results in an ebbing and flowing of incidents and it allows an emergent development of game play as well as narrative – of course limited by the global red thread through the game and the educational objectives. In more practical terms this means, if the learner performs an action (e.g., closing the electric circuit) the probability distribution over the competence states is altered. In combination with other indicators (e.g., intervals between actions or the number of re-trials) this determines the properties of the game elements (the cells). In turn, altering the properties of a cell changes the properties of the neighboring cells, comparable to the propagation of waves when a stone hits the water surface. To give an example, if the learner fails to establish an electric circuit, the next learning unit automatically adjusts itself to teach the learner about electric circuits. The advantage of this approach is that the game only needs the assets for the described adjustments (maybe a set of re-combinable sentences an avatar could say), it is not necessary to develop all possible learning units.

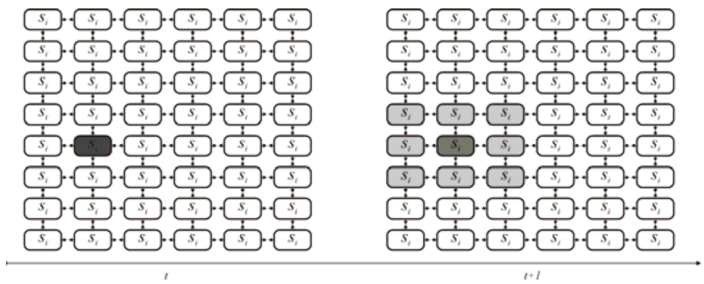

Figure 3: Cellular automata – or a stone hitting the water. The image – in a very basic way – illustrates the grid-like relationship between the game elements (e.g., props, furniture, non-player characters). The relationships are probabilistic in nature. When the player interacts with one game element, the properties of this element change and, subsequently, specific properties of related elements change

4. Conclusion

In conclusion, the presented attempt to emergent game design in educational contexts can be seen as a hybrid model which tries to combine the best of both worlds, the author driven scripting of the global context (including the educator driven design of learning) as well as the degree of freedom and cost-effectiveness of emergent approaches to game design. Apart from the educational context, the hybrid model provides also ideas for designing virtual environments in general.

Emergence is primarily driven by “intelligent” characters and “smart props” (prop is a term for objects in the game such as tools, weapons, furniture, etc.). The approach of cellular automata enables changes in the game context (by actions of the player and by micro or macro adaptive assessments) affecting not only one specific character or prop but, driven by more or less complex rules, semantically neighboring characters and props.

Particularly from an educational perspective it is crucial, of course, that the information recorded by the system during gaming episodes and the conclusions drawn from that information are appropriate and valid. Although the approach is at an early stage, especially the combination of educational adaptation with interactive storytelling and aspects of emergent behavior, first evidence comes from the context of evaluation studies in a predecessor project (ELEKTRA, www.elektra-project.org; cf. Kickmeier-Rust et al., 2008). Currently the ideas are implemented in a prototype demonstrator game in 80Days and evaluated at schools in Austria and the UK.

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Learning is not Self-Evident: Conceptual Change Demands Time an Support

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Abstract: Most learning theories relay on an assumption that concepts change through enrichment of prior knowledge. Conceptual change, as a learning theory, states that change in conceptual structures could not be achieved through additive mechanisms involving only enrichment of pre-existing knowledge. Conceptual change is required, for example in acquisition of the concept of fraction because it requires radical changes in the pre-existing concept of natural number. The aim of this article is to study the conceptual change in the context of game based learning. The study focuses on the process of conceptual change trying to reveal playing patterns that facilitate and trigger it. In this article, conceptual change is studied through game designed to teach mathematics - number axis with decimal, fraction and percent numbers. Traditionally, the comparison between these numbering systems has been found relatively challenging. The overall aim of the study (N=369) is to broaden knowledge of the process of conceptual change in games involving teachable agents. The results clearly indicate that some of the learners had illusions of understanding about the number axis, but their high motivation and good metacognitive strategies lead to perception of the conflicting notions and finally resulted in more radical conceptual change. To summarize, the results of this study, as well as previous research, indicate that sufficient playing time, adequate prior knowledge, good metacognitive strategies, high motivation and game elements that trigger reflection support conceptual change. Thus educational games cannot be only supplementary amusement, but pedagogically well designed tools that should facilitate reflective processes both during and after the playing sessions.

Keywords: Conceptual learning, game based learning, mathematics learning

1. Introduction

According to Mayer (2004), constructivism has become the dominant view of how people learn. The underlying premise of constructivism is that learning is a process in which learners are active sense makers who seek to construct coherent and organized knowledge (Mayer 2004; Papert 1999; Phillips, 1997; Dewey, 1938/1997). It has been argued that learning games may act as effective learning tools supporting knowledge construction (e.g. Kiili 2007; Gee 2003; Amory 2001; Prensky 2001). However, these arguments rely too much on conceptual research and more empirical research about knowledge construction processes in learning games is needed.

In this article conceptual change is studied in the context of game based learning. The overall aim is to deepen knowledge about the process of conceptual change in games involving teachable agents. Traditionally, the conceptual change approach has been used in the realm of science, but research shows that it is applicable to mathematics also (Vosniadou & Verschaffel 2004). Conceptual change is required, for example, in the acquisition of the concept of a fraction because it requires radical changes in the pre-existing concept of a natural number (Stafylidou & Vosniadou 2004). In this article, conceptual change is studied through a game designed to teach mathematics – the number axis with decimals, fractions and percentage numbers. In basic mathematics a comparison between these numbering systems has been found to be relatively challenging, and therefore it is expected to be a fruitful context for research. The study focuses on the process of conceptual change while trying to reveal playing behavior that facilitates it. In the pages that follow we briefly describe the conceptual change approach. The dynamics of motivational, cognitive, and metacognitive processes are considered in particular. After that details of the empirical study and the learning game that was used are presented. Finally, the results of the study are presented and discussed.

During the last two decades numerous models of conceptual change have been developed. The creation of cognitive conflicts has been a dominating instructional strategy in supporting conceptual change (Limσn 2001). Cognitive conflict makes a learner dissatisfied with his or her existing conception of phenomenon and may lead to conceptual change. In order to explain why cognitive conflict does not always support conceptual change, Merenluoto and Lehtinen (2004) proposed a theoretical model of the dynamics of motivational, cognitive, and metacognitive processes in conceptual change. Merenluoto's and Lehtinen's (2004) model describes a learning situation in which the learner experiences tasks dealing with phenomenon calling for a new conceptual understanding. A learner's cognitive, metacognitive, and motivational sensitivity to the task influences how the learner perceives the task. With sensitivity Merenluoto and Lehtinen (2004) mean the extent to which the learner is aware of and interested in the novel cognitive aspects of the phenomenon. The model distinguishes three possible learning paths: the experience of conflict, the illusion of understanding, and having no relevant perception. For a more detailed description, see Merenluoto and Lehtinen (2004).

2. Method

In this study, participants played the game AnimalClass, in which they taught a virtual pet, a teachable agent which can reason based on how it is taught. Previous studies on games involving teachable agents have provided evidence of learning gains (e.g. Ketamo & Suominen 2008; Kiili & Ketamo 2007). The current research paper is designed to take a closer look at the learning process in such games and it focuses on conceptual change while trying to reveal the playing behavior that facilitates it. The data modeling behind the AnimalClass game enables tracking and analyzing playing behavior in such a way that conceptual change can be studied virtually. The overall aim is to broaden knowledge of the process of conceptual change in games involving teachable agents.

2.1 Experiment groups and procedure

The sample (N=369) was collected during the year 2007 in Finland in co-operation with elementary school teachers who liked using educational games as a part of their teaching. Participants were observed virtually in order to study conceptual change in real life situations with high ecological validity. The concept of ecological validity is used to describe how natural the test situations in experimental behavioral studies are (Loomis & Blascovich 1999). In other words, participants are expected to use the learning game in as natural a way as possible. The procedure of the experiment was as follows. The teacher started the game session at suitable times during the field test month. Instructions for the teachers related to how the game is played. Pedagogical instructions were as minimal as possible. Only examples of good practices were provided. Because the aim of the experiment was to receive as ecologically valid data as possible, there was no mandatory procedure for playing the game. In general, pupils started game play at school, where they played in a one or two hour session. After that the pupils could continue playing at home, but some of the pupils could also continue playing at school.

2.2 Materials

The game, AnimalClass, (Ketamo & Suominen 2008) utilized in this study relies on a learning-by-teaching approach. In the beginning of the game the player meets his/her own virtual pet, a teachable agent, which wants to learn mathematics. The task of the player is to teach his/her pet the number axis with decimals, fractions and percentage numbers. From now on, we will use the term '(teachable) agent' instead of the term 'pet'.

At the beginning of the game the agent does not know anything. Its mind is an empty set of concepts and relations. The player has complete freedom to teach the agent what he/she wants, even wrongly. In AnimalClass teaching is always based on statements constructed by the player. The agent answers according to its previous knowledge. If there is no previous knowledge, it will guess. The player then tells the agent if the answer was correct or not, and based on this, the agent forms relations between concepts. The agent learns inductively: Each teaching phase increases and strengthens the network of concepts. When the agent achieves a concept structure of a certain size, it can start to conclude.

Teaching of the agent is performed in the classroom. The classroom (Figure 1) supports learning in two ways. Firstly, constructing a question requires knowledge about the subject. If the players do not have enough knowledge, they are encouraged to discuss the problem with their friends. Secondly, evaluating the answer of the agent supports reflective thinking: "What have I taught the agent? Why did the agent answer in this way? What should I do next?"

An interesting part of teaching is the possibility of teaching wrongly. There is a brain icon in the game (see Figure 1) that describes the quality of the agent's conceptual structure compared to formal goals. The brain gets bigger if the quality of conceptual structure increases and smaller if the quality decreases. If the overall conceptual structure is wrong, the brain is replaced with a cactus icon in order to show the player that he/she is doing something completely wrong.

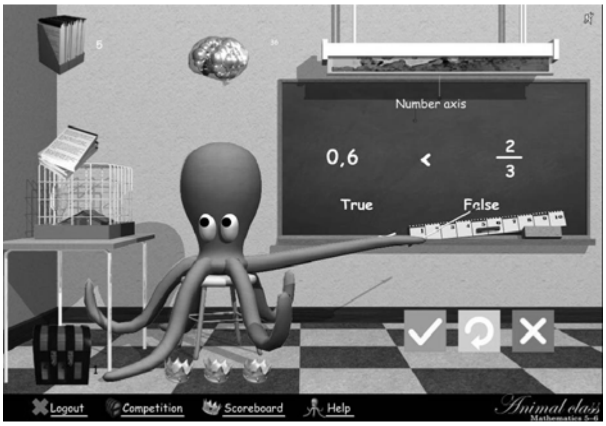

Figure 1: Classroom in AnimalClass

The player can send his/her agent to a competition (Figure 2). In the competition, the agent competes in a quiz against someone else's agent that has been taught by a real person (possibly a friend or classmate). The competition is completely based on previous teaching. The role of the player is to observe the successes and failures of his/her agent in order to grasp the agent's current skills and misconceptions. A competition challenge is automatically accepted; a player cannot refuse to compete. Furthermore, because the competition is based on the conceptual structure of the agents (previous teaching), the challenged player can be offline.

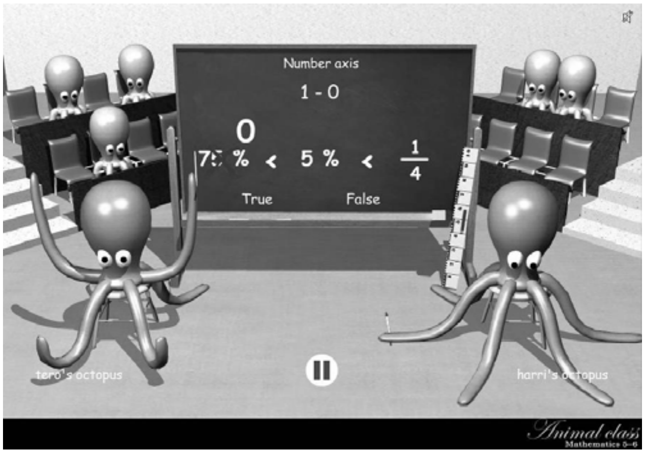

Figure 2: Competition in AnimalClass

A teaching phase term that is used in the Results section needs a more detailed definition. A teaching phase consists of a question creation and evaluation –pair. Each teaching phase adds new relations into the conceptual structure. Furthermore, if the concept is not taught before, the new concept is also added into the conceptual structure during the teaching phase. The following example briefly describes the development of conceptual structures in the agent's mind during teaching phases. The understanding of how an agent's conceptual structure develops during playing is important in order to be able to interpret the results of the study.

At first, the player teaches the relation between 1 and 1/2. The question, created by the player in AnimalClass's classroom is: "Is ½ smaller than 1?" The agent does not have previous knowledge, so it will guess. In the case it guesses "true" and the player's evaluation is "Correct." The relation "½ is smaller than 1." is formed in the conceptual structure (Figure 3a). The same would occur in a case where the agent guesses "False" and the player evaluates "Wrong".

In the second teaching phase, the player teaches a relation between 0.3 and ½, with the question "Is 0.3 bigger than ½?" The player knows that the question is false, but the agent answers (guesses) "True". So the player evaluates "wrong" and the agent determines that the correct answer is either "0.3 is equal to ½" or "0.3 is smaller than ½". The conceptual network in the agent's mind grows by both of these relations (Figure 3b). The gameAI is implemented to record the determining rules in order to 1) enable human-like-guesses in the future and 2) to decrease computational costs affected by a network's complexity. Naturally, in our example the network does not cause any computational costs, but in a real game 30 concepts may easily form more than 1000 relations. When there are 1000 players online, all extra computational costs should be avoided.

In the third teaching phase a player forms a question in another way and asks "is 0.3 equal to ½?". Again, we know the statement is false. The agent can guess that statement is either "true" according to an "is_equal_to" relation or "false" according to a "is_smaller_than" relation. The agent guesses "false". When the player evaluates the answer as "correct", the agent determines that correct answer must be either "0.3 is smaller than ½" or "0.3 is greater than ½". After adding relations into conceptual structure, the agent knows that the correct answer is "0.3 is smaller than ½" because it is the mode (average) relation (Figure 3c).

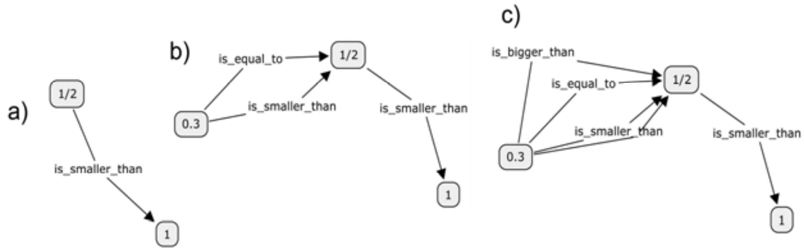

Figure 3: Development of semantic network in teachable agent's brains

While playing, the conceptual structure will grow to thousands of relations and a single teaching phase only has a limited effect on the areas of the conceptual structure already taught. Understanding this phenomenon is valuable when trying to correct a wrongly taught part of the conceptual structure. Naturally, wrong teaching could be corrected by teaching the correct structure enough times. The game AI uses all the taught information to back its decisions, and therefore it takes time to override the wrong relations in the agent's conceptual structure.

2.3 Measures and variables

The virtually observed data consisted of game-related data and complete log data about playing behavior. Game-related data included competitions, quantities of different events and the quality of agent's conceptual structure. The quality of the conceptual structure is defined as a binary correlation between the conceptual network, taught by a player, and the conceptual network, generated by the researchers, which is true according to definitions of mathematics. The correlation value [-1,1] can be used to compare the conceptual structures within this study. However, the correlation value cannot be used as a standardized unit outside this study. In fact, the previous research on AnimalClass games (Ketamo 2009) has indicated that the quality of agent's conceptual structure tends to have a strong relation with the knowledge and skills of a player, but it cannot be directly used to evaluate learning gains.

The variables related to the teaching phases were divided into five groups: a) adding new concepts to an existing conceptual structure, b) the strengthening of the correct conceptual structure, c) the strengthening of incorrect conceptual structures, d) excluding irrelevant relations, and e) the changing of incorrect conceptual structures. Changing incorrect conceptual structure is defined as an action that is meant to correct conceptual structure that has an incorrect mode relation and is connected to its vicinity by more than 6 relations. More detailed measures for each group were 1) performed without explanative competition or a break in playing, 2) performed directly after a competition, and 3) performed directly after a break in playing. A break in playing was counted if there were a new login with more than a pause of ten minutes.

The game play was divided into four sequences in order to examine the relationship between playing behavior and time. The limits for sequences were defined manually based on the number of teaching phases: The first sequence consists of teaching phases 0-150. If player completed less than 150 teaching phases during the whole game play, the player was excluded from following sequences. The second sequence consists of teaching phases 151-500. The third sequence consists of teaching phases 501-1000 and the fourth sequence consists of all of the teaching phases following that.

3. Results

In this study, the players had their agents do 128 829 tasks (avg=349, std=816) and performed 22 155 challenges for competitions (avg=60, std=237). The variance in playing behavior in general level was remarkably high. Therefore, all variables related to behavior patterns were normalized in order to bring the nature of behavior to the forefront instead of the quantity of events. In the variable based normalization each value was subtracted by the variable's average and divided by the variable's standard deviation. As the result of normalization, each variable was set to the scale: avg=0, std=1.

After normalization, the players were grouped using k-means cluster analysis in order to distinguish their behavior as related to modifying conceptual structure. The grouping was done according to a) adding new concepts to the existing conceptual structure, b) the strengthening of the correct conceptual structure, c) the strengthening of incorrect conceptual structure, and d) the correcting of incorrect conceptual structure events that each consisted of 1) performed without an explanative competition or a break in playing, 2) performed directly after a competition, and 3) performed directly after playing break states. When the number of clusters was set to five, a relatively explanative view of behavior related to conceptual change was achieved.

The clusters were formed according to normalized data, but the differences in behavior are still clearly seen in quantities. According to overall playing behavior, clusters 1 and 3 were quite similar, but the members of cluster 1 played much more (see Table 1). The competitions did not motivate these players, but rather they preferred teaching their agent. Although these players did not compete a lot they could still act reflectively in the classroom. In other words, they could perceive the hints presented in the classroom; the gestures of their agent and the growth of their agent's brains. Also clusters 2 and 5 were similar according to overall playing behavior, but the members of cluster 5 played much more. In contrast to clusters 1 and 3, the members of clusters 2 and 5 liked to compete a lot. After competitions and playing breaks these players tended to correct mistakes that they had made earlier. This indicates that the players could use competition as a reflection tool (reflection-in-action) and could reflect on their playing behavior also during the breaks in playing (reflection-on-action). We cannot be sure what triggered players to reflect on their playing behavior during breaks, but we assume that discussions with their classmates about the game may have played a major role.

Table 1: The quality of the conceptual structure, number of teaching phases, competitions and playing breaks within clusters

Cluster	N	Quality (mean)	Teaching phases (mean)	Competitions (mean)	Playing breaks (mean)
1	8	47,625	2732,00	322,00	52,88
2	50	16,32	918,42	159,28	37,64
3	36	10,33333	447,31	39,86	11,53
4	268	1,25746	67,71	12,47	3,65
5	7	45	3829,00	976,86	92,43

From table 1 we can see, that the agents taught by the members of clusters 1 and 5 had significantly better conceptual structures than other groups' agents ($t>4$, $p<0.001$ in both cases). This indicates that both a classroom-oriented and a competition-oriented playing strategy can produce good results.

In order to study conceptual change within formed clusters, playing behavior was divided into four time sequences. Figure 4 shows the percentage deviations of adding new concepts to the existing conceptual structure, the strengthening of the correct conceptual structure, the strengthening of incorrect conceptual structure, excluding irrelevant relations, and changing incorrect conceptual structure by sequences within clusters. It is not surprise that most of the new concepts were added at the beginning of game play and the percentage share of the strengthening of correct conceptual structures grows during the game play. When reading Figure 4, we have to remember that correcting the conceptual structure requires always more than one teaching phase, which means that there are several teaching phases observed for one conceptual correction.

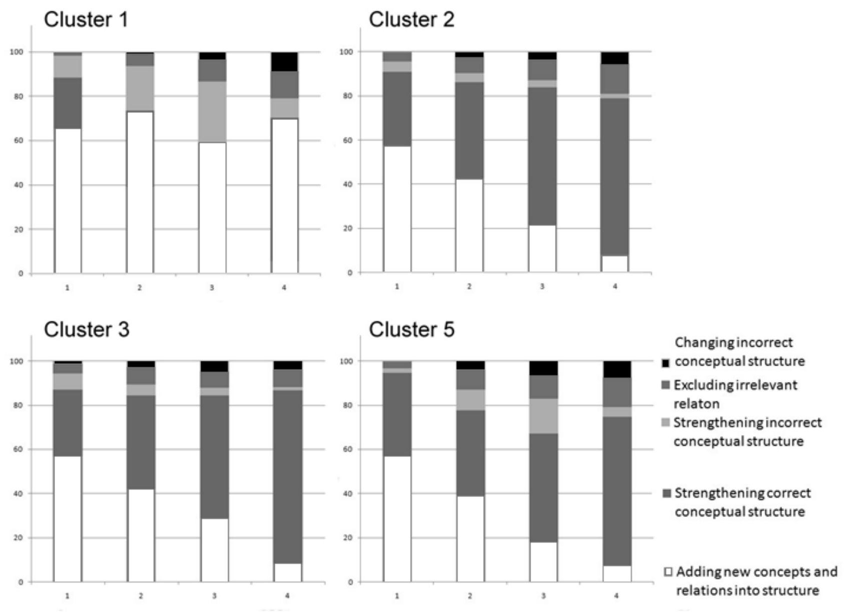

Figure 4: Percentage shares of adding new concepts to the existing conceptual structure, the strengthening of correct conceptual structures, the strengthening of incorrect conceptual structures, excluding irrelevant relations, and changing incorrect conceptual structures in four sequences of game play

An interesting result is that the clusters that were similar according to playing strategies differ clearly from one another according to the variables related to the creation of the agent's conceptual structure. Figure 4 shows that in clusters 1 and 5 the percentage share of the strengthening of incorrect conceptual structures increases from sequence 1 to 3, but dramatically decreases in sequence 4. In addition, the percentage share of changing incorrect conceptual structures is remarkably high in sequence 4. On the basis of these findings we argue that the members of cluster 1 and 5 have had illusions of understanding about number axis with decimals, fractions, and percentage numbers, but their high motivation have lead to the perception of conflicting notions and finally resulted in a more radical conceptual change during sequence 4. This finding supports Merenluoto and Lehtinen's (2004) argument that cognitive change requires time.

4. Conclusions

The results of this study support Merenluoto's and Lehtinen's (2004) model about the process of conceptual change involving experience of conflict, illusion of understanding and no relevant perception as paths behind conceptual change. The results showed that some of the learners had illusions of understanding about the number axis with decimals, fractions, and percentage numbers, but their high motivation and metacognitive strategies lead to perception of the conflicting notions and finally resulted in more radical conceptual change. Generally, it seems that some of the players were more sensitive to cognitive conflicts than other players and experienced them as solvable.

The results clearly pointed out that time have an important role in conceptual change process: The probability of conceptual change taking place increased when also the playing time increased. An interesting finding was that also breaks in playing facilitated conceptual change. We cannot be sure what triggered players to reflect on their playing behavior during breaks, but we assume that discussions with their classmates about the game may have played a major role. Overall, it seems that players became more sensitive to cognitive conflicts during playing and breaks and finally experienced them as solvable.

The results also revealed that players could use different playing strategies to achieve good results. Both classroom-oriented and competition-oriented players could perceive and solve possible conceptual conflicts. Part of the players found competition as a powerful reflection-in-action tool that facilitated them to perceive and solve conceptual conflicts. In contrast, some of the players did not compete much, but could still act reflectively in the classroom. In fact, they could perceive and utilize the hints presented in the classroom; the gestures of their agent and the growth of their agent's brains.

To summarize, the results of this study, as well as previous research, indicate that sufficient playing time, adequate prior knowledge, good metacognitive strategies and high motivation all support conceptual change. Furthermore, in virtual game environments the meaning of triggers of reflection should be emphasized. As Mayer (2004) has pointed out, guided discovery learning is much more effective than pure discovery learning. Guidance, structure and focused goals cannot be ignored when trying to promote appropriate cognitive processing. Triggers, clear goals and guidance are vital at the least to learners with low metacognitive abilities. Thus, based on the results of this study we argue that educational games cannot be only supplementary amusement, but pedagogically well designed and targeted tools that should facilitate reflective processes both during and after the playing sessions.

However, there are several points in this study that need to be addressed critically. In general, the game used as the test instrument is limited as an environment. In fact, all digital environments are limited in several ways and therefore we have to be careful when generalizing the results. The results of this study can be generalized in terms of conceptual change, but not in terms of educational games. The nature of conceptual change can be highly versatile depending on the mechanics, interactions and implementation of the game as a subject. From a validity point of view, one major threat is that we do not have any observation on what the participants really did at school and in their free time, because they were observed only virtually. Another threat to validity is related to incomplete data records. For example, competition played a major role in successful conceptual change patterns, but we cannot be sure whether a player perceived the conceptual conflict from competition or not. It seems very plausible, but from a data point of view, we cannot be sure about it.

In follow-up studies, a more detailed method to study competition, as a reflection-in-action tool will be built. The method that is under development will break down the competition into conceptual pieces that can be compared to the teaching phases after the competition. Also the analyzing middleware will be redesigned to produce timeline bound game statistics instead of sequences. Approaches like these will provide more valid analyses of players' behavior patterns.

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“One day I Will Manage FC Bayern Munich!” – How Sport Management Games Train Prospective Sport Managers, Development Of Competencies by Playing Digital Sports Games?!

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Abstract: Mass media continuously delivers breaking news on various sports. Among these sports, some sports might be more or less famous and popular. Undoubtedly, soccer is one of most famous and popular sports in the world. The huge amount of money involved and the number of worldwide fangroups indicate the high importance of this mass media spectacle. For instance, millions of people watch the world championships, while multiple people work hard behind the scenes to keep this business going. Moreover, soccer as a business enterprise seems to be still growing. Structures which have become as big as soccer naturally need to professionalize. Therefore, various professions tackle the demands of professional soccer. Among these professions, the so called sport manager plays a key role. The sport manager is responsible for serious decisions according to the present and future development of a soccer club. Someone holding that important position needs to be trained well, to be able to cope with the specific tasks within this specific field of work. For this purpose, university and higher education programs offer serious degrees to becoming a sport manager. Sport management even has become a distinct sub-discipline of sport science containing sophisticated scientific theory, content and methodology. Therefore, studying sport management opens the complex structure of the field of work in question that might appear quite simple in every-day conversation at first sight. At this point, digital games and the idea of integrating them into sport manager training processes come in. The immersive and engaging characteristics of digital games are leading current pedagogical discussions about digital media. Game scientists, (pedagogical) researches, and practitioners continue to attempt to embed digital games in pedagogical settings. They consider these games to be so called “serious games”. The idea of serious games is that a digital game is not only played for fun and entertainment, but to employ the specific game-play for serious learning outcomes in a specific field of learning or work. Hence, the question arises, whether, and if so how, a digital sport management game can assist prospective sport managers and students of sport management at the introduction to this complex field of work. To tackle the research question, it is necessary to investigate the profession of sport managers in “real” life and compare the game-play of a digital sport management game to them. Therefore, the best selling and most famous so called COTS (commercial off-the-shelf) game “FIFA Manager 09” by EA Sports is picked to be the subject of analysis. In conclusion, “virtual” sport manager-competencies actually match “real-world” sport-manager competencies well. However, further research will be needed, especially empirical studies.

Keywords: Digital sport games, game-based learning, serious games, sport computer games, sport pedagogy, sport management

1. Introduction

Soccer is undoubtedly one of the most popular fields of sport in the world. Among other things this is shown through its omnipresent appearance in global mass media and sport reporting. Nearly anybody has got at least something to say about that sport. Thinking of one’s wide circle of friends, one will surely find someone who is into soccer or at least has got an opinion on the specific action in this field of work and how professionals should act therein. The apparent need of outsiders to advise actors within a specific field (e.g. soccer) can also be observed in the field of politics.

Being a sport manager is professionalized as being a politician. Higher education offers degrees in sport management, which even has become a distinct sub-discipline of sport science containing scientific theory, content and methodology. Therefore, studying sport management reveals the complex structure of the field of work in question, which may appear quite simple in every-day life.

At this point, digital games and the idea of using them as serious games come in. The idea of serious games is that a digital game is not only played for fun and entertainment, but to employ the specific game-play for serious learning outcomes within a specific field of learning or work. Prensky (2001; 2006) developed a pedagogical framework for this idea, calling it digital game-based learning (DGBL).

Integrating sport management and digital games, the question arises, whether, and if so how, a digital sport management game can introduce prospective sport managers and students of sport management to this complex field.

To approach the research question, it is necessary to investigate the tasks of a sport manager in real life and compare the game-play and tasks of a digital sport management game to them. Therefore, the best selling and most famous so called COTS (commercial off-the-shelf) game among sport management games is picked to be the subject of analysis, namely "FIFA Manager 09", developed and published by EA Sports. FIFA Manager 09 offers tasks and options which are comparable in complexity to the scope of real world decision-making.

The aim of the paper is to show how beneficial learning outcomes can be assisted by playing a digital game. The profession of a sport manager needs to be described here to set the informational basis for argumentation. Thereafter sport management games must be also defined. Game-play analysis of FIFA Manager 09 shall lead to an insight of the inner structure of this digital game. The results of the game-play analysis will allow a comparison of digital sport-manager competencies and "real" sport-manager competencies.

2. The profession of a sport manager, types of sports computer and video games

Sport management is a relatively young academic discipline (Chalip, 2006). It is both a sub-discipline of sport science and business (and management) studies. Sport management refers to "all people, activities, businesses, and organizations involved in producing, facilitating, promoting, or organizing any product that is sport, fitness, and recreation related" (Pitts & Stotlar, 2002, p. 4). "Sport management programs train people for management positions in such areas as college athletics, professional teams, fitness centers, recreational centers, coaching, officiating, marketing, youth organizations, and sporting goods manufacturing and retailing" (Lussier & Kimbal, 2009, p. 4).

Appenzeller and Lewis (2000) structure the fields of sport management into six parts: a) human resource management, b) program management, c) marketing management, d) facility and event management, and e) legal management.

Further descriptions of the sport manager profession can also be found at Lussier and Kimbal (2009): Sport managers have to deal with several resources: a) human resources, b) financial resources, c) physical resources, and d) informational resources. Sport managers need to have a set of skills: a) technical skills, b) people skills, c) communication skills, d) conceptual skills, and e) decision-making-skills. Moreover, sport managers plan, organize, lead, and control, which correspond to the four (sport) management functions: a) planning, b) organizing, c) leading, and d) controlling.

Parks, Chopra, Quain and Alguindigue (1988) modeled sport management task clusters which combine general sport management tasks with organization and information management:

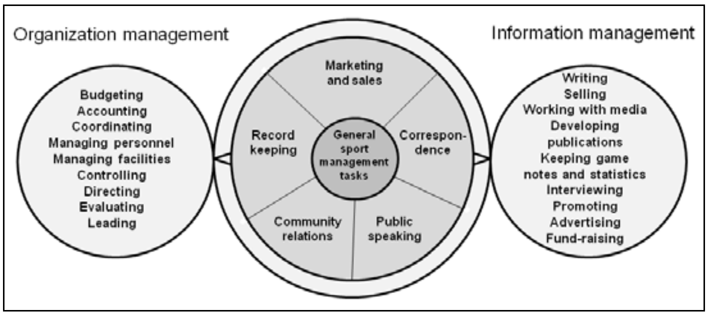

Figure 1: Sport management task clusters (Parks, Chopra, Quain & Alguindigue, 1988, in Parks, Quarterman & Thibault, 2007: 16)

Hoff, Kroll and Fletcher (2007 p. 61) consider the following skills as necessary for success in sport management (according to Patterson and Allen, 1996): "a) computer literacy in all types of technology, b) flexibility and adaptability to handle ever-changing roles and management styles, c) diversity in ability to function and work with people from a broad range of ages, cultures, and learning styles, d) language skills – especially for the global marketplace, e) team players – networking and negotiating skills a must, f) learning skills and continueous reeducation, g) personal career planning skills (self assessment, inner worth, current skills), h) global awareness/ orientation – knowledge of a country and region as well as the culture of the people there, i) oral and written communication skills – become even more valuable as corporations flatten, j) people must be self-starters, k) self-comfort –

the company no longer defines the worker, l) strong ethical framework, m) environmental scanning skills – knowing where your company is going, where the opportunities will be, see which direction to flex forward".

3. Sport management games

Consulting digital game research literature, one will surprisingly notice that sport management games like Football Manager 09 are not covered in-depth. Research on genre of digital sports-games is highly underrepresented. For instance, neither Wolf (2005) nor Laird and van Lent (2005) allude to sport management games. Even Kayali and Purgathofer (2008), who deal with digital sports-games explicitly, do not tackle sports-management games. Only Kretschmann (2008) dares to attempt a classification of digital sports-games and developes a competence model. He differentiates between sport simulation games, sport arcade games, and sport management games.

"Sports management games are to be placed in the category of role-playing games. The user (or player) assumes the leadership of a sports club or an athlete and has to deal with all the reality-based problems a person in that role has (e.g. economics and financials). Compared to sports simulations and arcade games, sports management games have almost real-life complexity but only from the view of a person in a leading position. They do not allow the user to intervene in the specific sports-action 'on the court' by playing an athlete in certain situations. Here are some examples: Box Sport Manager (boxing), FIFA Manager 08 (soccer), NFL Head Coach (American football)" (Kretschmann, 2008, p. 245).

Kretschmann could not refer to the the latest version FIFA Manger 09 due to publishing date of his paper. Nonetheless, the definition is still up-to-date, even if examples can be exchanged and updated.

3.1 Sports simulation games, sports arcade games and game-play analysis of "FIFA Manager 09"

The sub-genre of sport management games has not yet been of much interest to game research, even though Becker (2007), Dondi, Edvinsson and Moretti (2004), Gee (2003), and Mitchell and Savill-Smith (2004) focus on the pedagogical use of COTS computer and video games in general. They do not differentiate sharply between genres or even certain games or game series. Actually, Kirriemuir (2005) surveyed certain digital games, but did not examine a sport management game. McFarlane, Sparrowhawk and Heald (2002) report on positive learning outcomes and skill development by playing various digital games, including the sport management game "Championship Manager" (soccer). Unfortunately, the game was merged with other games of different genres, so that the posited skill development can't be attributed unambigiously to Championship Manager.

In the serious games paradigm a sport management game could be a good introduction to the field of work of prospective sport managers. Game-play analysis of the game FIFA Manager 09 should be a good start to test this hypothesis. Although the term "game-play" is ambigious, one can state some (wide) definitions. Björk and Holopainen (2005, p. 3) define game-play as "the structures of player interaction with the game system and with other players in the game", while Rollings and Adams (2003, p. 201) consider "one or more causally linked series of challenges in a simulated environment" to define game-play. Integrating the described approaches, game-play analysis simply means an objective description of the possible actions that a player of a digital game has while acting within the game or gaming environment. Thus the following should serve as an informational input and map for non-players of FIFA Manager 09.

In FIFA Manager 09 the player assumes the role of the manager of a soccer club. The player can freely choose an avatar and its attributes as name or face. He or she has to decide between various international soccer clubs all over the world, considering whether to take a lower or higher league club. The FIFA Manager 09 licence includes real names of soccer clubs and players. The game-play contains several areas of possible acting. Aside from optional informational slides and options for preferences, sounds, music, etc., the player can choose between four main categories: a) team, b) transfer, c) club, and d) career. Within each category one can find several sub-caterogies. For "team" the player can choose seven topics: a) news centre, b) calendar, c) first team, d) reserve team, e) youth team, f) training, and g) dressing room chemistry. For "transfers" the player can choose between five topics: a) contracts, b) staff, c) transfer market, d) cooperation, and e) scouting. For "club" the player can choose between seven topics: a) financial status, b) stadium, c) club facilities, d) merchandising, e) ticketing, f) sponsoring, and g) achievements. For "career" the player can choose between five topics: a) my career, b) personal life, c) watch other matches, and d) career options.

Figure 2: FIFA Manager 09 desktop

The high degree of complexity of possible decision-making can be illustrated by regarding decision-making options in the exemplarily selected field "team", specifically in the sub-category "dressing room chemistry". In order to keep it brief, only this one example of game-play analysis with FIFA Manager 09 will be given.

Confronted with the "dressing room chemistry" screen, the player has several options to choose. He or she can talk to each soccer player or the whole team and/ or can make promises. Depending on the position (e.g. goalkeeper or striker) the player can choose up to ten different sentences to say to a soccer player (e.g. "You're in fantastic shape."). Additionally, the he or she can make promises to each soccer player (e.g. "You are a first eleven player." or "Don't expext to play.") and "special promises" (e.g. "Next year I'll make you captain."). On "team promises" the player can act within four areas: a) season objectives (e.g. "We'll win the championship!"), b) team (e.g. "Anyone who isn't fit doesn't play."), c) infrastructure (e.g. "The stadium will be extended."), and d) reserves (e.g. "We'll win promotion this season!"). The player's decisions have an impact on the mood and performance of each player and the whole team. Thus, the player's decision-making process gets immediate feedback by the digital game.

The selected example of "dressing room chemistry" stands for more than 100 decision-making alternatives. According to all the sub-categories within the four main categories the number of possible decision-making options in the whole game increases exponentially. The player can definitely spend hours just for a first superficial adjustment on demanded decision-making options in the game. Fine adjustment while playing a game season will take additional time and careful consideration as well. The combination of all possible (and therefore clickable) decision-making options in Football Manager 09 reaches almost real-life complexity, covering almost every relevant field of sport manager decision-making.

Figure 3: Dressing room chemistry: player relationships

For further information on the game, consultation of game reviews is approved (e.g. Clifford, 2009; Korda, 2009).

4. Digital sport-manager competencies vs. "real" sport-manager competencies

The intended comparison of digital sport management and "real" sport management needs criteria and a model. Therefore the theoretical background of academic sport management will be coupled with the game-play analysis. Due to practicality and handleability the desktop-menu (sub-)categories of FIFA Manager 09 will serve as the basic framework, into which the models by Lussier and Kimbal (2009), Parks et al. (1988), and Hoff et al. (2007) are integrated.

		Planning	Organizing	Leading	Controlling
Team	News centre				×
	Calendar	×			×
	First team	×	×	×	×
	Reserve team	×	×	×	×
	Youth team	×	×	×	×
	Training	×	×	×	×
	Dressing room chemistry	×		×	×
Transfers	Contracts	×			×
	Staff	×	×	×	×
	Transfer market	×	×	×	×
	Cooperation	×	×	×	×
	Scouting	×	×	×	×
Club	Financial status	×	×	×	×
	Stadium	×	×	×	×
	Club facilities	×	×	×	×
	Merchandising	×	×	×	×
	Ticketing	×	×	×	×
	Sponsoring	×	×	×	×
	Achievements	×			×
Career	My career	×			×
	Personal life	×	×	×	×
	Watch other matches	×			
	Career options	×			×

Figure 4: FIFA Manager 09 vs. Lussier and Kimbal (2009)

		Computer literacy	Flexibility and adaptability	Diversity (people)	Language skills	Team players	Learning skills and continuous reeducation	Personal career planning skills	Global awareness/ orientation	Oral and written communication skills	Self-starters	Self-comfort	Ethical framework	Environmental scanning skills
Team	News centre	x	x				x		x					x
	Calendar	x	x				x		x			x		x
	First team	x	x				x							
	Reserve team	x	x				x						x	
	Youth team	x	x				x						x	
	Training	x	x				x							
	Dressing room chemistry	x	x	x			x						x	
Transfers	Contracts	x	x	x			x		x				x	
	Staff	x	x				x					x	x	
	Transfer market	x	x	x			x		x					
	Cooperation	x	x	x		x	x		x				x	
	Scouting	x	x				x		x					
Club	Financial status	x	x				x							x
	Stadium	x	x				x							x
	Club facilities	x	x				x							x
	Merchandising	x	x				x		x					x
	Ticketing	x	x				x							x
	Sponsoring	x	x			x	x		x					x
	Achievements	x	x				x		x					x
Career	My career	x	x				x	x	x					
	Personal life	x	x				x	x	x					
	Watch other matches	x	x				x	x	x					
	Career options	x	x				x	x	x					

Figure 5: FIFA Manager 09 vs. Parks et al. (1988)

		Organization management									Information management									General sport management skills				
		Budgeting	Accounting	Coordinating	Managing personnel	Managing facilities	Controlling	Directing	Evaluating	Leading	Writing	Selling	Working with media	Developing	Keeping game notes and statistics	Interviewing	Promoting	Advertising	Fund-raising	Marketing and sales	Record keeping	Correspondence	Community relations	Public speaking
Team	News centre								x				x		x								x	x
	Calendar		x	x			x						x											
	First team				x		x			x														
	Reserve team				x		x			x														
	Youth team				x		x			x														
	Training			x	x		x			x				x										
	Dressing room chemistry			x			x			x				x										
Transfers	Contracts	x			x		x			x				x										
	Staff	x		x	x		x	x	x	x				x										
	Transfer market	x			x		x			x		x												
	Cooperation			x	x		x			x				x								x		
	Scouting			x	x		x		x	x				x										
Club	Financial status	x				x	x		x			x		x					x	x				
	Stadium	x					x			x				x						x				
	Club facilities	x				x	x			x				x						x				
	Merchan-dising	x					x			x		x		x			x	x		x				
	Ticketing	x					x			x		x		x			x			x				
	Sponsoring	x					x			x		x		x			x	x	x	x				
	Achievements						x		x	x		x		x	x					x	x			
Career	My career			x			x		x	x				x	x						x			
	Personal life			x			x			x				x										
	Watch other matches			x			x			x														
	Career options			x			x			x				x										

Figure 6: FIFA Manager 09 vs. Hoff et al. (2007)

Knowing the game and its game-play well enough, it is relatively easy to scan through the basic framework of FIFA Manager 09 and check whether an aspect of the particluar sport-management model matches or not.

The model by Lussier and Kimbal (2009) reaches almost a total match. The model by Parks et al. (1988) leaves some aspects untouched (language skills, oral and written communication skills, and self-starters). This negative match can easily be explained by the fact that face-to-face conversations with human beings are missing. The game-play of FIFA Manager 09 does not simulate complex human conversational interaction. Hence, language and communication skills are not fostered because FIFA Manager 09 does not allow the player to have complex written or oral communication. The negative match of “self-starters” does not surprise much, due to the fact that FIFA Manageger 09 is a computer game and therefore unable to set the start-up for a real-world sport-management career. The model by Hoff et al. (2007) shows negative matches for “writing” and “interviewing”. This can be explained similarly to the Parks et al. (1988) model; equal reasons of game-play and missing human interaction cause these negative matches.

The Hoff et al. (2007) model produces the lowest number of matches compared to the other models. This can be explained by the inner complexity of the model. Numerous sub-categories are evidence of a specialized and highly differentiated model. Matching one complex model with another complex model, as the framework of FIFA Manager 09 surely is, naturally leads to a small intersection. Thus, the overall matching rate can’t be as high compared to less complex models. Moreover, quantity can’t be the only measure for the presented matching process. Some specialized aspects of the Hoff et al model are important for only some specialized sport-manager processes. For instance, “managing facilities” is so specialized that is has got nothing to do with the FIFA Manger 09 categories “team”, “transfers”, and “career”. These specialized aspects indicate a quality match; that means that there actually is a high matching rate, although quantitative analysis displays a lower matching one.

In overview, only a few categories of the selected models are not covered by FIFA Manager 09. The intersection of digital sport management and “real” sport management is truly obvious and therefore strengthened by academic theory.

5. Conclusion

In sum, sport management games are of use for prospective sport managers. FIFA Manager 09 can be employed for serious learning outcomes which have a large amount of skills and tasks in common with “real” sport management and managers. Nonetheless, there is “open space” that is not covered by the sport management game due to a lack of face-to-face interaction and physical experience within the "real" world.

Sport management games, exemplarily FIFA Manager 09, can give an overview to students of sport management. They can serve as an exploratory introduction to critical thinking and cybernetic basics of the dynamic sport-management processes and the profession of a sport manager in a professional sport club, namely a soccer club.

After re-considering the sentence "One day I will manage FC Bayern Munich!" from the paper title, further thinking will probably lead to the question "What type of manager?". And this might lead to a possible answer when considering the manager-types model by Lussier and Kimball (2009):

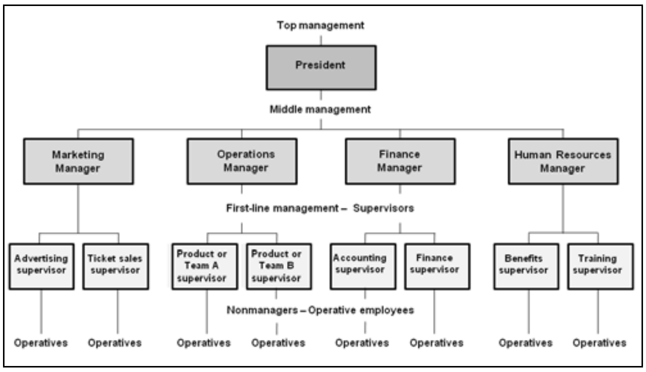

Figure 7: Types of sport managers (Lussier & Kimball, 2009, p. 14)

Following this thought, game developers may in the future focus on games which only feature a certain type of sport manager. Specialization in terms of a special training for certain manager types might be the result of this development. On the other hand, future sport manager training concepts might build on digital sports management games with a broad focus that cover all manager tasks and types in general. In this case, sport management games, which deal with a certain manager type only, might be used for specialized training in the training program for the selected manager type.

However, FIFA Manager 09 by EA Sports is not the only product in this sub-genre relating to soccer. "Football Manager 09" by Sega is a serious competitor on the market place (Clifford, 2009; Hassoun, 2008). Football Manager 09's game-play and design differ from FIFA Manager 09 and could possibly lead to different results when using the same theoretical framework presented in this paper. Even other sport management games, featuring different sports, could lead to different case studies due to specific game-design.

Further research might continue with an in-depth game-play analysis and might even change the point of view to "real" sport management as a starting point and basic framework, instead of using "virtual" sport management as the initial point for investigation. Furthermore, empirical data in quasi-experimental settings are recommended as well. These studies might compare prospective sport managers learning-groups using sport management games and "traditional" education methods learning-groups. In this case, curriculum development is highly inconsistent. Therefore, curriculum development should integrate digital sports management games. The original digital game-based learning approach by Prensky (2001; 2006) might serve as initial point.

In conclusion, FIFA Manager 09 as a representative of digital sports management games offers a sensible introduction to the field of work of sport management and associated work. However, scientific evaluation of future didactical scenarios integrating sport management games is needed. The digital game is only meant to be an assistant embedded in pedagogical arrangements that can't replace "real" experience with being a "real" sport manager. Research in this field is nearly not existent, even though of utmost importance.

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Jirafa Learning World – Massively Multiplayer Online Role-Playing Game for Primary School Math Education

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Abstract: Jirafa World is a project started in 2008 to develop an massively multiplayer online role-playing game (MMORPG) for children aged 6 to 10. The project is made in collaboration between game developers from Jirafa AB, researchers from Malmö University and teachers and children from Björnbodaskolan primary school in Stockholm, Sweden. The project has been granted financial support from Vinnova, the Swedish authority for innovation systems. The main objective of the project is to develop an online educational game and to demonstrate its ability to motivate children to learn Mathematics. There are several unique properties of this project: The development process is extremely user centered. The main story line and content of the game will be developed in a series of workshops with children in Björnbodaskolan during the spring of 2009. The children will truly be co-creators of the game. Researchers, teachers and game developers will work in close collaboration throughout the development process. All roles are seen as key to develop a game that will have high entertainment values and invoke the children's interest to learn more Math. The project will actively involve the parents of the children and find ways of including the parents as co-players. The main reason for this is that the parents' involvement is seen as a very important motivating factor for the children. The first version of Jirafa World will be developed by October 2009 and tested in several primary schools in Stockholm during the autumn. Prior to this project, Jirafa AB and Björnbodaskolan primary school have been collaborating on the development of a series of educational mini-games that have been developed according to the national knowledge goals in Mathematics and Swedish. These mini-games were included in the school curriculum during the autumn of 2008 and resulted in very interesting findings regarding the ability of children to learn through educational games and the individual differences between children regarding motivation and learning styles in relation to educational games.

Keywords: Game, mathematics, K-6, educational, MMORPG

1. Background

1.1 The start of the project

The Jirafa world project was initiated in the Summer of 2008 when the game developer Jirafa AB teamed up with teachers from Björnbodaskolan and researchers from Malmö University. Together we applied for funding from Vinnova, the Swedish authority for innovation systems, to develop and demonstrate an online educational game for children aged 6 to 10. The application was granted in December 2008 and the production of Jirafa World started in February.

1.2 The project partners

Jirafa AB is an IT-developer working with web portal services and educational games. Jirafa AB started in 2002 with the main business of producing custom made advanced web portals for corporate clients. The founder Björn Cronqvist developed a series of free online educational games for pre-school children out of his own interest in educational games and out of the needs of his own children. This small scale pilot project was followed up in 2008 when Jirafa AB teamed up with teachers in Björnbodaskolan primary school to produce a series of educational mini-games for use in the classroom with pupils aged 8 to 9. Four primary school teachers from Björnbodaskolan participated in the development and test of the educational mini-games. In order to make a larger scale project, Jirafa AB decided to apply for financial support from Vinnova and to find a research partner to complement the team from Jirafa AB and Björnbodaskolan. We contacted Professor Gunilla Svingby from the School of Teacher Education at Malmö University who accepted to become a partner in the project Jirafa World. Professor Svingby is Professor in Education and Social Education since 1983 and has over 10 years of research experience within the field of educational games. Professor Svingby brought in Dr Eva Riesbeck from Linköping University who specializes on Mathematics Didactics for primary school children. She worked as a primary school teacher for 20 years prior to going into research. Dr Riesbeck wrote her doctoral thesis in 2008 on Mathematics Didacitics (Riesbeck 2008).

1.3 Project goals

The objective of the Jirafa World project is to create an educational game that is as fun as it is educational. The primary use of the game will be outside of the classroom, at home or in school after school hours.

The specific goals of the project are:

- To develop the Jirafa World online educational game
- To test the Jirafa World educational game on the target group
- To make a scientific evaluation of the Jirafa World educational game and to communicate the results

1.4 Key points of the project

An important aspect of the game is that it should motivate the children to learn Mathematics by offering a virtual world where the use of Mathematics is an integral aspect of the context. In the real world, the children rarely can make direct use of their knowledge of Mathematics outside of the class room. By contrast, in the virtual world, Mathematics can be a very important skill for the players to advance in the game.

Another purpose of the project is to develop an educational game that has the potential to become a commercial success. This implies that the game has to combine high entertainment value with educational content. Our solution to this problem is first of all not to burden the game with educational instructions. The game will primarily serve as a motivator to learn Mathematics as a prerequisite to master the game. The actual instruction, i.e. teaching of Mathematics, may as well take place outside of the game. In our experience, children can spend a lot of time learning a skill that is necessary for mastering a game, even though there is no instant reward and the learning itself is not considered to be of particular value. Secondly, pupils will play together with other pupils from their class. The game will require a high degree of cooperation and the combined knowledge of the class. Our assumption is that it will be a motivating factor to play with the entire class and that the cooperation between the players will be a motivator in itself. Thirdly, the parents will be actively involved in the game play, which is an important motivating factor for the target group of 6 to 10-year old children.

The theoretical framework for our game concept is partly inspired by D.W. Shaffer and the concept of “epistemic games” (Shaffer et al 2005). Dr. Shaffer and others argue that the power of video games as a learning tool primarily lies in their ability to let the player simulate various characters, thus enabling him or her to learn through experience in the simulation. In Jirafa World, the players will have characters – avatars – that simulate the pupils themselves. These avatars will have to complete tasks in the game that require knowledge of Mathematics and that require cooperation among the players. The formal learning that is taking place in the game will also be reflected in the development of the avatar. We believe that the use of avatars will enable the pupils to reflect upon themselves as learners, in much the same way as children use dolls to enact various situations in life. This will hopefully lead to a kind of action and reflection learning, where the children will complete missions, develop their avatars and reflect upon their accomplishments. In Sweden, the MiL Institute that works with leadership education has coined the term “Action Reflection Learning” (Marsick 2002). In their concept, the action, learning and reflection take place in real life situations with “learning coaches” that guide the learners by asking questions and putting the learners outside of their comfort zones. All learning takes place in a social context, where the learners interact with people in real life situations and by trial and error arrive to new conclusions. Jirafa World will ideally offer an environment where action and reflection will lead to learning and at the same time encourage the pupils to experiment and to co-operate, like they do in real life.

1.5 Challenges of the project

We have identified a number of important challenges in association with this project. First of all, our own user experience from a number of educational games is not very positive. The main problem is that most of them are quite boring to play and lack the appeal of commercial games. Our analysis is that educational content cannot just be added to an existing game, the basic idea of the game should reflect the educational context. Our solution is to make problem-solving missions the story-telling vehicle of the game and to design the game as an MMORPG in order to allow the players to interact online and to form problem-solving teams. Thus, problem-solving and team play will be two basic components of the Jirafa World educational game. Another problem is the lack of computers in Swedish primary schools, in particular for children in lower classes. A municipal school is often equipped with just one computer per 30 pupils. In many schools, the teachers do not have their own computers (Skolverket 2009a). By contrast, most Swedish homes are equipped with one or more computers. Thus, only a few pupils will be able to access the game in school at the same time. Instead we rely on the participation of parents and that the game will be used at home. A related problem is the outdated equipment in many schools and strong restrictions on what software may be installed in schools. Our solution is to develop a game that is based on Adobe Flash and that does not require any local installation of software. Nor will we have the bandwidth requirements of a commercial MMORPG, since the schools usually have very limited bandwidth capacity. Apart from the poor equipment, there is also generally a low level of ICT-competence within the Swedish teaching staff (Ibid). In the Swedish teacher education, ICT is not a mandatory part of the curriculum. There is however a growing number of teachers that out of their own interest apply ICT-tools in the classroom. Thus, for our project to work as intended in school, we will rely on finding the early ICT adopters among the teachers and school leaders.

2. Production

2.1 User-centered production process

To develop a game that will meet the demands of the children, they have been made part of the development process. In a series of workshops we will test our ideas and let the children come up with development ideas of their own. The first version of the game will be developed as a prototype and tested on a focus group of some 40 children and their families that have volunteered to participate in the project. After that, the game will be further developed with expanded content and tested on children from several schools with different demographic characteristics. The process started in January 2009 and is planned to finish by November 2009.

2.2 The production process

The project team including game developers, researchers and teachers started the production process by a brain storming session in January 2009, where we came up with the basic ideas for the Jirafa World game. The ideas were further processed in February and March when the actual production started and the project plan was created. A workshop was held in April with some 20 children where we put forward the rough concept of the game and some sketches. We asked the children to come up with further ideas about what the story of the game should be. The first prototype was ready by May 5, when we held the first of a series of user test workshops to test the game prototype. A total of four user test workshops will be held in school with the children to test the game prototype. The workshop group will consist of 20 to 30 children and a team consisting of a game developer, a researcher and a teacher.

In order to inform the parents and to invite them to participate in the project, an information meeting was held in Björnbodaskolan in April 2009. The parents were informed about the scope of the project and the project plan and given the chance to participate in the project by volunteering to test the Jirafa World game at home. About 20 families volunteered to be a part of the test group. The plan is to give the parent a role in the game as a helping hand that can aid the children when they perform missions within the game that require a certain level of understanding of Mathematics.

The Project Plan
Jan – March: Developing the concept
April – June: Simultaneous production and testing
July – August: Production of beta-version
September – October: Test of beta-version
November – December: Communicating the results

Figure 1: The project plan

The first stage of the production process will go on until August 2009, when the game will be fully functional. During September and October, the game will be tested in more schools in the Stockholm area. During this phase, observations about the learning effect and the general motivational effect on the users will be made by the researchers. Observations will be made using various methods such as online observation of the players and interviews with the children and their families.

3. The Jirafa World game concept

3.1 Game background and mission

The background story is about three brothers and three sisters that lived in an enormous tree and dreamed of creating their own kingdoms in the tree. They asked the tree's guardian to help them, but she said that they did not have enough knowledge to create kingdoms. If they could find ways to build their kingdoms without hurting the tree, the guardian would help them in their quest.

The siblings gathered the best mathematicians that they could find to figure out how to build their kingdoms and eventually after several years they succeeded. The tree had beautiful fruits in the form of colored balls. From the tree's fruit they could extract energies and by combining these energies they could get things to grow in exactly the way they willed it to grow. The siblings took fruits from the tree and placed them on the ground and the fruits evolved into whatever they were thinking of: A bridge, a castle, a forest or a walking stick. The guardian was impressed by what she saw and decided that the siblings were ready to build their kingdoms. The siblings were allowed to use the tree's fruits to build their kingdoms on one condition, that they never took the fruits of the moon and the sun, since they were too powerful for the siblings to handle. They made the promise never to touch these fruits and started constructing their kingdoms.

Thus, the kingdoms of the tree were created. The kingdoms were called Platonoidesia, Abiesia, Roburia, Castanumia, Sylvestrisia and Aucuparia. Over the years the kingdoms grew and prospered and the siblings became kings and queens of the tree world. But they eventually grew bored with governing their kingdoms and wanted to make new constructions that would outshine the other kingdoms. They started to yearn for the forbidden fruits of the moon and the sun and eventually one of the siblings took these forbidden fruits and made the most fantastic creations. The other siblings were jealous of their brother and sent out spies to find out how it was possible to make such fantastic creations. When they found out that their brother had stolen the forbidden fruits they sent thieves to steal them from him. A war broke out between the tree kingdoms and the tree dropped all of its leaves because of the grief that it experienced. All of the kingdoms died and all was chaos and despair…

A thousand years later, the players arrive to the dead tree with a mission to return life to the tree and reconstruct the kingdoms. The only way that life can be returned to the tree is to gather knowledge of Mathematics that conveys the secret formulae that were originally used to construct the kingdoms of the tree. The players start by going through a training session to decide the starting level. After the initial training they get various missions and tests they must pass. A non-player character greets the players in the beginning of the game and explains the basic rules. When the players succeed in a mission or pass a test they earn one of the tree's fruits, in the shape of a colored ball. As they make progress in the game, the tree starts to come to life as new leafs are coming out on the branches.

Figure 2: The avatars

The players will get missions that require knowledge of Mathematics. Each player's accomplishments will be stored and displayed within his avatar's "inventory" so that each player can follow his individual progress.

Figure 3: The tree

The main driving force for the players will be to develop their avatars by accomplishing the missions in the game. Secondary driving forces will be to solve the riddles that they will encounter in the game and to master various skill-based mini-games.

3.2 Learning in Jirafa World

The knowledge content is partly based on the Swedish national goals for Mathematics in the primary school (Skolverket 2009b). In school years 3 and 5 nationwide tests are carried out in all Swedish primary schools to measure the pupils' progress towards the national goals. By complying with the national goals, it will be easy for the teacher to validate the pupils' achievements in the game in order to use the game in class. Since the pupils play with other pupils from their class, the teacher can use the game as a departure point for various projects in class where the game can be a part. In this way, the knowledge content will not be restricted to Mathematics. For example, the game can be used in a biology project where the pupils explore the mechanisms of seeding and growth in nature, using the tree in the game as a study object. Our intention is that teachers will be co-creators of the total gaming experience by using the game in innovative ways in school.

Jirafa World is to a large extent a cooperative game where the strong pupils will benefit from helping the weak pupils in order for the group to make progress. The idea is that the pupils to some extent will learn from their peers. Achievements are generally measured individually, but pupils can earn extra points in the game by helping others. For example, a pupil that earns a number of points for helping others will be able to unlock a new mini-game. This mechanism also serves to adjust the level of challenge so that strong pupils will get access to tracks that require a higher level of Mathematics, whilst still enabling the class to play together.

3.3 Past experiences

In 2008, Jirafa AB developed a series of educational mini-games in cooperation with Björnbodaskolan. These games were tested on pupils in year 3 during the autumn of 2008. The games had educational content based on the Swedish national goals for Mathematics and Swedish. The games also had an online statistics tool that kept track of the pupil's performance in real time. The tests were carried out in the class room with some 70 pupils over a period of about two months. This test gave a number of interesting results, according to the observations of the teachers:

- The children did not make the connection between the learning in the game and the learning in the classroom. Even though some of the Mathematics games in particular were very similar to exercises in the text book, the children did not comprehend that they were doing exercises of the same kind.

- Some of the weakest pupils in Mathematics made the most significant progress in their learning of Mathematics, by using the games. The games clearly worked as a motivational factor for learning (even though the pupils did not identify the gaming activities as learning).
- The statistics tool was highly appreciated by the teachers and the use of this feature to track the children's progress lead to a deeper understanding of the children's level of knowledge since the teachers could identify exactly in what exercises that the children experienced difficulties.

4. Outcomes

One outcome of the project is to produce an MMORPG that is entertaining for children and that has the potential of becoming commercially successful. Another outcome is to create a model for the development of educational games by bringing researchers, teachers and game developers together in the production team. The Jirafa World project will end on January 15, 2010, and we will publish a scientific report in the spring of 2010 to disseminate our experiences for the benefit of the international educational games community.

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Story Patterns for the Design of Game-Based Learning Experiences

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Abstract: The paper presents a step towards a catalogue of storytelling patterns intended to facilitate design of motivating educational game content. Designers will find reusable best practises regarding plot construction for game quests or missions. To arrive at a first version of a catalogue, we carried out an empirical, qualitative search for recurring plot sequences in two corpora, (1) award-winning TV commercials, (2) feature films related to education and growing up. The results are a first step towards a catalogue of patterns. As a first trial in a blended-learning course at our university indicated, designers of educational game content can already use our patterns when transforming traditional eLearning into a game-based approach. In the context of this task, three major questions arise. The first question is how the transformation can be realised. There is a need for reusable heuristics, based on prior experiences and on research in eLearning as well as in games. The next question is how to evoke intrinsic motivation, immersion, and flow in a potentially extrinsically motivated learner. Strategies are needed for enabling meaningful learning experiences to make the promises of educational games work. A final important question deals with avoiding that a playful environment dissolves a carefully laid-out knowledge structure. Game design needs structure as well. To address these issues, we began constructing the pattern catalogue. Employing the psychological concept of 'script' and focusing on the storytelling dimension of narrative educational games, we identified 37 recurring meaningful plot sequences in Corpus 1, and 70 in Corpus 2. Of these results, 13 patterns were evident in both corpora. As an illustration of our findings, we present seven patterns from this intersection using a semi-formal pattern language, and discuss how the results relate to gameplay and learning in digital educational games.

Keywords: Game-based learning, storytelling, design patterns, scripts

1. Introduction

Educational games promise to stimulate intrinsic motivation, and to enable transfer of knowledge from simulated to real environments (Martens, Diener and Malo 2008). Thus, the desire grows to turn traditional eLearning content into games. Authoring tools support game content creation via drawing tools, animation timelines, collision detection, or physics engines. Yet, their support usually ends when it comes to gameplay design and storytelling. Many educational games are story-based though. Stories appear e.g. as scenes, missions, or quests. They support learning by tying knowledge reception to meaningful experiences, anchoring the knowledge in a learner's episodic memory (Kritzenberger 2005:122–123). Not every content developer is a professional game designer or screenplay writer though. Designing and realising game modules can therefore become a major obstacle in producing game-based learning. Authors would need access to guidelines or documented best practices.

2. Patterns

Design patterns collect best practices and put them together in a way that different actors in a development process can understand and use. The approach can be dated back to the 1970s, when Alexander developed architectural patterns for architects and inhabitants (Alexander et al 1977). He organised his patterns in a catalogue with descriptions at different levels of granularity. The pattern approach has later been adopted in computer science (Gamma et al 1995), and recently in eLearning as well (e.g. Harrer and Martens 2007). ELearning pattern catalogues combine patterns at different levels of abstraction, e.g. content, didactical, and behaviour patterns (e.g. Martens and Cap 2009), but also computer-science patterns (Harrer and Martens 2006).

When combining games and learning, content developers have to bridge the gap between playful environments and carefully laid-out knowledge structures. How do we turn learning objectives into game objectives; a lesson into a level; an exercise into a puzzle; a case or scenario into a scene, mission, or quest; real-world knowledge into simulations; a tutor into a non-player character? Ideally, patterns would document successful translations and support structured approaches. This insight is not new. Björk and Holopainen (2005) may have been the first to publish an extensive, formalised catalogue of gameplay concepts ("character development") and features ("high score lists"). Bates (2004:120–127) does not formalise his typology of game puzzles nor call them patterns, yet his puzzle types (e.g. "excluded middle puzzles", "machinery puzzles") are more concrete and immediately useful. For educational games, it would be interesting to map Bates' puzzles to typologies of non-game eLearning exercises. Schanda (1995: 77–85) and Mair (2005: 100–107) both list exercise types ("multiple-choice", "sequence exercises"...), but do not formalise them as patterns. The main drawback is that a designer can only use those types in isolation, whereas a generic pattern catalogue brings approaches together and indicates how to combine patterns. This has also been an insight in the Kaleidoscope project (Pratt and Winters 2006), which produced patterns for game-based learning. These patterns cover a wide area, e.g. including the deployment of games in class, yet they are limited to the domain of mathematics. To attain the goal of linking concrete game design with generic eLearning models through patterns, there is still work to do.

For aiding storytelling in educational game design, there are software-engineering patterns for implementing quests (Onuczko 2005), content-level patterns for character design (Lankoski and Björk 2007), or collections of character roles (e.g. Isbister 2006: 225–252). Isbister's "mentor" would work fine as a game-based-learning equivalent of an intelligent tutor or pedagogical agent. However, an empirically-founded, formalised catalogue collecting content-level subplot skeletons and relating them to gameplay and/or learning – something that is needed for mission or quest design – has not been proposed yet, as far as we know. Studies from the field of literature that are sometimes cited and used by game designers mostly deal with storylines as a whole, i.e. the grand, macro-level plot, not the small subplot. Tobias' 20 master plots, including "rivalry" or "sacrifice", would be somewhere between micro and macro, yet not being related to games and/or education (Tobias 1993). The question remains: What valid strategies can we use within smaller-scale narratives to evoke intrinsic motivation, immersion, flow, and meaningful experiences in an extrinsically motivated learner?

3. Scripts

This is where Mikunda's (2005) concept of *brain script* comes to help. *Scripts* were invented in the mid-1970s by cognitive scientist Schank (e.g. 1995), who claims that human knowledge is represented in the form of stories. He describes a script as "a set of expectations about what will happen next in a well-understood situation" (ibid.: 7), e.g. a visit to the restaurant. For Mikunda, the restaurant script would be a *slice-of-life (SoL)* brain script, as it describes an everyday-life activity. Further scripts are based on Berne's (1964) *games people play* – in fact an early pattern catalogue describing situations of social conflict and interaction – or rooted in *myths*, such as "David vs. Goliath" (Mikunda 2005: 22–24). Myths preserve cultural knowledge and provide answers to the essential questions of life. Contemporary media and popular culture keep them alive.

People have experienced and learnt scripts all their lives. They have become common knowledge. A person needs only very limited hints to recognise a certain script. An author can use *contradictions*, *headers*, i.e. obvious pointers, and *accumulations* of similar clues to raise a recipient's attention. These would trigger the *slots*, i.e. a sequence of actions which constitute the brain script, in the recipient's mind. He or she is now 'in the loop', an 'insider' to the story. Mikunda's point is that an author can equip a potentially dull activity with an exciting variation of a commonly known script, and thus turn it into a meaningful experience. Designers can surprise recipients by finding the special in the ordinary, providing subtle clues, or leaving slots empty so recipients can fill them on their own. All in all, Mikunda's technique points out how one can attach entertainment to serious causes. The problem is that he provides only a couple of informal examples – no catalogue.

Yet, as Harrer (2009) has shown, scripts can be transformed into patterns and vice versa. Musielak and Schmidt (2008) take a first step towards applying scripts to educational adventure games. They use a pattern-like language detailing participants, activities, resources, and sequence (i.e. slots) of a script. Their scripts, however, will probably remain domain-dependent, and no catalogue is given.

4. Objectives

In the following, we assume the perspective of the content designer, regard scripts as design patterns for educational game plots, and begin constructing a pattern catalogue. Our primary goal was to formulate behaviour patterns on the content level. These patterns would provide a meaningful tool for content developers with diverse professional backgrounds, avoiding drawbacks of the approaches found in literature (no catalogue, too informal, not reusable, not transferable, not applicable...).

5. Method

We needed a corpus of storytelling material in which we could do pattern mining. The most obvious choice would have been successful educational games. Yet, game-based learning is still a young discipline. The range of compelling commercial products is still rather small. Moreover, the underlying system development aspects are often not made accessible – software engineering decisions either did not take place in the development process, or have not been explicated for public reuse. We sought to mine a corpus holding a wealth of information stemming from undisputed professionals in entertainment, yet with some connection to edutainment/infotainment and education. We might have studied successful video games, yet as a first step we wanted stories outside the context of certain gameplay features. Thus, we went for (1) the advertising industry, (2) the film industry as sources of knowledge. TV commercial writers tell intense stories within a short time and by this form of entertainment achieve something more (selling products). Screenwriters create short, entertaining scenes as well. In addition, they are used to exploiting myths, as well as creating their own myths by building up genre knowledge. Film genres promised to be a good source for recurring plot patterns. Both subcorpora would be based on "scripts" in the original meaning (i.e. dialogues).

To build Corpus 1, we aimed for a set of award-winning TV commercials. The *Cannes Lions International Advertising Festival* may be the most prestigious competition in this area. We therefore studied official selection tapes from these festivals – one from the 1990s (CL 1990–94) and one from the 2000s (CL 2004). The first video features one hour of advertising spots, the other one two hours. Corpus 2 came to us, rather than having been set up deliberately for this study. For another storytelling-related project, we were investigating the film genre "coming of age", i.e. films about growing up. While preparing this study, we realised that the mentioned genre study fit our game-based-learning interests as well. Narrated maturation (also a master plot in Tobias 1993) of a young protagonist should suit educational situations well. In fact, coming of age as a film genre builds on the literary genre "Bildungsroman" (Schmidt 2002: 92–104) – a term from German that could mean "formation novel", but also "education novel". We considered looking only at the sub-genre of school films (Shary 2002: 26–79). This setting does appear in games. The pure-entertainment computer role-playing games *Morrowind* (Bethesda, 2002) and *Dawn of Magic* (SkyFallen, 2007) e.g. include wizard academies, with teachers, books, classrooms – even alchemy labs. These might be well-suited game settings for teaching chemistry. In *Morrowind*, initial wizard quests centre round "rivalry" between students of magic – another motive among Tobias' (1993) master plots. In the end though, we decided that limiting our search to school films would not have been constructive. A strength of game-based learning lies in the fact that it can create any virtual environment. Rather than re-creating a school situation, it can place the learner in a simulation of an actual site where domain knowledge is applied. We therefore considered the whole set of 117 coming-of-age films we had chosen for the other study.

The next question was what kind of scripts to look for in the data. Myths might create the strongest experiences. However, a game can exploit SoL as well, e.g. to evoke humour. As a student of magic, the player in *Morrowind* is at one point sent out on a quest to collect membership fees from a wizard with outstanding payments. Likewise, there are games that simulate social interaction, e.g. *The Sims* (Maxis, 2000). Educational games taking on that idea can make use of games-people-play scripts. Thus, we did not limit our search to a certain type of script. In both corpora, we were looking for recurring meaningful plot sequences. In Corpus 1, we registered any TV spot that seemed to embody a script, and then looked for further occurrences in contemporary media. If we found several such references, we considered the script a pattern. In Corpus 2, we registered typical subplots that occurred in several coming-of-age films and were related to maturation. We combined both analyses by determining the intersection (patterns that emerged from both corpora).

6. Results

Corpus 1 yielded the following mythical scripts: Assault; David vs. Goliath; Fountain of Youth; Interrupted Wedding/Runaway Bride; Machinery; Mole; Message in a Bottle; Musical Chairs; Narcissus; Release Me; Revenge Is Sweet; Revolt; Rivals; Robinson Crusoe. Games-people-play patterns in Corpus 1 were: Artist vs. Producer; Coming out of the Closet; Declaration of Love; Different in Private; Doing Something Childish; Doing Something Mature; Good Cop, Bad Cop; I Don't Wanna Go Home Yet; I Want My Money Back; Long Time No See; Nice Weather, Isn't It; VIP; Visit of the In-Laws. We also found a couple of SoL scripts and named them: At the Circus; At the Hairdresser's; At the Restaurant; Bad Photo Shot; In the Classroom; Life's Just a Game; Picnic; Safety Instructions; Staff Meeting; Wedding.

Corpus 2 yielded these scripts: Assume Responsibility; Artist vs. Producer; Bet; Birthday; Bullying; Casting Call; Coming out of the Closet; Committing a Crime; Conversation on the Balcony; Cruising; Dare; Date; Declaration of Love; Delay Growing Up; Detention; Different in Private; Doing Something Childish; Doing Something Mature; Driving Test; Emotional Burst; Fake Parents' Letter; Family Feud; First Job; First Kiss; First Love; Funeral; Getting Closer/Sharing Secrets; Getting Past the Bouncer; Hitchhiking; Impress; In Five Years; In the Classroom; Interrupt Class; Interrupted Wedding/Runaway Bride; Judge Love Interest; Leave Hometown; Lying about One's Age; Looking in the Mirror; Losing Virginity; Makeover; Malicious Mischief; Monotonous/Bizarre Job; Moving out; Musing; New Beginning; Partner Retrospect; Play Stupid; Pregnancy; Pregnancy Test; Primal Scream; Prom; Quit Job; Realise Childhood Dream; Release Me; Revenge is Sweet; Review Record Collection; Revolt; Rivals; School Announcement; Secret Society; Self-Injury; Smalltalk; Soliloquy; Stay Friends; Stealing; Suicide (Attempt); Teenager Party; Therapy Session; Triumph; Wedding.

Assigning a type of pattern is more difficult here. For instance, Birthday would normally be a SoL script. Yet, in the context of coming of age, certain birthdays like the sixteenth, eighteenth, or the thirtieth birthday have a mythical quality. As a demonstration, we will detail scripts/patterns of highest validity here. Due to spatial limitations, we omit those scripts that in Corpus 1 occurred only in CL 1990–94 (the older spots), but not in CL 2004. Those six patterns are: Declaration of Love, Different in Private, Doing Something Childish, Doing Something Mature, Revolt, Rivals.

Tables 1–7 list the remaining intersection of results from Corpora 1 and 2 using a semi-formal pattern language. Each pattern is given a number, a name, and a validity rating from 0 to 2 asterisks (cf. Alexander 1977): 0 for occurrence in one of CL 1990–94, CL 2004, Corpus 2; * for occurrences in two of these sets; ** for occurrences in all three. Type can be one of: myth, game people play, and SoL. A textual description of the plot follows, then evidence from the primary sources (the corpora). A Petri net models the sequence of actions, i.e. the slots. We chose a more formal Petri-net notation instead of just a sequence of items due to its expressiveness: Petri nets can model loops, alternative sequences, and concurrency. Many feature films have concurrent subplots, technically realised by cross-cutting, i.e. jumping back and forth between locations. Games would use cut-scenes or alternation between player characters. Observed triggers can be one or more of: contradiction, header, and accumulation. Aggregation identifies observed associations with other patterns. Secondary sources as well as literature discussing the script theme are included to back up the pattern. Finally, the reason for this study was to aid design of game-based learning, so we mention occurrences of the pattern in digital educational games, when they came to mind.

Table 1: Pattern artist vs. producer

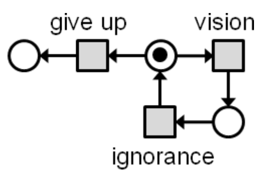
(1) Artist vs. Producer *	
Type	Game People Play
Description	The artist presents his or her visions to the producer. The producer reworks the idea into something sellable yet devoid of artistic value.
Evidence	Three spots in CL 2004 raising awareness for switching off the phone in the cinema. Prominent in *Reality Bites*; *Les Poupées russes* (France/UK 2005); weaker in *Zur Sache, Schätzchen* (Germany 1968, May Spils); *God Save the King* (Sweden 2005, Ulf Malmros).
Slots	
Triggers	Contradiction (opposite views)
Aggregation	Revenge Is Sweet
Educational games	In many narrative educational games, the learner needs to present inventions, concepts and ideas, or diagnoses to a supervisor or advisor character. The supervisor (perceived as "producer") might judge the solution as incorrect, while the learner (seeing him- or herself as an "artist") might think it is right. This can create frustration. Avoid this, and see to that the "ignorance" slot is filled by an antagonist, not a mentor.

Table 2: Pattern coming out of the closet

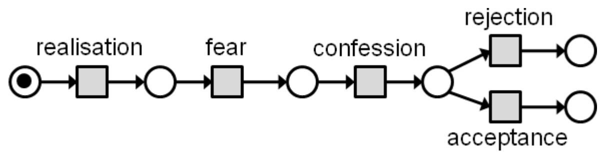
(2) Coming out of the Closet *	
Type	Game People Play
Description	Despite the fear of being stigmatised, a homosexual dares to make his or her sexual preference public.
Evidence	Spot for *TurnOut.org*: Different homosexual employees in the US walk in to a meeting with their bosses to tell them they are gay. The viewer does not see the result (slot left empty), but is informed that they could be fired (CL 2004). Many coming-of-age films have a scene in which a young gay or lesbian comes out of the closet. The lesbian protagonists in *Show Me Love* (Sweden 1998, Lukas Moodysson) step out of a literal closet (a school toilet). In *Reality Bites* (USA 1994, Ben Stiller), a gay character practises his coming-out by reading stereotypical lines from an actual script.
Slots	
Triggers	Header (“I am gay.”)
Aggregation	Bullying, First Love
Secondary sources	Problem films like *Brokeback Mountain* (USA 2005, Ang Lee) stretch this script over a whole storyline. When the mayor of Berlin confessed he was gay, his quote “...and it is good that way” developed into a saying.
Educational games	The diving simulation *Mission: Schatztaucher* (in German) features a lesbian team member, but – delightfully – introduces this fact as something perfectly normal.

Table 3: Pattern in the classroom

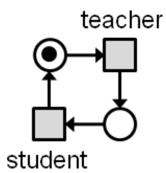
(3) In the Classroom **	
Type	SoL
Description	Interaction between teacher and students. This may include various activities like reading aloud, answering questions, written or practical exercises, exams.
Evidence	Acting class in a commercial for the *Worldwide Short Film Festival* (CL 2004): Actor students play out the actual Good Cop, Bad Cop script. Public awareness spot for using condoms (CL 1990–94): A strict, elderly physical education teacher finds a condom in the locker room. In a menacing voice, he asks whose it is. A boy gets up. Everybody else gets up, too. Any movie in the school film sub-genre; other films with school or university settings.
Slots	
Triggers	Header (obvious setting); if it is not a regular classroom: accumulation of clues
Aggregation	Good Cop, Bad Cop; Bullying; Detention; Doing Something Mature; Interrupt Class; School Announcement
Secondary sources	Realistic school in a game: *Bully* (Rockstar, 2006); fantasy schools in *Morrowind*, *Dawn of Magic*
Literature	Shary 2002 for school films

Table 4: Pattern interrupted wedding / runaway bride

(4) Interrupted Wedding / Runaway Bride **	
Type	Myth
Description	A hero (usually male) interrupts a wedding ceremony and takes away the bride from her groom. The bride is happy as she prefers the hero. Alternatively, the bride may run away on her own.

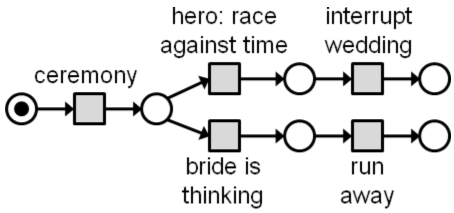
(4) Interrupted Wedding / Runaway Bride **	
Evidence	*Miss Dior* perfume ad in which a woman runs down a staircase, the menacing voice of a priest reading the vows in the background (CL 1990–94); *Audi* spot acting as a sequel to the film *The Graduate* (CL 2004). *The Graduate* (USA 1967, Mike Nichols), *Bridget Jones's Diary* (UK/USA 2001, Sharon Maguire; vaguely, one scene may trigger the script), *Miffo* (Sweden 2003, Daniel Lind Lagerlöf), *Penelope* (UK/USA 2006, Mark Palansky).
Slots	
Triggers	Contradiction (script Wedding takes an unexpected turn)
Aggregation	Wedding, Rivals
Secondary sources	*The Princess Bride* (USA 1987, Rob Reiner; novel William Goldman), *Spaceballs* (USA 1987, Mel Brooks), *Four Weddings and a Funeral* (UK 1994, Mike Newell), game *The Secret of Monkey Island* (Lucasfilm, 1990); wedding ritual in which the priest asks whether anyone objects to the marriage.
Literature	"Runaway Brides (and Other Interrupted Weddings)", a text in TV station TCM's blog (moviemorlocks.com/2007/02/14/runaway-brides-and-other-interrupted-weddings) finds this subplot in many movies from the 1930s to the 1960s.

Table 5: Pattern release me

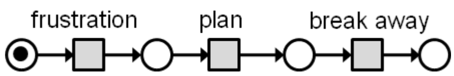
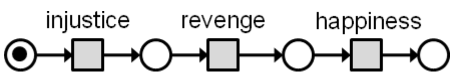
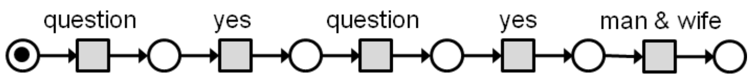
(5) Release Me *	
Type	Myth
Description	A wild animal flees from captivity. Figuratively, a person may feel trapped in their surroundings and cry for a release.
Evidence	*Audi* spot featuring sad images of trapped animals. The last shot shows a car in a dark garage (CL 2004); various coming-of-age films about teenage runaways, e.g. *Ferris Bueller's Day Off* (USA 1986, John Hughes) or *Somersault* (Australia 2004, Cate Shortland).
Slots	
Triggers	Contradiction (wild animal in captivity)
Aggregation	Hitchhiking, Leave Hometown
Secondary sources	Similar spot by Saab using the song *Release Me* (Oh Laura, 2007), *Free Willy* (France/USA 1993, Simon Wincer), *Chicken Run* (UK 2000, Peter Lord/Nick Park), *Madagascar* (USA 2005, Eric Darnell/Tom McGrath); with humans: *Cube* (Canada 1997, Vincenzo Natali).
Literature	Ohler (1994: 230–238) describes an experiment in which viewers of a TV spot needed only seven shots to recognise the genre "prison film" and to correctly anticipate the subsequent slot: a prison break/revolt.
Educational games	*Mathica* (BrainGame, 2002) starts with an intro showing an imprisoned girl condemned to calculate Pi up to the 'final' digit.

Table 6: Pattern revenge is sweet

(6) Revenge Is Sweet *	
Type	Myth
Description	Someone is treated in an unfair manner and takes revenge.
Evidence	*Toyota* spot: A car splashes father and daughter with rain water. They inspect the parking lot and find the driver. "Is this your car?" He admits it, knowing he will face consequences – "a car to be proud of". The father smashes him to the ground. The little girl has great fun kicking him (CL 2004). A number of coming-of-age films in which young people experience injustice and take revenge on their environment, e.g. on one's boss in *Reality Bites*, twice on cheating partners in *Fröken Sverige* (Sweden 2004, Tova Magnusson-Norling).
Slots	
Triggers	Header (clear injustice)

(6) Revenge Is Sweet *	
Aggregation	Artist vs. Producer, I Don't Wanna Go Home Yet, Malicious Mischief
Secondary sources	Same-named proverb; rivals playfully taking revenge on each other during a wizard-school quest in *Morrowind*; more general mythical pattern "Revenge" that is often found e.g. in Greek tragedies
Literature	Mikunda 2005: 20–21; Tobias 1993

Table 7: Pattern wedding

(7) **Wedding** **	
Type	SoL
Description	A priest or city official marries a bride to a groom.
Evidence	See Interrupted Wedding/Runaway Bride; *I vitelloni* (Italy/France 1953, Federico Fellini), *William Shakespeare's Romeo + Juliet* (USA 1996, Baz Luhrmann); *Les Poupées russes*.
Slots	
Triggers	Header (obvious setting, the question)
Aggregation	Interrupted Wedding/Runaway Bride
Secondary sources	See Interrupted Wedding/Runaway Bride; more in *Four Weddings and a Funeral*; marrying can be a game objective as in *Pirates!* (MicroProse, 1987)

7. Discussion

Our pattern catalogue addresses the story-writing part of designing narrative educational games. This is connected to gameplay and instructional design: A plot pattern can form the basis of a game mission or quest. While we did not have a mission or quest catalogue to refer to, some of our patterns would work well in connection with puzzle types (Bates 2004). "People puzzles" and "dialogue puzzles" can be brought to life through game-people-play scripts. "Machinery puzzles" relate to our pattern Machinery – the fascination of cause-and-effect chains. Educational games in technical domains might try to evoke this fascination. Björk and Holopainen's (2005) patterns describe gameplay features and concepts that can be linked to our patterns: A Robinson Crusoe plot can motivate "exploration" gameplay. Rivals sharing a background with the character may make for better "enemies".

Our story patterns relate to constructivist eLearning approaches utilising narration: cognitive apprenticeship, case-based learning, problem-based learning, goal-based scenarios. They can form the basis of cases, problems, or scenarios. A scenario in Schank et al's goal-based scenarios (in Kritzenberger 2005: 19–21) requires, among other ingredients a goal, a mission, and operations. Using our patterns, a mission could be based on a script, with individual slots relating to operations and the final slot being the goal.

In a blended-learning course about artificial intelligence (using the multi-user virtual environment *Second Life*), our students program intelligent agents in the form of animated mice. In the first online session, they find the mice in a cage at the virtual beach. Later, they find a message in a bottle, and learn that the mice escaped from a laboratory, and that a genetically-engineered monster (another agent) is hunting them. We applied the patterns Release Me and Message in a Bottle to insert memorable content into the exercises. The message also acts as an informational vehicle to introduce a programming task. Likewise, a script like Casting Call e.g. might stimulate competition in an educational game. *Mission: Schatztaucher* involves casting crew members with different skills. Robinson Crusoe can explain why an educational game takes place in a restricted setting.

Our scripts are behaviour patterns on the content level (Martens and Cap 2009). Yet, we are going to use them on the software-engineering level as well. Their Petri nets are a first step towards turning story content into executable code. In the expert/knowledge module (Harrer and Martens 2006) of an eLearning system, the Petri nets could provide structure to a case database. In the process-steering module, a drama manager would then be able to execute the narrative cases, and present one slot at a time (e.g. as a stored animation or puzzle), based on interaction with the user. Behaviour patterns thereby form a connection between content and software-engineering level.

Moreover, our pattern catalogue can act as a boundary object (Martens, Hambach and Lucke 2009) in an interdisciplinary design team. In future work, we plan to flesh out the structure of our patterns so that they can be made into reusable software components. There is still work to do on aligning gameplay narratives, e.g. quests, with eLearning narratives, e.g. scenarios. Further steps will perform pattern mining in games and eLearning applications to arrive at catalogues of behavioural quest and scenario patterns – ultimately resulting in a catalogue of educational quest patterns.

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Fort Ancient, Ohio: a Curricular Approach to Developing Mobile Games for Tourists

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Abstract: This work in progress presents a course that was developed for digital design students who have received no prior training in game theory or production methods. The curricular goal is to teach creative thinking skills, collaborative learning models, iterative design methodology, and simple objective-c programming. The students were asked to develop a series of simple games that promote learning and social interaction among visitors at the Fort Ancient archeological site. The Fort Ancient archeological site is a collection of American Indian mounds built by the Hopewell Indians (100 BC-500 AD). With three and one-half miles of earth walls, the 100-acre complex is the largest prehistoric hilltop enclosure in the United States. Located near Cincinnati Ohio, it is now a state historical park and designated as a National Historic Landmark. The challenge was to develop mobile games that encourage visitors to interact with each other as they explore this large landmark. Because there is limited signage available at the Fort Ancient site, students also addressed problems with way finding and lack of historical information at the site. The 10-week course included a brief overview of game theory with assigned activities that explored various aspects of game design such as balance, feedback loops, and other core game mechanics. After these exercises were complete, students performed on-site research, ideation, and development. The development process included writing a game treatment, paper prototyping, and simple user testing. While the students performed these tasks, they were given a series of class labs on objective-C programming and iPhone development. The final project involved developing a poster and a working prototype of their game. Currently, the students are collaborating with the Center for the Electronic Reconstruction of Historical and Archeological Sites (CERHAS) at the University of Cincinnati in an attempt to expand the topic to include other historic landmarks on the Ancient Ohio Trail. This process will also include further development and refinement of initial student projects with extensive user testing and analysis.

Keywords: Educational games, archeology, group learning, game design

1. Introduction

Recent advancements in mobile technology have provided new opportunities to deliver location-specific information for educational purposes. With an iPhone or a modern cell phone, users can access video, audio, maps, or other forms of interactive media that is tailored specifically to their geographic location or their topic of interest. This capability is particularly useful for archeological sites and museums that are interested in delivering a more complete and culturally rich experience (Ardito, Buono, Costabile, Lanzilotti, and Pederson 2007).

Several articles have been written describing the benefits of using game design to engage college students in their curriculum. Specifically, it has been noted that game design is a useful vehicle to teach aspects of group learning and introductory programming skills (Claypool, Claypool 2005), (Leuttenegger, Edgington 2007).

This paper presents a 10-week course that was offered to undergraduates in the digital design program at the University of Cincinnati. The goal for this course was to teach students how to develop a simple yet engaging application for a mobile device that addresses a specific social problem. Specifically, the students were asked to design an application for visitors at the Fort Ancient archeological site located near Cincinnati, Ohio. Prior to this course, students within the digital design program have received courses on interface design, flash programming, and animation principles. This course is the student's first exposure to game design, designing for mobile media devices, collaborative learning methods, and objective-c programming.

The Fort Ancient archeological site is a collection of earthen mounds built by the Hopewell Indians (100 BC – 500 AD). Located near Cincinnati Ohio, the earthen embankments extend for more than three and a half miles along the Little Miami River. The 100-acre complex is the largest prehistoric hilltop enclosure in the United States. Archeologists believe that this site provided ceremonial and settlement purposes for the ancient Hopewell culture. Though it is a National Historic Landmark, the earthworks present a challenge for on-site appreciation. The size of the complex, its degraded condition, poor signage, and plant growth in the surrounding area make it difficult for visitors to interpret and visualize the entire site. Most visitors have a difficult time developing a mental image of the architecture and understanding its cultural significance. As a result, there has been a decline in the public awareness of Fort Ancient over the past century-and-a-half. With the aim of providing visitors with a more engaging experience, the digital design students were asked to develop an iPhone application that would support the learning of the Fort Ancient archeological site.

2. Curriculum

This was the first game design course offered within the Digital Design program at the University of Cincinnati. As such, I referred to the IGDA (International Game Developers Association) Curriculum Framework and sample syllabi as a guide for course development. Course readings included content from selected books on game design and game theory (Prensky 2007), (Schell 2008), (Adams, Rollings 2006), (Salen, Zimmerman 2003). In addition, students were given selected academic readings on serious game design and collaborative learning methods. To gain a better understanding of the overall structure, see the table below.

Table 1: Curriculum overview

Fort Ancient, Ohio: Developing Mobile Games for Tourists Digital Ideation II: University of Cincinnati, DAAP	
Weeks 1-3	The first 3 weeks covered the following topics: - Introduction to game vocabulary and formal elements. - Game balance and game theory. - Game Dynamics, Types of Players. - Game Genres: Educational/Serious Games.
Weeks 4-5	Weeks 4-5 covered the following topics: - Lecture and research exercise on various collaborative learning methods. - Class Fieldtrip & Guest Lectures at Ft. Ancient Site - Who are the Hopewell? Research and report exercise. - Developing a Game Treatment.
Weeks 6-7	Weeks 6-7 covered the following topics: - Prototyping and testing gameplay on paper. - Player choices and user experience. - Class Review: initial prototype designs. - Assessing function and balance. - Introduction to iPhone Development. *This was delivered as a series of class labs. Video of lab exercises was taken for student reference.*
Weeks 8-10	Weeks 8-10 covered the following topics: - Production and Final Development of the application. - Additional iPhone programming tutorials were provided as needed - Development of additional materials such as posters and presentation slides.

The first three weeks involved lectures, readings and simple classroom exercises on the principles of game play. Topics included rule design, game balancing, play mechanics, and social game interaction. Students analyzed and augmented simple card and board games to develop a basic understanding of rules, goals, conflict, and play mechanics.

Weeks four and five involved researching the Fort Ancient site and formulating ideas for the final game. Students formed groups (four or five members) and studied various aspects of the Hopewell tribe. Experts from CERHAS (The Center for the Electronic Reconstruction of Historical and Archaeological Sites) also provided the students with tours of Fort Ancient. Course lectures on collaborative learning methods were also given. With this information, the students developed various ideas for their game and wrote a simple game treatment. This written document described the target audience for their game, a rough overview of the game play, and how a specific collaborative learning method contributes to the social interaction of the game.

Week six and seven involved further development on rule design, game balance, and play mechanics. The student groups developed small paper prototypes of their game ideas and tested them on their classmates. During this phase, students adjusted the rules and the information feedback loops within their game to establish a balance of penalties and rewards. As the testing evolved, the students began to sketch out the user interface for their game. At this point specific users who fell within the age range of their target audience tested the paper prototypes. This iterative process ensured that the final game interface was easy to learn and easy to use for the end user.

During this two-week cycle, course lectures and video tutorials were prepared to teach basic objective-c programming. The students would use this language to develop a working prototype of their final game.

Figure 1: Photo at Fort Ancient

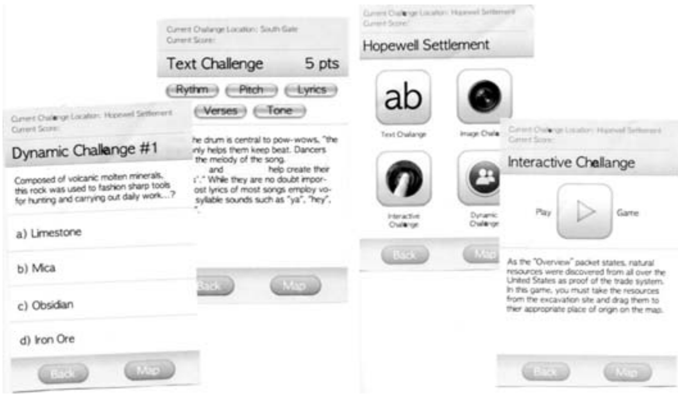

Figure 2: Sample paper prototype

During weeks eight through ten, students worked on the final production and implementation of their design. Course lectures and video tutorials on objective-c programming continued through these weeks while the students worked on final prototypes. Given the size of their initial designs, the final prototype needed to illustrate only a section or a complete chapter of their final idea. To supplement their prototype, the students also developed posters to describe how their game design will be applied to various locations around the Fort Ancient site. The final deliverable included a working application on the iPhone, a poster, and a presentation of their final design to the experts from CERHAS. Given their extensive experience developing museum displays and multimedia pieces for school-age children, families, scholars and educators, CERHAS provided excellent feedback on the strengths and weaknesses of each student project.

Figure 3: Screen from final application

3. Final design example: Fort Ancient adventure

Four separate game designs were presented at the end of the academic quarter. The genre of the games included a turn-based strategy structure, a role-playing structure, and a party game. All of the designs included a series of trivia questions and supplemental information that was provided to the player depending on their GPS location at the Fort Ancient site. In this paper I will provide an overview of one student design. The project entitled "Fort Ancient Adventure" falls within a party game genre. My definition of a party game is a design structure that often consists of various mini-games. The end purpose is to entertain or engage several players of various skill sets. Player elimination is rare in a party game. Instead, players are allowed to participate until the end of the game.

The premise of this game is centered on the jigsaw classroom learning method (Aronson, Patnoe 1996). Developed by Eliot Aronson in 1971, jigsaw is a collaborative learning method that is used to reduce group conflict while providing an efficient way to learn new material. With this method, students are divided into small groups. Each group member is assigned a specific topic to research and learn with other group members. After each individual sufficiently understands their topic, the groups reconvene and perform a complex task that is dependant on each group member's area of expertise. Success depends on the student's ability to listen, understand, communicate, and discuss an idea with others. With "Fort Ancient Adventure", the digital design student's approach involved breaking groups into visual, participatory, experimental, and interpersonal categories. With this structure, group members with various learning styles can address a specific task within a game and contribute the entire groups success (Campbell, Campbell, Dickinson 1996).

3.1 Game rules and procedure: Fort Ancient adventure

The target audience for this adventure is middle school students on an educational field trip. After the children arrive to the archeological site, the instructor then provides a brief introduction about the place and period being studied. The students are then divided into groups of 4 and given the following instructions:

> *Fort Ancient Adventure: Rules*
>
> *Welcome to Fort Ancient. Today you will learn about the historical significance of this site by participating in an adventure with your assigned group members. Your objective is to complete sixteen separate challenges, which are located in four different geographical areas. To play the game you will need 3 teammates. Within your group, each teammate must be assigned one of the following roles: Navigator, Scholar, Actor, and Investigator. You will be given an iPhone and a map to help you complete your challenges. The iPhone will provide tasks, clues, and trivia questions tailored for each teammate: Navigator, Scholar, Actor, and Investigator.*
>
> *If a challenge is directed to your teammate you may only assist your teammate in completing the task. You are **not** allowed to complete the task for him. Each challenge is worth 5 points. A group can earn a maximum of 80 points (5 points per challenge). The group can also earn an additional 20 points according to the amount of time it takes the team to complete the entire course. The team with the highest number of points wins the Fort Ancient Adventure. Good Luck!*

The instructor then notes four locations on the map (A, B, C, D), and asks the navigator in each group where they would like to begin. The groups are allowed to visit the locations in any order. (A, B, C, D D, B, A, C A, C, B, D etc). After the navigator decides on a location they select that location on the iPhone (A). A digital packet containing video, images, text, or audio provides the group with important information and clues to help them complete their first task. The navigator then uses the map to lead his group to their chosen location (A).

Near each location, the group is asked to complete four challenges or "mini-games". The mini-games are: a "text challenge", an "interactive challenge", an "image challenge", and a "dynamic challenge". The *text challenge* is catered toward verbal learners who need to verbalize or read instructions out loud. The challenge is mostly text based and requires the student to read a series of incomplete sentences out loud. She must then select and drag the correct word into the corresponding slot. The *interactive challenge* is for experiential learners who learn from hands-on activities and observation. Interactive challenges vary from location to location. They involve physical activities that combine the iPhone's touch screen or actuator capabilities with visual observation of the surrounding area. The *image challenge* is for kinesthetic or participatory learners who prefer to use their body and sense of touch to learn. An example of an image challenge would involve remembering figurines provided in the information packet and photographing a group member acting out what the figurine is doing in a specific location. The *dynamic challenge* is developed for logical or interpersonal learners. These individuals prefer to use logic, reasoning, and systems to solve problems. With this challenge, the student must answer three random multiple-choice questions (created by other logical learners and derived from a database). The student must then create a new question that could potentially “stump” the other groups that are playing the Fort Ancient Adventure.

Figure 4: Map locations

When the group has successfully completed the challenges at their location (A), the navigator discusses with his group their second location (B, C, or D). The group then opens a digital packet containing video, images, text, or audio that provides clues for their second location (B, C, or D). A group can earn a maximum of 20 points at each location (5 points per challenge). The group can also earn an additional 20 points according to the amount of time it takes the team to complete the entire course. The team with the highest number of points wins the Fort Ancient Adventure.

4. Application development

The development of the final iPhone applications was completed using the free software development kit (SDK) available from Apple’s iPhone Dev Center. The digital design program at the University of Cincinnati is a registered iPhone developer. As such, students were provided with the appropriate certificates to enable them to test their applications on their personal iPhone and iPod touch devices. Various lectures and video tutorials were delivered to the students to assist in the programming and final deployment of their applications. Because this was their first exposure to objective-c programming, the requirements for their final application was to simply illustrate how a component or section of their design would function. A supplemental poster and presentation was also delivered to describe components that were not included due to difficulty or lack or time. If a section was not included in their prototype, the students were required to describe the techniques that can be realistically performed through code or the iPhone device. For example, location specific information would be available through the device's location manager delegate and database access would be provided through the embedded SQLite3 database.

5. Conclusions

This paper presented a course that was developed for digital design students at the University of Cincinnati. The curricular goal was to teach creative thinking skills, collaborative learning models, iterative design, and simple objective-c programming. For a 10-week undergraduate course, these objectives were slightly ambitious. However, the students met the overall objectives admirably. It is interesting to note that after presenting several collaborative learning models, the students applied variations of those models to assist each other with the completion of their coursework. Students assessed their particular strengths (design, research, programming, etc) and applied them to their individual group projects. The depth of the student research in their final designs was more than I expected. The students took the overall concepts from the readings and the lectures and sought additional resources on game and learning models to further develop their final projects. As a result, the students produced innovative and unique approaches to this problem. The experts from CERHAS have confirmed that research was clearly successful attribute with course. In addition, the students were also encouraged with a newfound understanding of mobile devices and the development process. Though the course was successful on many aspects, it is certainly not perfect. I have personally noticed that the aesthetic aspect of the interface designs could be stronger. Given the existing schedule and the learning curve for this project, I believe the students were naturally tentative when developing an interface that is intended to be interesting, engaging, and easy to use. To address this issue, I plan to shorten the lectures on game play by one week and increase the paper prototype/interface design process by one week. I also plan to increase the number of critiques on aesthetics and interface design.

From the Fort Ancient project's perspective, the overall assessment of the student's final designs is still undetermined. The results from the usability testing the students performed during weeks six and seven appears to demonstrate effective engagement with their audience. Their users really enjoyed playing these games. However, the students did not perform any tests on retention. After the final presentation to CERHAS, it was noted that the research on game play and interaction was very thorough. I consider these projects a work in progress and we now plan to work with the experts from CERHAS to develop selected student projects for extensive on-site empirical evaluation and potential commercial deployment. The results from this study will be described in a future paper.

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Serious Games – Research and Design for Game-Based Language Learning in a Global Perspective

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Abstract: This paper presents and discusses methodological and empirical approaches to researching game-based learning in the context of an ongoing research project in *Serious Games on a Global Market Place* (2007-11). In this project academics work with companies to explore, build and implement game prototypes, using the products and experience of commercial game designers to develop knowledge about serious game challenges. One aspect of this research consists in exploring how a game-based platform for teaching and learning English online, www.Mingoville.com, can be developed for classroom teaching and learning locally as well as globally. Research methods used in the study are comparative studies in Denmark and Portugal within an ethnographic research tradition. In the paper we are proposing that Mingoville as a learning environment emerges and participates in a variety of local learning contexts, all of which add meaning and educational significance to the platform. We are using these different enactments of Mingoville to explore and discuss how the study and design of game-based learning can be approached and interpreted in a global context. Inspired by Pelletier (2008) we are asking how Mingoville.com becomes playable (or not playable) in different local school contexts, and how these empirical interpretations and translations of Mingoville can be researched. Findings indicate that the playability and researchability of the game studied is significantly affected by contextual issues such as the ways in which technology becomes available and accessible to teachers and pupils, as well as by local and national policies of education and technology.

Keywords: Game-based language learning, comparative studies of games, global game studies, game design, research methodology

1. Introduction

Research in the use of games in the classroom is new, and we still lack experience in using different forms of ICT-based and ICT-supported games in schools and educational contexts. Whereas games are often highly recommended for being powerful learning environments, educational practices with games are still rare and emerging. In addition to this, research into the use of video games for learning has produced inconclusive and contradictory results (European Schoolnet 2009). This may be due to contextual issues, game design, research methodology or the definition of games within game theory.

In terms of methodology, approaches are needed that can capture and account for the changing and diverse environments in which games are used for teaching and learning. Though a substantial part of the research done in game-based learning is inspired by qualitative methodologies, social, cultural and contextual perspectives on games as environments for teaching and learning are generally missing (de Castell and Jenson 2003, Pelletier 2008). This highlights the need for not only empirically based arguments for the potential of games in education, but for methodologies that can describe the emerging and global use of games both inside and outside formal education.

In this paper we shall present and discuss methodological and empirical approaches to researching game-based learning in the context of an ongoing research project in *Serious Games on a Global Market Place* (2007-11). In this project academics work with companies to explore, build and implement game prototypes, using the products and experience of commercial game designers to develop knowledge about serious game challenges, design for learning and teaching, and assessment with the aim of innovation. One aspect of this research consists in exploring how a game-based platform for teaching and learning English online, www.Mingoville.com, can be developed for classroom teaching and learning locally as well as globally. In the paper we are proposing that Mingoville as a learning environment emerges and participates in a variety of local learning contexts, all of which add meaning and educational significance to the platform. We are using these different enactments of Mingoville to explore and discuss how the study and design of game-based learning can be approached and interpreted in a global context.

2. Introduction to the study

In the *Serious Games on a Global Market Place* project we are focusing on researching and developing games for teaching and learning based on existing games and platforms designed by companies for commercial purposes. Our context of research is primarily formal education (primary and secondary levels), and the school subjects foreign language education (English), history, civics and citizenship education. In this paper we are focusing primarily on research in the classroom use of Mingoville.com, a platform for teaching and learning English targeted to children aged 9-12 years.

Figure 1: The Mingoville universe

In our research in serious games we are inspired by design based research (Cobb et.al 2003) and by ethnographic research in children's learning with games in and out of school (Sefton-Green 2006, Holm Sørensen 2002). Design-based research is experimental in nature and should not be understood as one approach but rather as a series of approaches aimed at developing new theory, artefacts and practice. Design-based research is characterised by being experimental and interventionist, taking place in natural contexts and being iterative (Barab, Suire 2004, Barab, Kirsher 2001, Cobb, diSessa, Lehrer, Schauble 2003). Design-based research is therefore well suited where research meets development and user driven innovation. Ethnographical research is not necessarily interventionist, but focuses on the observation and analysis of teaching and learning as social and cultural practices in context(s). The relationship between interventionist, experimental approaches and studies of authentic social practices in classrooms is a significant methodological issue in the research project, as these methodologies enable us to explore both how game-based learning can be initiated and maintained as a practice in classrooms, and how innovation can be conceptualised.

In this paper we are focusing mainly on the ethnographical aspects of the research, i.e. how Mingoville becomes playable in classrooms in Portugal and Denmark and how this can be researched.

3. Conceptualising the comparative studies

In the serious games project our theoretical framework consists of a combination of game theory, learning theory and theories related to the design of games for teaching and learning (Holm Sørensen 2008, 2009). Using the concept of educational design in relation to serious games implies that the design is directed both towards the construction of the game, i.e. what is built into the game, and towards the educational context in which the game is going to be used (Holm Sørensen 2009).

In our research in serious games design we are looking both at national examples of game-based learning and at the global aspects of serious game design and games for learning. The purpose of this approach is to find ways of developing serious games locally with a global scope.

For our international studies we are taking a comparative view on gaming as an educational activity (Osborn 2003, Sørensen 2008). Some of the issues raised by these studies are how national and local variations in educational traditions, curriculum, and assessment affect the understanding of serious games and how they can be researched. National sites for the study of Mingoville are Portugal (spring of 2009) and Sweden (autumn of 2009). Studies outside Europe will be initiated at a later stage in the project.

Comparative studies often focus on “cross-national, single-sited comparisons” (Sørensen, 2008, 311, Marcus 1995). This approach may be problematic, as a nationally based approach to comparison may underline homogenous interpretations of cultures and practices, an approach that has been critiqued for decades within anthropology and other research traditions (Wright 1998). Against this homogenisation of cultural practices, Sørensen suggests a multi-sited ethnography based on Marcus’ conceptualisation of ethnography (1995). The significance of a multi-sited approach for studying game-based learning is that game-based learning generally takes place in multiple contexts, for instance in schools, at home and in leisure contexts such as after school centres. Mingoville, the platform studied in the Serious Games on a global market place project, is for instance intended for learning at home as well as in schools, as online access allows multiple time and space use, and as different markets will have different needs for learning. Thus, in for instance China, game-based learning of English may be more viable at home than in schools in contrast to Europe, where games may be more pervasive to the school/home dichotomy (Danish E-learning Center 2007). The commercial success of Mingoville is therefore partly dependent on its ability to translate into different contexts of use, these can be larger nationally defined contexts of education or more local sites such as specific formal or informal environments for learning.

In the serious games project we are inspired by classical cross-national comparative approaches in the sense that comparison is conceptualised within national boundaries and national traditions for curricula and education, i.e. Denmark, Portugal and Sweden (Alexander 2001, Osborn 2003). However, Marcus’ approach is a significant parallel inspiration, as Marcus suggests that multi-sited analyses “examine the circulation of cultural meanings, objects, and identities in diffuse time-space” (1995, 96). In this sense Marcus’ approach represents a revival of comparative studies within anthropology, a revival that can grasp objects of study that are “ultimately mobile” and “multiply situated” such as learning games. In continuation of this approach, Marcus suggests a methodology for multi-sited analysis that constructs the object of research by following for instance the people, the thing, or the metaphor. Comparative analysis of Mingoville (‘the thing’) will follow the platform in different local and national settings where Mingoville is understood to be relevant for teaching and learning. This will enable us to develop knowledge about how Mingoville is translated and transformed into different educational settings, and how these settings draw on knowledge and ideas about how games can be used for language teaching and learning.

We are proposing that following Mingoville as a game-based platform that is multiply situated in contexts of learning is closely associated with following teachers’ encounters with Mingoville and how these encounters are negotiated pedagogically, as teachers are the main gate keepers of the learning culture, and therefore central actors in defining game-based learning activities. In game-based learning the role of the teacher is central, as playing the game without teacher intervention or planning is often an unlikely strategy for encouraging the kinds of learning required by formal educational settings. In game-based teaching and learning the teacher’s role is therefore often that of “translating between immersion and reflection, implicit and explicit knowledge, between the games world and the world of formal, summative assessment” (Facer et al. 2007). This is not a trivial task, and underlines the significance of following not only learning games but also teachers’ planning, performance and assessment of the use of games in classrooms.

4. Initiating research: following Mingoville into schools

As mentioned above, research in the global significance of Mingoville as a platform for learning English online, will have to establish how Mingoville becomes playable (or not playable) in different national and local contexts and how this can be researched. For our research we therefore chose to follow Mingoville into different European (educational) markets and contexts of use, based on both the company’s commercial interests and dissemination of the platform, and on our own research interests and aims. An initial parameter for the selection of countries was playability as supported by an existing user practice documented by the company or our own background research. Other parameters for the selection of research sites were how language teaching practices with Mingoville could support curriculum aims or other kinds of aims relevant for language education.

Denmark was chosen as a primary site for research in Mingoville, as the Mingoville platform has been developed in a Danish context, and as the project aims at finding ways of developing a local, Danish tradition for serious games for a global market. This requires, as mentioned above, solving problems related to for instance educational design, user involvement, national curriculum variations, assessment, marketing and distribution that work on a global level.

Denmark can be described as a country in which ICT policies in education have been supported by policy for a number years. In Denmark there has been a focus on the implementation of ICTs in schools for the past decade, and much has been done to highlight and support the development of ICT based education. One example of this is a large-scale research- and development project in cross-country implementation of ICT in Danish primary schools called ITMF (ICT and media in schools) that was funded by the the Danish Ministry of Education in 2002-04. In addition to this an online Educational Meeting Universe for teachers and learners has been set up by the Ministry of Education to make relevant educational material, services and resources available on the Internet (www.emu.dk). This site is hugely popular with teachers and also offers resources for using games in education.

Danish ICT policies have focused on both the use of ICT in school subjects and on the development of pupils' ICT and media literacy. In Denmark, there is an interest in schools and among teachers in the use of digital games for learning and sufficient autonomy is given to schools and teachers to use games in the classroom (European Schoolnet 2009). In addition to this there is a tradition for using games for teaching and learning in some subjects, for instance foreign language education (Wagner 1990). In terms of playability, both ICT policies in education, curriculum, school cultures and teaching methodologies therefore seem to support the use of games for teaching and learning English in primary school. However, teachers have generally not had training in using digital games for teaching and learning, relatively few game-based materials for teaching and learning have been produced so far, and the choice of teaching material is almost entirely up to the individual teacher.

With regard to the curriculum and approach to language education Denmark has a long tradition for communicative foreign language learning. This approach can be assumed to be game-friendly, in the sense that play, musical and creative activities are central to teaching English in primary school, the level of education targeted by Mingoville. Research in the use of games in schools for language education has established a significant link between the use of games and communicative language education (Baltra 1990, Crookall 2007, Li & Topolewsky 2002, Garcia-Carbonell, Rising, Montero and Watts 2001). In addition to this, there is an awareness in Danish schools of the fact that children do not necessarily learn their initial English vocabulary in school, i.e. that many children learn English at an early age through the media, for instance television, films, music and computer games. This means, as stated in the curriculum, that instruction and learning must relate to the fact that some learners have already acquired vocabulary and initial communicative experience when they start learning English in school (Danish Ministry of Education 2004).

In Portugal ICT policies for primary school education are emerging. Since the autumn of 2008, the Portuguese ministry of education has initiated a high-profile education technology plan called the Magellan Initiative in which 500,000 Intel Classmate PCs have been distributed for free or sold at very low prices to primary school children throughout the country. Mingoville is preinstalled on these computers together with *English is Fun – Interactive Activities for English.* The Magellan initiative provides a context for Mingoville to be playable in Portuguese classrooms, which is why Portugal was chosen for our second study. In addition to this, the curriculum for English as a foreign language in primary school in Portugal is potentially game-friendly, in the sense that the curriculum supports some of the same methodologies (for instance a communicative approach to language education and pupil centred approaches to teaching and learning) as the Danish curriculum. Thus, the use of for instance games, songs, drama and stories is mentioned as part of the curriculum for English in Portuguese primary schools, which could support the playability of Mingoville in a learning context. However, as it will be clear from the examples below, playability and learning are not supported only by curriculum aims, but are to a large degree dependent on local ICT policies and infrastructures and on the ability of teachers to plan and perform teaching in classrooms through game-based material.

5. The Danish study

Two Danish classroom studies were initiated and carried out within the project frame, a pilot study in the spring of 2008, and a more extensive study in the spring of 2009. As described above it was the intention of these studies to develop the initial design of the Mingoville platform by testing and revising ideas about game-based language learning and teaching through an ongoing analysis of the platform itself, its genesis as well as pupils' interaction and learning with the platform. As the results of the extensive study have not yet been analysed thoroughly, we are concentrating on the results of the pilot study.

We followed Mingoville into two suburban schools of Copenhagen, one situated in a multicultural, lower middle class area and one in a largely white upper middle-class area. We observed and did interviews with teachers and pupils in one class in each school, the first a 5th form class (children aged 11), the second a 4th form class (children aged 10). None of these schools had used Mingoville or digital game based learning on a larger scale before, however, in the 4th form class the teacher had introduced the children to Mingoville once two years before (in the 3rd form) through the interactive whiteboard used in class. However, she had not found it possible to continue this practice as Mingoville turned out to be too difficult for the pupils to use at this level and as problems with a group of pupils in the class affected the extra effort that she felt was needed for using ICT in class. This meant that we had to initiate a practice with the platform for our studies, in order to understand how pupils and teachers would interact with the platform.

As our study aimed to understand the performance and role of the teacher and learners in the classroom during game-based teaching and learning, we had suggested to teachers that they use the platform in the ways that they found most relevant for their teaching. This approach allowed us to see how teachers managed, negotiated, and conceptualised gaming in the classroom as an aspect of teaching English as a foreign language. Comparison and analysis of the two classroom studies would therefore be based on an understanding of how teachers contextualised the platform as part of their individual instructional strategy rather than on the similarity or sameness of instructional approaches, as a more controlled study would prefer. As the examples below will show, teachers intuitively chose two very different approaches to using the platform, one being exploratory and the other directed.

Following Mingoville into local contexts of use enabled us to understand that Mingoville, in spite of an apparently supportive curriculum and ICT and game-friendly school culture, would not necessarily become immediately or naturally playable and thereby available to teaching and learning. In the studies described, this would be due to a number of locally relevant, contextual factors that would influence the ways in which Mingoville could be enacted and understood as a medium for teaching and learning. One of the central issues at stake here was the role of teachers and how teachers could act in the classroom on the basis of their education and training, policy and curriculum as well as the complexities of the local school culture. Teaching can be said to be a changing profession that to an increasing extent is subject to pressure from larger political and societal agendas, which may affect how teachers can implement and work with innovative pedagogical practices such as game-based learning (Day et al 2007, Flores 2005). With regard to the implementation of technology in schools, research shows that teachers are often slow to bring about changes to educational practices when computers are involved (Bryson and de Castell 1998, Kimber et al. 2002). However, this should not, as Bryson and de Castell suggest, be understood as a general resistance among teachers to technology, but rather as a result of "skepticism towards faddish educational "innovations of the moment", lack of direct hands-on experience with new technologies, and an adaptively cautious response to the challenges posed by an already overloaded work-related agenda" (1998, 548). For teachers, the issues involved in the use of technology in class may therefore be quite different from those of administrators, one of the central issues for teachers may for instance be how technology can preserve and enhance their professional culture and agency (Bryson and de Castell 1998, 561).

In the Danish classrooms a number of activities could be observed that were relevant for language learning such as spelling, listening, and training vocabulary through game-based material. However, one of the most observable effects of pupils' encounters with Mingoville in two classes was that pupils interacted with the platform in very different ways as a consequence of the way the teacher had defined the game-based language learning. We are assuming that these differences in performance correspond to differences in learning processes and possibly outcome.

In the first classroom we visited, which was the fifth form class, the children had been advised by the teacher to use Mingoville in the ways that they found interesting and that reflected the individual pupil's need to work with specific aspects of the language (for instance vocabulary, grammar, spelling). This approach can be described as exploratory, and is associated with the idea that gaming is an experimental and engagement-driven activity (Squire 2006). In this class pupils would typically move quickly through the tasks, and often skipped from the platform menu to individual tasks. One example of a game-based activity that was very popular with the 5th formers was a Pacman spelling game in which the learner leads the Pacman through a labyrinth to select and 'eat' the exact letters that make up a certain word (for instance "parrot", or "cat"). The Pacman game is used in several of the platform missions, and was the task that almost all children would complete and play several times, even though they had obviously 'learned' the spelling of the words in question. However, in the 5th form class, children quickly tired of the platform, after little more than 30 minutes most of them had moved on to search for their favourite songs and music videos in YouTube.

In the second classroom, a fourth form class (10 year age group), the teacher had selected a specific set of tasks for the pupils to work on. In this class the teacher's approach to teaching with the platform was directed, i.e. she conceptualised the platform as a serious learning material that required the intervention of an instructor or supervisor. In the 4th form class pupils were much more likely to work through the tasks and to do this in the order suggested by the teacher, though a number of the children also chose to do the tasks in the order that seemed interesting to them. The attention span of these children was generally longer than that of the 5th formers, also their pace of learning and interacting with the platform was much more relaxed than the 5th formers. Whereas these differences may be due to differences in age, we propose that differences in interacting and performing with Mingoville may generally be understood as teachers' and students' different constructions of the platform, and therefore different (learning) games to be studied. The playability of Mingoville and its learning potential is therefore highly dependent on how it is defined and conceptualised by teachers (and learners), for instance as entertainment, edutainment or serious game (Meyer 2009).

6. The Portuguese study

The Portuguese study was carried out in the spring of 2009. As mentioned above, Portugal was chosen for the initial comparative study of Mingoville, because we had chosen to follow Mingoville through various national and local sites, and as Portuguese school children were assumed to have access to the Mingoville platform through the Magellan computers distributed in Portuguese schools during the beginning of the schoolyear 2008-2009. However, by the end of April 2009 a number of pupils had still not received their PCs, and schools were generally not able to use the computers that pupils had been given. This was due partly to the fact that classrooms generally lacked plugs that would allow pupils to recharge the computers – these PCs have a battery lifetime of less than an hour. Another reason for the inability of pupils to use the PCs in school was that the school did not have wireless internet access, which meant that students could not access the internet from their computers. As Mingoville is only accessible online, this would prevent pupils from using the Mingoville platform in school through their classmate PCs.

For practical reasons we chose to do fieldwork in a school in suburban Porto, a provincial town of Northern Portugal. As access to schools was more difficult for us in Portugal than in our native country Denmark, only one school was chosen, however, two classes were selected as sites for our research. These were two 4th form classes (children age 10), none of which had any prior experience with Mingoville in class, partly for the reasons mentioned above. However, both classes were familiar with using games for learning English in class through the use of interactive whiteboards and locally produced teaching material. As there was no existing practice with the Mingoville platform in these classes, we had to ask teachers to set up a practice with the platform, and to move the pupils into the computer room where they would usually not be taught. As with the Danish studies we suggested to teachers that they use the platform in the ways that they found most relevant for their teaching in order for us to observe how they (and the pupils) would perform and interact with the platform. Interviews with teachers were done before and after the classroom studies, and brief interviews with children about their experience with Mingoville in the classroom were made after the Mingoville sessions. As analysis of the Porto data have not yet been completed, we shall concentrate briefly on teachers' views of the sessions and on using ICTs and games in school. The teachers' views will illustrate to what extent Mingoville is conceptualised as playable and supportive of learning in this specific local learning context and how this has made Mingoville accessible to research.

For the Portuguese teachers we interviewed there was a considerable and significant gap between the national strategy for implementing the use of computers in primary school (the Magellan project) and the local, municipal policy for supporting the use of ICTs in education. As described above, the Magellan project focuses mainly on facilitating pupils' use of ICTs by distributing computers to pupils as their own property. This, it is assumed, will allow children to use computers at home as well as in schools, and to boost the general use of computers for learning, as many families in Portugal, according to a ministry official, are unable to buy computers for their children on their own budget.

However, what is missing in the national ICT policy is, as stated above, a consideration of school infrastructure, as most schools do not have plugs to keep the computers running, or wireless internet access to allow pupils to work on them online. We were told that in the suburban, largely middle-class area of Porto where the school we studied in the project was situated, it was not common for families to have wireless internet access at home and therefore it was often not possible for pupils to access Mingoville through their classmate computers at home. The multiple uses of the Mingoville platform envisioned by the platform designers were therefore significantly disabled due to local policies and infrastructures. For the Portuguese teachers the national strategy of ICT policy (The Magellan project) had failed to establish a basis for a practice with computers in their school for the reasons described above.

In contrast to the national initiative for the implementation of ICTs the local, municipal strategy for ICT implementation in primary school in the Porto area was described as being generally successful by teachers, something that was also observable in our classroom studies. The reason for this success was mainly that local policies had focused on the existing practices of teachers, i.e. their communities of practice as professionals and the tools and materials they were used to using in class. Rather than focusing on the pupils tools (the classmate PCs), the municipal government had given schools interactive whiteboards to facilitate teachers' work with digital material and the internet. Thus, interactive whiteboards had been installed in all classrooms in all municipal schools. In addition to this every teacher (and pupil) had been given a USB key storing locally produced teaching material (called Manual Digital), material that could both be used interactively in class through the interactive whiteboard, as printable matter to be included in children's portfolio, and at home on children's own computers for homework and training. The Manual Digital contained a number of mini-games and other playful material used by teachers in the class to support for instance language education.

As whiteboards were the main tool used for teaching English (and other subjects) in class, English teachers would generally not use the computer room (situated next to the classrooms) for teaching - the computer room was therefore mostly used for teaching ICT literacy, a non-compulsory subject taught after school simultaneously with English lessons. In terms of the playability of Mingoville, this meant that the only real possibilities for using Mingoville in the school studied would be to take over the computer room from the ICT teacher, which was what was done for the study described. Even though teachers felt that Mingoville had more to offer than the Manual Digital in terms of the number and quality of language learning activities, interaction and interface, establishing a practice with Mingoville was therefore only possible as a consequence of the development and research work organised and initiated by the Danish researchers. As pupils would not on a general basis have access to Mingoville through the Magellan computers or through the whiteboards in class – in which internet access was not reliable and which would not support pupils' autonomous work with Mingoville – a future practice with Mingoville does not seem viable in this local environment at the moment. This is significant for research, as the question of how Mingoville can be developed for use on a global market depends on research that can study the continous and changing uses of Mingoville as an educational game-based platform and how these uses qualify and facilitate language education.

7. Conclusions

As suggested above game-based learning (with Mingoville) is an emerging practice that is not easily introduced into classroom practice. This has methodological consequences when researchers aim to understand how game-based teaching and learning works in authentic contexts of education. In the serious games project we followed Mingoville into classrooms in Denmark and Portugal in order to understand how Mingoville becomes playable – and accessible to learning – in these local contexts. The purpose of these studies was both to understand how Mingoville is used and becomes playable in classrooms and how it can be developed for a global context of teaching and learning. Our research showed that following Mingoville into formal learning contexts significantly involves the study of teachers and the ways in which teachers encounter game-based design for teaching and learning – with Mingoville as an example. Teachers are to some extent open to the potential of using games in school for for instance foreign language education. In addition to this teachers do work on negotiating games for school based learning. However, teachers are also deeply involved in and affected by contextual issues such as the availability and accessibility of technology, and local and national policies of education and technology when creating a practice for game-based learning. This underlines the significance of studying game-based learning not only through the perspectives of game taxonomies and typologies and their implications for teaching and learning, but through multi-sited ethnographies that can grasp and comprehend the mobility and circulation of games in multiple contexts. As argued by Pelletier, "The implications for understanding the relationship between games and learning…are that games need not be defined as a set of forms, or a type of content, but as entities whose forms and meanings are both situated and strategic" (2008, 100).

Further studies of Mingoville will be initiated in the autumn of 2009 in Sweden as well as in global contexts where users have identified a practice with Mingoville for learning English in or outside school. These studies will focus on 1) *social practices and learning with the platform*, i.e. how, where and to what extent Mingoville can emerge as a site for game-based learning globally 2) *methodology*: i.e. how, where and to what extent Mingoville can be researched as a site for game-based language learning and 3) *implications for the development of game-based language learning in a global perspective* based on the empirical and theoretical studies.

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Development of an Educational Immersive Environment for Primary School Literacy Education

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Abstract: There is currently a growing movement in the research of the application of computer game technology to produce materials suitable for education and training. This research to date has a narrow application-based focus, such as in the military and medical sectors, yet this research is broadening to applications in tertiary, secondary and primary education. This is significant since our current school children are 'Digital Natives', whose lives embrace this technology. It is our belief that they may benefit from learning within Educational Immersive Environments (EIEs), single and multiplayer environments which use computer game technology but which are neither computer games nor are designed according to computer game design principles. However, we acknowledge that computer game design principles can be of help in designing a captivating, motivating and 'fun' learning experience. This paper reports on a year-long research project developing an EIE suitable for Primary School Literacy Education, using the commercial game-engine "Unreal Tournament 2004". The project involved working closely with a local primary school in Worcester, UK. Our design process was based upon Constructivist and Experiential learning theories and included elements of instructional design principles (IDP). A mapping was made from these theories and principles onto the "affordances" of the game engine. We suggest that this mapping may form a significant part of establishing a theoretical basis for EIE design. The EIE content was informed by the teacher/practitioners and from consulting the Primary National Strategy Framework and web based resources. An iterative development methodology was employed involving the teachers at each key stage of the development process. A small-scale evaluation of the EIE was conducted using teacher-questionnaires and pupil observations. This revealed some significant indicators. The potential effectiveness of the EIE was judged by teachers and pupils to be high. Pupils showed a high level of motivation and engagement due to the freedom to roam, autonomy of choice and level of interactivity. However, we have reflected on shortfalls of the EIE indicated by the evaluation. Three concerns emerged: First, a possible conflict exists between giving the learners freedom of movement and choice of tasks, and the need for structured guidance. Second, the need to critically assess mechanisms of information delivery, especially related to structured guidance. Third, the need to review the separation of 'learning' and 'fun' spaces.

Keywords: Computer games, primary school literacy, educational immersive environments, vcop, education theory, instructional design, unreal tournament 2004

1. Introduction

The design and development of computer games for education and training has become an important area of research drawing on many disciplines. This is largely a consequence of the contemporary cultural context of our digital age. Our youth has grown up immersed in digital technologies, especially computer games. These 'Digital Natives' (Prensky, 2001) expect to play computer games. According to the JISC report (JISC, 2004), learning should be congruent with the cultural context and therefore should employ games based technology. Prensky describes today's learners as 'engage me or enrage me' (Prensky, 2005). In this paper we argue that computer game *technology* can be employed to produce 'Educational Immersive Environments' (EIEs), learning resources which are based on sound pedagogical principles and may be used in all school classes from physics to literacy (Price, 2008). While such EIEs use computer game technology, they are not computer games; rather their design is informed by educational theory, instructional design principles, computer game principles and curriculum content.

The use of computer game technology in education and training can be traced back to the 'America's Army' games; the first 'AA-Soldiers' game was aimed to combat falling recruitment, the second 'AA-Operations' game was developed as a training resource (Zyda et al., 2003; Zyda et al., 2005). These are examples of 'Serious Games' which combine various aspects of education and simulation. Other examples include 'Foodforce', 'Stone City' and 'VR Therapy for Spider Phobia'. Some early educational games were produced as part of Becta's 'Computer Games in Education' project (Becta, 2001) and MITs 'Games-to-teach' project. A more recent educational game is Disney's 'Hot Shot Business' designed to teach children of ages 9-13 how to run a business. Links to these games are provided at the end of this paper.

Sections 2 to 4 of this paper provide an overview of theory and principles used in the EIE design process. Section 5 discusses a case study, an application to primary literacy. Conclusions are presented in Section 6.

2. Education theory

Our concept of an EIE provides a semiotic-rich, highly interactive environment, where learners are able to construct their own learning experience; this may be usefully discussed within the 'Constructivist' learning paradigm. Proposed by Bruner (1966), this paradigm sees learning as an active process where learners build upon their past experiences and knowledge and so advance their understanding of a subject. The three basic dimensions to Constructivism are: (i) Situated Learning, requiring learners to be placed in an authentic context, i.e. a real world scenario; (ii) Cognitive challenge or puzzlement where the learner is motivated by finding solutions to problems; (iii) Collaboration, where inter-learner communication establishes a peer-review process of checking and validating understanding (Savery & Duffy, 1995). Constructivism gives students control over their learning by providing choice of what, when and with whom they learn. Such EIEs could encourage social, collaborative and interactive learning (Honebein, 1996).

The learning process is also *dynamic* and is often modelled using Kolb's 'Experiential Learning Cycle' (ELC), a cyclical dynamic of (i) *direct experience,* (ii) *personal reflection*, (iii) the *situation of this reflection within existing theory*, and (iv) the *formation of a plan to inform the subsequent direct experience* (Kolb, 1984). Gee (2003) suggests that this cycle is inherent in most computer games; we were therefore mindful of game design principles whilst developing our EIE as seen in our case study below. The learner experiences this ELC through (i) engaging with activities, Non Player Characters (NPCs), and listening to and acting on instructions, (ii) reflecting on the result of the engagement (an incorrect answer elicited reflection on why this was incorrect), (iii) relating the results of their reflection to the task at hand and (iv) formulation of an alternative response.

The EIE concept may have some pedagogical advantages. These include: (i) The realization of deep learning through arousal of curiosity (Gee, 2003); (ii) The acquisition of cognitive skills not so readily realised in a traditional educational setting (*ibid*); (iii) Promotion of a problem-solving approach (Khoo & Gentile, 2007); (iv) Enabling peer-review through collaboration (Hamalainen, 2007); (v) Real-time feedback of success and failure to remove misunderstanding (Laughlin et al., 2007). We have applied the Constructivist paradigm to the design of our EIE (see Table 1 below).

3. Instructional design principles

Instructional design principles complement educational theory by focusing on elements of instruction which may be best deployed to achieve intended learning outcomes. Squire (2006) comments in his discussion of how one should design EIEs, '… this shifts the question from one of delivering content to one of designing experience'.

Table 1: Mapping the principles of constructivism (left) onto how they were realized in the EIE

Constructivist Principle	Realisation in the EIE Case Study
C1 The learner is allowed to take responsibility for their own learning.	The learning process is in the hands of the learner regarding what, where and when the applied activities commence. (i) Choice of which activities to perform, (ii) choice of the order of activities, (iii) choice to repeat or quit a task.
C2 The learner is presented with multiple perspectives on the material.	A variety of presentation modes have been used such as text to speech and static and dynamic providers of information.
C3 The learner becomes aware of the learning process.	The EIE allows for a experiential learning process where the learner 'learns' how the environment works through 'playing' it. They become aware of the multimodal semiotics which, through association, they learn to understand the meaning and therefore the rules.
C4 Relevance of the learning context, based on real-world scenarios.	(i) Roman Villa context supports the curriculum, (ii) this EIE correlates to classroom activities and therefore represents a real-time classroom scenario.
C5 The learner is cognitively challenged, e.g., using puzzles and	(i) How to find buckets of water to put out the fire in the 'Castle Map', (ii) How to escape from a moat when you've accidentally

conflicts.	fallen in! (iii) The need for capitalization in the correct spelling of a word.
Constructivist Principle	Realisation in the EIE Case Study
C6 There is a high level of interactivity.	(i) Selection of words and other objects (such as newspapers) using the cross-hair, (ii) inputting text through dialogue boxes, (iii) engaging with an NPC for instruction, (iv) triggering information sheets which emerge from the floor, (v) triggering music and sounds, (vi) receiving feedback from the 'score' and the 'count-down timer' on the 'heads-up-display' (HUD).
C7 Collaboration is encouraged.	The EIE can be used in a 'multi-player' and hence collaborative mode. This fell outside the remit of this project. However, collaboration was a prominent issue since pupils worked in pairs during formal observations and it became clear that they had been discussing it on the playground.
C8 There are various modes of rich representation (e.g., text, visuals and audio material).	(i) The visual semiotics of this EIE were designed to provide an appealing experience which was neither figurative nor cartoon, but 'semi-realistic'. (ii) A combination of text (words on banners), visuals (icons corresponding to those words) and audio materials (words spoken via NPCs) was used.

The design of instructional materials has been influenced greatly by Gagne (1977) and Keller (1987). Gagne's nine 'events of instruction' have been used in the production of the EIE. These are (i) Gaining attention, (ii) Informing the Objective, (iii) Stimulating Recall of prerequisite learned capabilities, (iv) Presenting the stimulus material, (v) Provision of learning guidance, (vi) Eliciting performance (practice), (vii) Providing feedback, (viii) Assessing the performance, (ix) Enhancing retention and transfer (generalization). Gagne's events have been directly applied to our EIE (see Table 2 below).

4. Game design principles

Whilst an EIE is not designed according to computer game design principles, it may be useful to reflect on such game 'principles'. There is yet no *theory* of how to design computer games, however Salen and Zimmerman (2003) suggest the following principles: (i) Rules. These define the game process, especially the nature of interactions within the game; (ii) Play. In-game activities define the experience of the player (Crawford 2003); (iii) Culture. The game visuals, objects, sounds and music, and the behaviour of the NPC. all serve to establish 'beliefs' and 'norms' within the game.

Table 2: Mapping Gagne's 'events' (left) onto how they were realized in the EIE

Gagne's Event	Realisation in the EIE Case Study
G1 Gaining attention	(i) Compelling visuals e.g. cheering crowd scene, flashing arrows, (ii) NPC instructor who uses human voice. (iii) Sound icons (e.g. loudspeakers and sound box instructors).
G2 Informing the Objective	(i) Score indicates number of correct answers. The score does not decrement if the answer is wrong. (ii) Timer decrements showing how much time remains. This creates a sense of a goal and increases excitement as learners try to beat the clock. (iii) Explicit instructions via static instructions sheet which emerge from the floor. (iv) Computer text to speech providing instruction (v) Implicit signs including constrained pathways. (v) 'Distant' animations e.g. fire in the castle map.
G3 Stimulating recall of prerequisite learned capabilities	(i) Consistent use of interface components e.g. crosshairs, menus, floor targets which become familiar throughout the lessons. (ii) Need to remember facts such as spelling a word which has been visualized then hidden. (iii) Recall of when capital letters are required for correct spellings.
G4 Presenting the stimulus material	(i) Firework display when score increments by 10. (ii) A score of 20+ releases a 'flash screen' informing the learner that they may enter the fun-area; the 'Castle Map'. Stimulates motivation as learners become aware of an ultimate goal.
G5 Provision of learning guidance	Learners learn how to play this EIE by investigation and exploration, in which the EIE becomes an implicit 'tutor'. The VCOP environment is spatially intuitive, allowing freedom of choice of tasks and also whether or not to complete each task.
G6 Eliciting	Heightened interactivity, giving the player greater control compared with 2D

performance (practice)	multimedia "point and click" applications. Engagements with certain interactivities within each of the VCOP rooms build and call upon previous knowledge and understanding of previous activities. This enables them to progress through the lessons in a non–linear way.
Gagne's Event	Realisation in the EIE Case Study
G7 Providing feedback	There are a multitude of feedback elements which operate on several time scales. (i) The learner is given immediate feedback via a screen menu and computer text to speech on a task and is invited to repeat or quit. (ii) The HUD provides a subtle feedback mechanism where the timer counts down from 10 minutes and the learner score increases (but never decreases on an incorrect response)
G8 Assessing performance	The accumulative performance of the learner as they work through the various VCOP rooms is set against their timing and score. This is recorded in a log file available to the teacher.
G9 Enhancing retention and transfer (generalization)	(i) The simple and familiar HCI enables the learners to retain and generalize their learning experiences, since they are not distracted by the technology. (ii) The EIE context implies transfer, since it refers to existing classroom-based activities (VCOP, Big Writing, study of Roman History).

In our consideration of how to apply these principles to EIE design, we align units of educational activity ('lessons', 'modules of instruction') with learning outcomes specified by the course and the curriculum. These correspond to the 'rules' of game-play and are designed as challenges, puzzles or problem-solving activities. During 'play', such learning activities develop cognitive skills and the formation of new concepts. Through 'play' the learner discovers correlations between cause (the learner's actions) and effect (results of these actions). Concerning 'culture', one expects educational games to bury the educational process behind a cloak of fun and motivation, where the learning process is not forefront in the mind of the learner.

5. Case study: application to primary school literacy education

5.1 The development process

The EIE discussed in this paper was developed for Primary Literacy learning for children of ages 7-11 within the UK system. The theme was a classroom activity based upon an approach known as 'VCOP' (Vocabulary, Connectives, Openers and Punctuation). These fundamental reading and writing elements are taught separately, then brought together in an activity called 'Big Writing' where pupils work in a silent environment with music and a burning candle, providing a relaxed space to allow a focus for reflection and thought. Our EIE was informed by (i) the requirements of the curriculum and the needs of the teacher-practitioners in the classroom; (ii) theories and principles mentioned above (iii) the affordances of the chosen game engine (iv) the ability to extend these affordances through programming. The EIE was developed iteratively in which the content was informed by teachers at a primary school. Each stage was evaluated by the teachers and their feedback was input into the next development stage. The final EIE was evaluated by eleven pairs of pupils. We feel that this iterative development process is crucial to the production of EIEs where the teachers are consulted at each developmental stage.

5.2 Design and construction of the EIE

The design of an EIE comprises many orthogonal factors which must be brought into harmony. These include the topology and geometry of space, the choice of interaction and feedback (and their location within the EIE space) and the use of guiding multi-modal semiotics such as text, sound, speech and visuals. A significant computer game engine affordance is the NPC which may be programmed to realise many functions; we programmed the NPC as an 'informer'. Our deployment of the engine affordances has been guided primarily by Constructivism and Instructional Design. Mappings from these theories and approaches are summarised in Tables 1 and 2 above.

The 'VCOP' method consists of four distinct sets of activities which we have mapped onto the 'V-C-O-P' rooms which contain distinct resources and challenges. The connectivity of these rooms is set by the teacher to guide pupils between various combinations of rooms. For example, some pupils would be required to visit the 'V' and 'C' rooms, others would visit 'V', 'C' and 'P' rooms during a particular lesson. A programmable topology was therefore adopted where all rooms are connected to a central ‘atrium’, and doors from the atrium to individual rooms are configured to be open or closed according to the teacher’s specification (C2). The geometry of the EIE was then established: Since the pupils were also learning about history and culture, the geometry of a Roman Villa was chosen (C4). The topology and geometry are shown in Figures. 1 and 2.

This initial topology was extended by attaching additional rooms to the primary VCOP rooms to provide supporting activities, and separate ‘Library’ and ‘Big Writing’ rooms. Finally a fun ‘Castle Map’ was created, intended as a motivational reward for the pupils progressing through the VCOP rooms. Initially there were concerns raised by one teacher about the appropriateness of a castle appealing to girls; this issue was resolved mid way through the project when a study of castles was made in class. The associated web-page (see section 8) contains movies of the VCOP EIE and of the password protected Teacher Portal (TP). The TP provides a facility for the teachers to configure the lessons according to the ability of the pupil by way of a database. This database is available to the teachers via a non technical, user friendly on-screen menu allowing them to change or update their lesson content. In a typical scenario, the learner enters the EIE and logs in by typing their name and class (establishing a personal log file which records their activity).

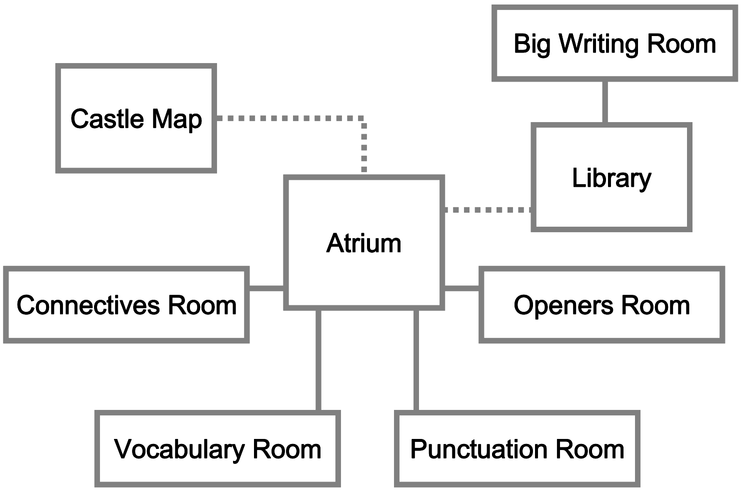

Figure 1: Shows the *topology* the EIE. Rooms are clustered around a central atrium. Solid lines indicate passageways between the rooms, dashed lines indicate teleporters

They are asked to select a ‘lesson’ as directed by their teacher. The learner is approached by an NPC who offers instructions to go to a particular room such as the ‘Vocabulary Room’, (C8: G4,5). Here the learner receives an audio instruction to spell a word which appears on a banner. The word disappears and a dialogue box opens up where the learner types in the word. Feedback (correct/incorrect) is given, if incorrect an opportunity to recover is provided (G7). The activity then cycles through a word list.

The learner moves to the adjacent room containing ten words on banners. The learner must pick these words up using a cross-hair and mouse and deposit them on a board in the correct sequence to make up a sentence. Incorrectly placed words fly back into the room (G7). The ‘Punctuation’, ‘Openers’ and Connectives’ rooms employ a similar method of interaction (C5,6). Learners may access the ‘Library’ at any time using a teleporter located at the end of the atrium (C1). They are informed about this by a large bright sign, and by an NPC who tells them how to get to there, if they *choose* to. They then have the *choice* to enter the ‘Big Writing’ room where they can write a story using materials they have learned together with resources provided in this room. They may transport to additional rooms for specific information (C1:G3). Since this classroom activity occurs at the end of the week in the classroom setting, it seemed appropriate to place it in the ‘Library’.

A number of interaction approaches were used. These include (i) in-play dialogue boxes to provide hints and collect input (such as words to test spelling); (ii) a text-to-speech facility where input words could be heard via computer-generated speech (C8, G1, G2, G7) (iii) a cross-hair used to select items such as the correct punctuation to complete a sentence, or items to be picked up (C6,8). Information and guidance was provided to learners through a number of techniques: (i) the use of a programmed NPC to approach the learner and give instruction using recorded speech; (ii) pages containing instructions which emerged out of the floor; (iii) static instructions attached to the walls of the rooms (G5).

5.3 Evaluation of the EIE

The EIE prototype was presented on a gifted mid-range computer system (Pentium 4 2Ghz CPU 512 Meg RAM) to a local primary school. The system was installed in a 'break-out' area which pupils could access in their free time, as well as during scheduled time-slots for formal evaluations. The evaluations involved the researcher conducting a classical 'observation' of the pupils' interaction with the EIE. Pupils worked in pairs, their time spent within the EIE was captured by screen capture software. A range of pupils were presented involving children of ages 7-11 (years 3-6 in the UK system). A total of 11 pairs were presented. The evaluation procedure was primarily based on individual pairs' observation records, supplemented with information from screen captures of their movements and of the individual pairs log files. First an analysis of the *sequence* of progression through various activities was made. This is important given the degree of choice available in the EIE; how did the learners use this choice factor? Second, a series of more than 60 questions were formulated through a reading of individual observation records. These questions were then applied to all observation records; the answers provided support of the proposed theories (or not) and also guidelines to inform future EIE design. Concerning constructivism, there were many examples of providing *cognitive challenges* (C5). Many pairs fell into a moat and had to work out how to escape. All pairs reflected collaboratively (C7) on which answer to a particular question was correct and shared previously discovered information (e.g. the need for capitalization in spelling), learned skills and agreed-on tasks. There was also *collaboration* 'on the playground' where pupils shared information about the EIE with their peers (C7).

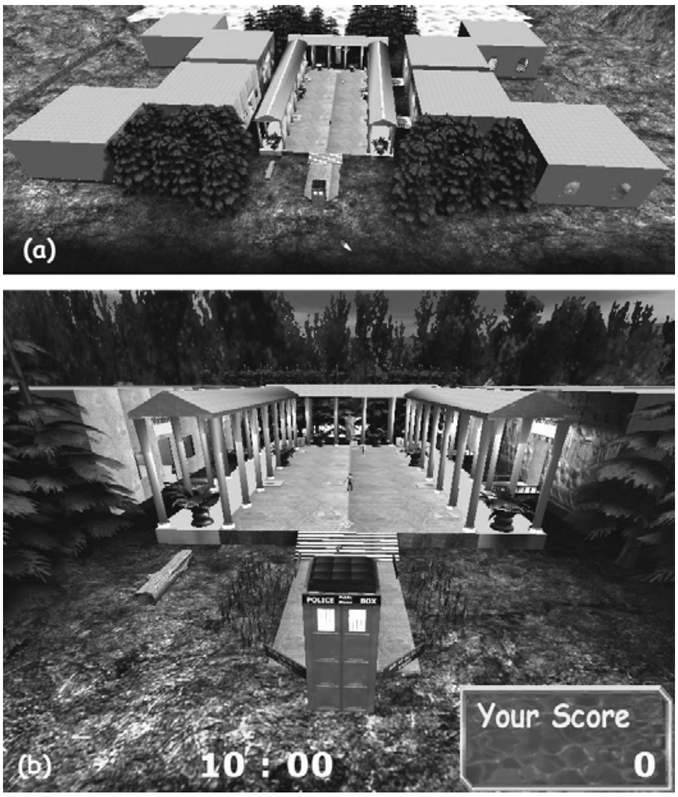

Figure 2: (a) Shows a 'bird's-eye' view of the VCOP rooms, (b) shows the 'Atrium' area and the heads-up-display indicating the learner's score, and time remaining 10 minutes

The EIE contained a high level of *interactivity* (C6). Interestingly, all 11 pairs visited the library, a highly interactive space, while only 6 pairs completed all VCOP rooms where interactivity was lower. Learning was judged to be relevant *based on real-world scenarios* (C4). This was evidenced by the amusement shown on encountering non real-world elements such as a flying submarine. Three pairs showed *curiosity* by running off the beaten track to explore terrain, exploring the EIE in sequences not intended by the designer (e.g. moving directly to the library, ignoring VCOP). One pair had discovered the 'fly cheat' (by their own research) and used this to fly around the EIE in a spree of discovery. Concerning instructional design, the *stimulus material* (G4) worked well but not always. This sometimes failed in *gaining attention* (G1); pairs sometimes ignored instructional text and flashing arrows. Only 4 pairs engaged with pop-up information sheets, yet 8 pairs immediately associated floor targets as triggers to starting activities (G3). There was on occasion a lack of response to *learning guidance* (C5), only 5 pairs listened to instructions given by NPCs. Consequently the learners missed some important information such as the score to unlock the Castle Map, or indeed the existence of this map! Pupils were attempting to discover what to do (the 'game rules') by 'playing the game'. The provision of *feedback* (G7) worked well. The learners appreciated the reward system, (displayed score on the HUD and fireworks on a score of 10), as well as effects consequent on their actions, such as words which moved onto a white-board, spoken text, doors opening. Interestingly where feedback was not provided, such as the number of buckets collected in the Castle Map, learners did not keep a tally on this number. The EIE was successful in *stimulating recall* (G3) of facts learned within the EIE, e.g. where to use capital letters, how to use the cross-hair. They also learned to associate the NPC as a source of instruction. In the VCOP rooms, all instructor NPCs were female, whilst in the Castle Map the instructor NPC was male; here 6 pairs ignored him completely. All learners expressed *satisfaction* in using this EIE and displayed high levels of motivation evidenced by voluntary extra time spent in the EIE and a drive to complete all tasks.

The EIE has been a great success as evaluated by the pupils and teachers in the school. Its presence in the school spread like wild fire and pupils were frequently using the EIE during their free time. However, we must reflect on the negative aspects of the evaluation to inform how to create better EIEs. There are a number of issues. (i) Information Flow. More thought needs to be given on how to improve communication of information to the learners through NPCs and other interactive elements by increasing the opportunity to gain information, through repeated exposure, or by pausing the learner until the information has been read. (ii) Separation of learning areas (VCOP) from the fun area (the 'Castle Map'). This was an explicit design feature, perhaps misplaced. Learners seemed to divorce learning from fun, some were motivated to complete the learning activities as a goal to have fun, others engaged with the learning activities *per se*. (iii) Choice and Exploration. The current EIE restricted choice based on the teacher's lesson plan. It may be more appropriate to remove this restriction by abandoning separate learning rooms and allow the learners to choose their own path through the VCOP activities. This retains the *topological* structure of the EIE while modifying its geometrical form. The teacher would make suggestions to the pupils on which areas are more appropriate for the individual's progress, but ultimately the pupils would choose. (iv) Thought needs to be given on the provision of *learning guidance*. There was clearly a conflict between the freedom of the EIE design which elicited *curiosity*, and the need to temporarily constrain the learners to give them guidance opportunities.

6. Conclusions

Even though the evaluation of the EIE has been informal, perhaps rudimentary, the results are encouraging. The EIE has been judged to be a success by teachers and pupils in the school. Pupils got to know about the EIE (through 'playground' chat) and they were often seen using it during their free time. Despite this success, we must nevertheless reflect on negative aspects of the evaluation to inform how to create better EIEs. There are a number of issues identified above, which we shall take on board to inform the next iteration of this project as well as an up-coming project in Primary Mathematics Education.

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Materials to support this chapter are available at the authors' website available at http://www.worc.ac.uk/departs/bm_it/colin/Resources/ECGBL2009
FoodForce is available at http://www.food-force.com
Hot Shot Business is available for on-line play at http://www.hotshotbusiness.com
America's Army is available at http://www.americasarmy.com
Details of Becta's Computer Games in Education project is available at http://partners.becta.org.uk/index.php?section=rh&&catcode=&rid=13588
MIT's Game-to-Teach project is available at http://www.educationarcade.org/gtt/home.html
(All sites accessed April 2009).

Motivation in Alternate Reality Gaming Environments and Implications for Education

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Abstract: Alternate Reality Games (ARGs) are being used increasingly in Higher Education to provide a stimulating context for student learning. By combining a narrative with puzzles that are solved by a community, both online and in the real world, they offer the opportunity to create problem-based learning experiences where students can work together to discover secrets and solve mysteries. Some players become highly engrossed in these games, expending large amounts of effort in solving challenges or creating artefacts. In the context of education, however, while high levels of engagement are seen in many students, it is certainly not universal. This paper draws on four case studies of the use of an ARG-based learning environment to examine what can be learned about motivation, and how this could be used to influence student engagement in learning. This paper first explores the literature on motivation with games and learning, and presents a model for understanding motivation with ARGs as a distinct genre. Then four cases studies are used to explore different ways in which motivation can be facilitated in educational ARGs (and activities that are inspired by ARGs). This includes two of games to support student induction, an online problem-solving course to teach Historical research skills, and the first charity ARG, presenting a comparative study from a related sector. Each of these cases will be described and the lessons learned with respect to motivation highlighted. Finally, the paper will explore and discuss overarching issues raised in the case studies. In particular: pros and cons of competition; appropriate levels of challenge for motivation; increasing participation levels and the niche ARG aesthetic; assessment; and ways of increasing learner autonomy. In all, this paper hopes to provide an insight into what can be learned about motivation from alternate reality games.

Keywords: Alternate reality games (ARGs), motivation, engagement

1. Introduction

In recent years, the phenomenon of *Alternate Reality Games* (ARGs), which has spread across film, media and charity sectors, has been tapped by Higher Education, where course designers are keen to replicate the high levels of engagement and turn it into a desire for learning. ARGs combine an unfolding narrative with puzzles that are solved by a collaborative community, both online and in the real world. They offer the opportunity to create engaging learning experiences in which students can work together to discover secrets, solve mysteries and compete for prizes. Some players become highly engrossed in these games (Moseley (2008) found that players of one popular game were playing 1-2 hours each day as a positive lifestyle choice) spending time collaborating, researching, problem solving and creating materials to further their progress in the game. As will be explored below, it is these elements that have attracted a growing number of course designers to bring the genre into the education sector.

In the educational context, however, ARGs enjoy mixed success. While high levels of engagement are seen in many students, this is certainly not universal - indeed, some students fail to engage at all. In this paper, four case studies are examined, in each a learning environment has been inspired by or designed around alternate reality game concepts (two in the form of complete ARGs, two utilising key features) to explore the motivating (and demotivating) factors, and to determine which features or approaches are best placed to improve widespread student engagement with learning.

2. ARGs for learning

As well as being engaging for many people, ARGs offer great potential for learning. The elements that comprise this type of game relate to a number of contemporary pedagogic theories. ARGs can be considered to be constructivist learning environments in that they meet three basic precepts of constructivism (Savery & Duffy, 1995): they involve individuals constructing their own understandings of the game environment; they provide a stimulus for puzzle solving and a goal for learning; and they support social collaboration. There are also clear links with educational theories such as problem-based learning (Boud & Feletti, 1991) and experiential learning (Kolb, 1984). By actively engaging in the game and working together to solve challenges, the players solve authentic problems in context and directly experience what it is like to be part of a mystery as it unfolds. A common criticism of games for learning is that they do not integrate space for reflection; the more paced-out nature of ARGs, coupled with their collaborative nature, provide time in which the players can reflect with others on the challenges involved in order to discover the evolving storyline.

This strong communal aspect is also of interest to education - with players working together in teams or en masse to solve difficult or geographically/intellectually widespread problems: in an early ARG, *I Love Bees*, players across the world managed to answer a series of pay phone calls spaced four minutes apart, and relay a message on each time. McGonigal (2008) investigated this 'collective intelligence' phenomena, noting that "massively distributed puzzle pieces were tracked down and documented by individuals, but compiled and analyzed by the group" (2008, p206). The collective also provides support to new players outside of official game channels, developing, in Wenger's terms, "a local regime of competence" (1998, p184) and a sharing of "stories, explanations [and] descriptions" (p185): ARGs build up a very strong *community of practice* around themselves.

A further factor is the technical requirement to host an ARG-type game: in contrast to other online immersive environments or massive multiplayer games, ARGs can exist simply with a few basic web pages and some scraps of paper - their technical basis can be as small or complex as the budget or gameplay require.

Other features of ARGs make them compelling for higher education, not least the high levels of motivation and prolonged engagement shown by many participants. Moseley's (2008) study of the most engaged players of the *Perplex City* commercial ARG found seven key ARG features which might be useful in higher education contexts to bring some of the high levels of motivation and engagement:

- problem solving at various levels;
- progress through the game and rewards (players were rewarded with gifts for solving a certain number of puzzles, for submitting the best video, and so on);
- the narrative element (story/plot);
- a regular delivery of new challenges;
- the large active community;
- the influence the players had on the game outcomes (in an ARG there is often no fixed path or ending; the designers respond to the players' actions to develop the story line beyond a core skeleton);
- the independence from any particular technology.

Whitton (2009) describes six motivational elements of ARGs, saying that, while these elements are not mutually exclusive, each factor will motivate different players to different extents.

- Completion - being able to complete the game and achieve all the tasks or challenges.
- Competition - by competing against others and winning prizes or moving up a leader board.
- Narrative - discovering what is happening in ongoing story as it emerges.
- Puzzle-solving - the ongoing puzzles, riddles and challenges.
- Community - collaborative elements, discussion boards and completing challenges with others in the real world.
- Creativity - an opportunity for players to be creative, either through problem-solving or the development of game artefacts.

As well as the motivational factors of games, there are also characteristics present in ARGs which players may find *demotivational*. In research about demotivational factors regarding games in general, Whitton (2007) describes four key factors: difficulty in getting started without having to spend time setting up and learning rules and etiquette; getting stuck for a long time and being unable to see a path forward; lack of trust in the game system or perceived unfairness of the game; and an intrinsic lack of interest in the game or subject matter itself. This last point is particularly interesting as it counteracts the argument that anything can be made fun if it is made into a game (e.g. Prensky, 2001).

3. Case studies

There follow four case studies that explore different ways in which motivation can be facilitated in ARGs. *Viola Quest* was a full ARG that was run at Manchester Metropolitan University to support student induction. The *Great History Conundrum* at the University of Leicester used some ARG aspects to create an online problem-solving course to teach Historical research skills, while the *Never Ending Uni Quiz* at the University of Brighton used several similar techniques to support student motivation and engagement during induction. Operation Sleeper Cell provides a comparative study from a related sector, and was the first charity ARG, developed to raise funds for Cancer Research UK. These are purposefully not deep empirical studies, but are considered in terms of their qualitative importance to the theme of motivation.

3.1 Viola Quest

Viola Quest was developed as part of the JISC-funded ARGOSI project, which ran between September and December 2008 at Manchester Metropolitan University. The game was designed to complement traditional student induction and provide a way for students to get to know the city and meet new people. In addition, the challenges encountered matched the set of introductory information literacy learning outcomes covered in the University's standard library induction.

The game centred on a first year student, Viola Procter, and a mysterious letter, which describes a mysterious secret society and a hidden machine. As the game unfolded, the players worked together to find map pieces, which lead them to the machine and uncovered its purpose. The challenges included a variety of individual and collaborative puzzles, taking place both online and in the real world. The game made use of a bespoke game engine that delivered and assessed challenges (either automatically or by hand), allowed users to set up profiles and see how they were progressing relative to others, and offered a means of group and individual communication. The game also made use of external web resources including a bespoke site set up as part of one of the challenges, blog sites, social networking and video hosting sites.

The game was designed in such a way that it aimed to address a range of different motivations for playing. The completion motivation was addressed by making it clear from the start that there were a set number of challenges and this was heightened by linking challenges to collecting map pieces. Competition was fostered by implementing a leader board so players could see how they were progressing compared to others. The ongoing narrative and community were both integral to the game play and the challenges (although predominately based around puzzle-solving) also contained creative tasks.

Despite a fairly comprehensive marketing strategy the take up overall was relatively small with only 173 players in total, and only 23 of these who were engaged in the game beyond initial sign-up. However, there was a small number (3% overall) who showed extremely high engagement . Research indicated that kick-off during freshers week (when students are typically already overwhelmed) had contributed to the poor take up, as well as the cryptic nature of the publicity materials. Students said that they would have been more keen to take part if the marketing had made it more explicit that this was a game, and it was clear what steps they were expected to take, although many said that they did not have time to play ‘a game’ but would be more interested in taking part if they had realised that it would benefit their studies or there was external motivation such as a prize. Feedback also showed that many players found the first challenge too difficult, or did not see the value of spending time and energy on it, and so simply gave up at that point.

3.2 The great history conundrum

At the University of Leicester, there was a need within a first-year undergraduate History module to improve student engagement with critical analysis of internet-based historical resources. ARGs were used as a model to create a four-week activity based in problem solving, collaboration and competitive play. Rather than a fully-fledged ARG, the project took some elements (graded puzzle solving, competition involving leader boards and prizes, minor narrative/story elements, and community/collaboration aspects) and combined them with subject-specific and research skills elements already used in the original course.

During the course, students were provided with a number of puzzles of varying difficulty, which could be solved at any time, and would be immediately marked on a leader board, and replaced with new puzzles to solve via email (the instant reward and delivery of new problems thought to be key to maintaining engagement). The puzzles were graded and also covered different cognitive skills (searching, selection, filtering, criticism and application) to ensure inclusion across the 200 student cohort. Collaboration was encouraged by allowing students to trade puzzles with their peers, discussion forums and the construction of a collective wiki; carefully constructed assessment criteria were developed to encourage and assess engagement with the activity and concepts (with marks directly linked to each solution and discussion post; higher marks awarded for higher levels of understanding or critical reflection).

The first indication that engagement levels had risen was shown in the access statistics to the discussion forums and puzzle marking system: many students working long into the night, and spending 1-3 hours a day online. Additionally, the assessment results revealed pass rates similar to the previous year, but the standard of pass was significantly higher (half achieving over 60%). Students interviewed after the course rated the following features as most motivating: getting a good assessment score, solving and getting new puzzles, seeing themselves rise up the leader board, and aiming for one of the prizes. Initial anecdotal evidence from tutors of follow-on courses reveal that these students are a highly engaged, highly performing cohort with increased critical understanding of key concepts, when compared to previous years.

There were, though, two key demotivating factors which were revealed during the course and in the follow-up questionnaires. First, the ‘swapping’ system for puzzles meant that some students were waiting for one or more days before they could solve a new puzzle, which they complained about at length (an indication that regular and unhindered delivery of new puzzles/challenges is indeed a strong motivating factor); secondly, the final stage of the course, where groups of students created a shared wiki resource, received complaints about lack of clarity/instruction of the task and of higher performing students ‘carrying’ the lower ones (a common feature of group work - as noted by Kaufman & Felder (2000) among others).

3.3 The Never Ending Uni Quiz

Several induction ARGs had been run at the University of Brighton in previous years, with strong motivation shown from players but low overall take-up from the student population as a whole. The *Never Ending Uni Quiz* project was designed as a way to encourage more students to engage with an induction game, by making it clear what was expected of the players and giving very clear feedback about how a player was progressing. Social games outside Higher Education, such as those played on Facebook, were studied - and concepts were adapted to produce a workable game in a University context.

The Never Ending Uni Quiz is an online quiz, aimed primarily at new students to help increase awareness of University services and support. Launched in June 2008, the quiz has had well over 1500 active players, and new members are still joining daily. Applicants, who were due to start at the University in September, were able to play the quiz before arrival, learn about the University and to start to feel a sense of belonging.

In their own words, the students have this to say about the quiz:

> *“I have found it informative about the University and have found out things I would not have otherwise known.”*
>
> *“I like quizzes and think it is a fun way to learn about Uni.”*
>
> *“The fact that the quiz was everything to do with the University, and I was a first year student eager to know more about the university especially because at the time I started the quiz, I had not yet started University.”*

The quiz questions are continually updated and added to from staff across the university - including questions on the Senior Management Team, campus maps, parking arrangements and the local towns.

In terms of motivation for players, one of the fundamental elements of the quiz is a leader board - putting all the players into teams based on their level and campus. This added element of competition - between teams and also between individual players - has been identified as the key to the strong engagement observed. Initial analysis of players' behaviour, and feedback, shows bursts of intense activity - often playing for over an hour in a session until a target (e.g. top of the leader board for their team) is achieved. The model of attaching a leader board to a 'standard' activity, such as an online multiple choice quiz, does seem to transform the activity into something substantially more motivating to players than without (see Piatt, 2009).

It was observed that once targets had been reached players rarely returned continuously to play the quiz again. The lack of story or any significant collaborative elements to augment puzzle solving, no doubt contributed to this, and the absence of these became demotivational.

3.4 Operation: Sleeper Cell

Operation: Sleeper Cell was an alternate reality game that ran for ten weeks in late 2008 with the aim of raising money and awareness for Cancer Research UK. The game had a spoof spy theme and consisted of missions (puzzles, challenges and creative tasks), an unfolding story, and a larger 'metapuzzle' based on clues unlocked by completing missions.

Players could play individually or in teams. New missions were released at intervals during the game and could be unlocked via a donation to the charity. These donations unlocked the mission for all players of the game, with the team or player sponsoring the mission receiving a head start over other players. Points were available for completing missions and there were both team and individual leader boards. A full description of the game can be found in Law 37 (2009a) and the game website can be accessed at www.operationsleepercell.com. There were approximately 40 players actively playing the game for its full duration (Law 37, 2009b) and for a subset of these players, the competitive element was a major driver, with one team in particular going to great lengths to ensure that they stayed top of the leader board. This team also started a mini-fundraising contest between teams at one point during the game.

Overall, the quality and variety of puzzles was constantly cited as a reason for playing the game. The fact that the game was 'for charity' also featured. For example, one player noted "Put it this way... I wouldn’t have pushed other people into playing quite so much as I did if it hadn’t been for charity". The social element is harder to gauge - most of the more active players were members of teams. However the majority of teams were formed by people who already knew each other, despite the in-game forums provided for the players. Some players commented that they might have played more if they had know other people who were playing with whom to form a team.

The story and game universe certainly engaged many players, as witnessed by the comments of players, forum posts and entries to some of the creative missions and forum posts. The attention to detail and humour in the game were stated as being significant factors for some, although not all: one player said "I don't think it made any difference to me - there were just lots of quality puzzles, and that's all that mattered".

In terms of demotivators, a few main themes came up. Fairness of marking of the non-puzzle missions was a sensitive point with many players. At one point in the game, one of the players complained on the forums about the way that the puzzles were marked. As a result the marking process was made much more transparent, but there were still mild complaints later on in the game. Several players also brought up issues with the pacing of the game - either not having anything new to do for long periods of time, or mentioning that the pace towards the end was too fast, with too much to solve in too little time. People who stopped playing part-way through the game generally gave reasons revolving around not having enough time due to other events in their lives or being stuck on puzzles that were too difficult (although other players mentioned that they found the forums useful for hints when they were stuck on puzzles).

4. Discussion

From these four case studies, it is clear that a number of issues arise when considering the design and implementation of ARG-based learning activities, and that these can be addressed in a number of ways. There are five areas in particular that the studies have highlighted for discussion: the impact of competition; how to design for motivation; levels of participation; assessment; and ways of building autonomy. We have purposefully focused on these overarching issues rather than try to fit the discussion around existing theories, to both test and add to the debate within this area of study.

4.1 Competition

The degree to which competition is embedded within any game format will always be an issue as, while many students find it motivating, others find it off-putting. Ensuring that there is a good balance between competitive and other elements is important to ensure that the game is engaging to as many students as possible, as is designing the game in such a way that the competitive element is obvious but not obtrusive. Ways in which competition can be implemented include tangible artefacts such as prizes or intangible elements such as leader boards. Elements of competition can help to keep players engaged in the game but can also lead to negative effects such as demotivation when losing, and players focusing on what needs to be done to win the game (even through cheating) rather than learning from it.

In *Viola Quest*, a leader board was implemented but this did not seem to have a great motivational effect on most of the students who took part; however, feedback showed that students wanted a definite and clear rationale for taking part (prizes were mentioned but seemed to be less motivational than being aware of an obvious benefit to the players' studies). The *Never Ending Uni Quiz* did not offer prizes, but there was sufficient motivation for players to climb to the top of the leader board - and stay there - without needing to have a monetary prize. The *Great History Conundrum* showed prizes to be a good motivating factor, but less so than the leader board itself (which was linked to both assessment and prizes).

4.2 Motivation

Ensuring that students are motivated to play the game in the first place, and continue to engage in it, is key. A clear reason for taking part, whether it is because it is compulsory, assessed or simply promoted as 'a good way to learn' is crucial. Feedback from students at Manchester Metropolitan University showed that they did not want to take part in something that was too cryptic because they did not know what the game was about (or even that it was a game) and could not see any value in taking part. There are a variety of other ways to draw students into the game and keep them engaged, including developing involvement with story and its characters, a mystery that unfolds and stimulates curiosity, and ways in which they can demonstrate their creativity by developing artefacts or working collaboratively to add to an ongoing storyline. Ensuring an appropriate level of challenge is also crucial, and providing a variety of challenges at progressively different levels and of different types helps to ensure that there will be puzzles at the right level to engage students of different abilities and preferences. In addition, a variety of ways to support students when they get stuck - such as hints, clues or community forums - provide a way to avoid a common demotivator. Getting stuck is about the players knowing what is expected of them as well as actually being able to complete the puzzles or challenges, so clear and explicit instructions are crucial. Ensuring that the game is seen as fair and open by the players is also very important as this can be a crucial aspect that stops people engaging with the game, so scoring and the relationship between scores and evaluation of answers must be explicit to avoid demotivation.

4.3 Participation

In the ARG case studies, where there was a genuine choice to play (i.e. they were not related to course assessment), relatively small take-up was observed compared to the available audience. What is interesting in these cases is that the players themselves were hugely engaged with the game, but formed a niche audience without mainstream appeal. The comparison of player statistics from The *Never Ending Uni Quiz* with these optional ARGs shows a marked difference. Rather than a niche audience, player figures within an institution were in the thousands - not the tens. Fewer demotivational factors are present in something like a quiz, compared to a more challenging ARG: players of a quiz are always very clear on what is expected of them - no curiosity about solving a mystery is required, and therefore players are less likely to be stuck, confused and unable to make a start. However continued motivation, or engagement with a quiz in the long term, is a lot lower than for an ARG because of the missing elements of story, puzzles and creativity. It seems one can achieve high participation with low continued engagement or low participation with high ongoing engagement by selecting particular motivational factors.

4.4 Assessment

Assessment has always been a hot topic in higher education, and never more so than now. Antiquated forms of assessment geared towards final papers and the tutor-marked 100% scale are coming under scrutiny for their inability to test new forms of learning within new flexible delivery methods either effectively or efficiently (TLRP, 2008; JISC, 2007). Reeves (2000) suggests that new forms of assessment need to be developed to align them with new learning outcomes desired and expected from online learning. Problem solving and group work have, in turn, been equally difficult to assess effectively (Angelo and Cross, 1993).

Many institutions, and indeed students, have a dim view of game-related activities (viewing them as - variously - unacademic, frivolous, or time-wasting), and this has caused many designers to take games out of the formal curriculum into induction or as extra-curricular opportunities (as is the case with three of the case studies in this paper). However, with these difficulties come great potential benefits. There is no greater motivator for a student than gaining a high or pass grade, or knowing that their work is going directly towards their overall qualification. Assessment can therefore aid motivation with other areas of a course - where those areas and the assessment are aligned. There is therefore great potential in formally assessing game-related elements and bringing them into the curriculum: aside from motivation aspects, this inclusion would guarantee high student participation and also give the elements gravity in academic terms.

In the one case study which was embedded in this way (the *Great History Conundrum*) much time was spent developing solid assessment methods and criteria which were aligned very closely and very visibly with the course materials (linked directly to the leader board), and which would give the course weight within the academic department. The benefits were significant, but countered by the time and thought needed to align and design the assessment; the fact that students felt that they had grounds for complaint and unfairness; and the need to develop re-sit and review procedures.

4.5 Autonomy

Problem solving by its very nature is both autonomous (developing strategies and awareness of issues in own time) and collective (drawing on strengths and experiences of others to build new meanings) but what sets ARGs aside from more traditional academic problem solving activities is both the potential for independent, autonomous investigation and the willingness of the game community to take on board many of the support and development aspects normally have to be provided by teachers. Moseley (2008) found that peer support within *Perplex City* was extremely efficient: experienced players helping newcomers to cope with the game mechanics, technical issues, and to work through problem-solving steps ("I'd usually point new players to resources to catch up, as well as write tutorials" one player explained). This level of scaffolding (Wenger, 1998) and support links directly to student motivation - either to develop their own skills and competences to show off to, or gain membership of, the group; or share in the joint motivation of a group moving forward together.

The issue of quality arises in academia when students are learning autonomously. Lewis & Vizcarro (1998) note that there is a conflict between a desire to encourage students to be autonomous while also ensureing that appropriate support has been provided. The intervention, at some stage, of a trusted academic source is therefore seen as essential to guide autonomous learning down the right track. This could be programmed in to the content (as with the *Never Ending Uni Quiz*) or delivered through moderated discussion (as in the *Great History Conundrum*).

In conclusion, it is clear that designing an appropriate ARG-based learning experience is neither easy nor formulaic. The right balance of motivational factors will depend on the student group, the nature of the subject matter and learning outcomes, the skills and preferences of academic staff, the environment in which the game is played, and a variety of other factors. One observation that can be made from our qualitative analysis of these four case studies is that creating a motivating, engaging game may be less about providing a range of motivating factors (although this is still important) and more about ensuring that there is a clear rationale for students to engage with the game (be it intrinsic or extrinsic) plus - crucially - a lack of *demotivating* elements. By ensuring that games have a range of elements, including (but not necessarily all of) competition, something to complete, puzzles, narrative, creativity and community; are designed in a way that allows easy initial take-up and participation; include ways to avoid getting stuck; and are seen as being fair, then the chances of creating an environment in which students will be engaged and autonomous will be greatest.

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The Truth About Alternate Reality Games: Args in Educational Method, Args as Educational Method

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Abstract: To use the contemporary catch-phrase, in *post-method* times it is either an anachronism or arrogance to propose any one language-teaching method. Unlike their theoretical colleagues, teachers have long been eclectic in their approach and sceptical of blanket methods. Conversely, although theorists may of late be busy be deconstructing pedagogic philosophies, teachers have always retained a healthy respect for anything that works, particularly that which is empirically proven. For that reason, in this paper we will consider the benefits of ARGs, (Alternate Reality Games) to teaching method, or, indeed, ARGs as a teaching method in themselves. Among other ARGs cited, we make particular reference to the Tower of Babel, a game developed by the ARGuing project, innovative in that it has been developed to incorporate Web 2.0 technologies to learning tasks, and designed not just by experts in games but also by educators for educational ends. As we discuss, results from the final pilot demonstrate not just that ARGs work, but that they work tremendously well.

Keywords: ARGs, motivation, collaboration, social networks, education, method

1. Introduction

ARGuing is a cutting-edge project that addresses two fundamental needs in European education in an innovative manner: (1) how to bridge the widening technological gap between educators and their students; (2) how to motivate students to understand the benefits of learning languages at a level that impacts on their existing personal lives. To address these needs, the ARGuing project has developed an Alternate Reality Game (ARG) that utilizes digital technology (Web 2.0 tools) as a communication tool for international, multilingual peer student communities that have to solve online quests by working as a massively multiplayer collaborative group, in multiple languages. To accompany the ARG, we have also developed a methodology to show how the ARG can be used to motivate secondary school students (aged 15-16) to learn a modern foreign language. In this paper, we discuss Alternate Reality Games and present a methodology for incorporating such a game in the teaching of a second language. Although the paper does indeed refer to the specific game developed for the ARGuing project, the Tower of Babel, its focus is broader in that it addresses both other ARGs and educational methods in general. While it draws on examples outside the scope of the project, it bases its conclusions on the specific project experience.

The focus of this particular paper is educational method in ARGs, with particular emphasis on Constructivism.

2. Previous research

2.1 What are alternate reality games?

"Alternate Reality Games are a blend of online narrative and puzzle solving (similar to an online scavenger hunt). The narrative is gradually revealed through a series of media such as websites, Instant Messenger conversations, text messages, emails and in some cases, TV and newspaper adverts and telephone calls. Central to the development and running of an ARG is the puppetmaster, who is simultaneously an ally and adversary to the player base, creating obstacles and providing resources for overcoming them in the course of telling the game's story.

Fundamental to the solving of the game is collaboration – players must work together to solve the puzzles and ultimately the game. One further technological area that has been identified as having strong impact on learning is the emergence of social networking. Interestingly, not only are ARGs a form of computer game they are also heavily built around social networking in the course of telling the game's story." (Connolly *et al*, 2008)

2.2 Precedents in educational method

Educational games and simulations have been creeping their way into popular and professional culture for at least twenty years, Sim City and the Sims are both games with possible educational applications. More recent examples might include Nintendo's Brain Age or Professor Heinz Wolff's Gravity for the Nintendo Wii. There is an extensive list of examples in Sawyer and Smith's serious games taxonomy (2008). Organizations are spawning whose aim it is to harness the potential of games to engage, for educational purposes. In the Orange County Education Authority webcast, Games in Education, Henry Fielding, one of the experts interviewed, states that there is a need to evangelise, and to convince. It is his opinion that teachers and parents of this generation understand the potential value of games because they (parents) have grown up with these technologies. He maintains those that need most convincing are the commercial developers. No doubt this is true in Orange County, but over here the wayward congregation in need of hearing the truth about ARGs might yet include most of adult Europe.

2.3 The educational power of games

In Moving Learning Games Forward (Klopfer *et al,* 2009), the authors define play as a series of freedoms: freedom to fail, freedom to experiment, freedom to fashion identities, freedom of effort and freedom of interpretation." Not many of these freedoms are compatible with the formal learning context. The authors go on to stipulate: "Play has no agenda, and the child's goals are entirely intrinsic and personal." Games, the authors state, "possess rules, constraints and externally defined goals". The authors go on to argue that learning can occur where games and play meet. We will now see some examples of educational and non-educational ARGs.

2.4 Educational ARGs

In "Why I love bees", McGonigal describes the experience of one hugely successful ARG, I Love Bees (ILB) from an educator's point of view (2008). ILB was initially conceived as a marketing campaign for a video game. The game had programmers, writers, specialists working not just before but also throughout the game. McGonigal builds the argument for emergent collective intelligence culture and states that equipping young people with the skills to negotiate it will be crucial: "*A CI (Collective Intelligence) curriculum would provide students with the opportunity to develop a new kind of digital network literacy, one specifically tuned to the techniques, challenges and rewards of massively scaled collaboration*." (McGonigal, 2008, p.4). She illustrates such collaboration with concrete examples of how a worldwide community collaborated not just to solve complex puzzles proposed within the game, but how the designers and writers used that international community to help them to develop the game.

Difficult, on the other hand, to find "Lonely Girl 15", another ARG, with its Youtube TV instalments, and multiple communities, also massively 'successful', clearly entertaining to many, such an educational example. Think of the worst soap opera you have seen and then make it worse. Yet it abounds with communities inventing and debating story lines, posting mp3s and videos. Writing has never been so much fun.

To base the argument for including an ARG as an activity in a course, or to make a course an ARG, it is helpful to revisit some theories of education and learning. In recent years, digital technology has permitted outstanding use of games in a curricular context. To consider why and how an ARG can have educational value, to detect what it has in common with certain educational theories, where ARGs digress from theories, and, indeed, where they move beyond them.

2.5 Constructivism

Most important of these is Constructivist Learning Theory. Constructivism is a theory of how people learn (Piaget, 1968). The constructivist method in education is defined as "thinking of learning" and "thinking of knowing". This method refers to the organization of teaching and learning, more specifically to their active character. This categorizes the method as an educational innovation. The nature of this method is disclosed through a number of principles: learning is a quest for knowledge; learners should understand the whole as well as its parts, i.e. the learning process focuses on interrelations, not just isolated facts; learning is not a mere memorization, it is an acquisition of meaningful chunks relevant to the object of study; the evaluation of what is being learned should be part of the learning process. The constructivist method sees the learner as playing an active role in his/her cognitive processes. One should find meanings individually and independently and they should become important for the learner, that is why constructivism involves learning through participation. The nature of the activities can be cognitive or practical, i.e. by actually doing something with one's own hands.

Should we then unleash our students in a labyrinth of an ARG with a piecemeal plot, pieces of which can be found anywhere in cyberspace? What could be more deliciously constructivist? One can certainly sympathise with a gamer who pleas in a blog: "I've spent the whole day figuring out what I'm trying to solve," Letting students discover the questions and establish targets collaboratively, does not mean anything goes, educationally.

This might be the curricular equivalent of walking into a room and stating: the theme is physics, work out the questions, and then leaving the students to 'discover' the subject. For a game to be educational, some challenges need to be specific. The issue for the game designers is neither to stick education into a game (before you can shoot you have to do a little algebra), nor to stick a game into education (between equation and equation, there is a nice little battle folks). Education needs to be intrinsic (possibly implicit) to the fun and vice versa.

Quests, questioning, individual and collaborative discovery are evident in most ARGs. The need to discover what needs to be discovered is enticing to gamers. In a curricular, educational context, perhaps some key target objectives albeit interdisciplinary ones, will need to be pre-defined. In the Tower of Babel ARG, as its purpose was explicitly educational, students were asked to evaluate each other's forum contributions and blogs. They were also frequently asked to reflect and explain their reflections via blogs.

2.6 The Tower of Babel (TB) ARG

The ARG developed in this Comenius project specifically targeted secondary school children in the 14-15 age group. Teachers were involved to initiate their students in the game. Thus the specific initial context of the ARG was formal education, the game was included as an activity in the curriculum, presented principally by language teachers who had received an online introductory course on the game

The developers of the Tower of Babel set themselves the objective of designing a game that would be educational and Web 2.0 based, one that would incorporate ICT and plurilingual teaching objectives, set on the Moodle platform. In this ARG, there is a storyline based on saving languages, the players have to send information about languages and cultures to a futuristic world where both have vanished, to save their earth from the same fate. Communication from the future (in different languages) sent by a secret rebel society arrives to the players via e-mail and via a special game portal. In this, the Tower of Babel ARG differs from other ARGs which tend to have a much more oblique storyline, game aims and communication: participants are mostly anonymous. Members of the secret society ask players to solve a series of quests to help the world of the future remember what culture and languages are. If players can find the right answer they can add blocks to their virtual Tower of Babel. Some quests are closed (in multiple choice form) and automatically scored by the game. To find answers students need to do some research. They are encouraged to use online search engines and each other as resources. Other quests are open-ended (e.g. students are asked to upload text, sound and image files, representative of themselves and their cultures) and are graded manually. The platform itself provides students and participating teachers with opportunities to interact by participating in forums, sending messages and forming societies by means of the guilds. All of these possibilities permitted Student-Student, Teacher-Student and Teacher-Teacher interaction.

Thematically speaking, many of these questions are focussed on languages, writing, alphabets, books, to find answers students needed to collaborate with one another. Quests were set at CEF B1 (or Intermediate language level). The various languages proposed different quests; they were not translations of one another. For the main pilot, there were three sets of quests: in French, Spanish and English. Some of the game input came only in French, only in English or only in Spanish. One teacher participating in the pilot commented: "*I don't think students from different countries were equal in rights. At the beginning of the game video materials had captions only in French and Spanish. I saw Bulgarian captions only in the last video material*" (Tower of Babel, Post Game Questionnaire). While another states, "*This is the best way of using games in language learning I've ever seen. It was definitely worth it."* (Tower of Babel, Post Game Questionnaire). Certainly working within the classical framework of language teaching, this game could not be used as a pan-European game. Student start levels, target levels, levels of inter-language(deriving from mother tongue), levels of inter-comprehension (deriving from knowledge of second and third languages), zones of proximal development, existing competence in second and third languages, was in no way a constant or a given. But how many of these givens matter if 74% of teachers felt that the game created opportunities for students to communicate authentically in the foreign language(s)? (Tower of Babel, Post Game Questionnaire).

Perhaps the key point to remember is that an ARG is not a language learning activity in the classical sense, it is a language learning and using and opportunity in a ludic and authentic sense.

2.7 Overcoming obstacles and challenges: ARGs in the classroom

Difficulties with integration of digital games in education are manifest and complex. In terms of development itself, technology moves extremely fast and is expensive. Developers need promoters. Promoters are loathed to make enormous, risky investments in a market that changes so quickly. On the positive side, the target audience is broader than in previous years, it is no longer restricted to socially-limited teenaged males, with a tendency to isolation and time and money on their hands. Advertisements for games now target women, families and groups rather than individuals. All games move in a market with huge potential and high risk.

Educational games are a subset of this group and have their particular problems: game design experts needs to collaborate with pedagogical experts to meet the criteria of both. If a game can manage to meet these prerequisites, it will then encounter educational realities.

Even with an excellent game, a motivated teacher prepared to invest time, operates in the context of a department, a school, a community, a curriculum, an exam, set beliefs. The educational environment plays an important role. Using a game is not always just an issue for a motivated individual, there are many potential obstacles: Internet connection, access to computer rooms, sufficient number of PCs. Once those difficulties are overcome within the student body there may be resistance to change, unfamiliarity with technology, economical difficulties, no supportive home environment. For example, in the Comenius project which is the subject of this paper, some of the key game communication came via e-mail. In pilots we discovered at least a quarter of the students did not possess e-mail accounts. The accounts had to be created for the students. So apart from institutional difficulties, an ARG may be even more difficult to implement because in itself it can be complex. Despite all these difficulties, in later pilots, the impact and success of the game was manifest.

We might pay tribute to the teacher who participated in the Tower of Babel final pilot and described how "*It is difficult in our case because we have the only one computer with the access to the Internet in our language lab. We need more computers to use interactive exercises. I created my own thematic webquests but with one computer (without e.g. element of competition during the lesson) it is useless).*" (Tower of Babel, Post Game Questionnaire).It is teachers like him who, against all obstacles, demonstrate such initiative and drive that they are the ones who make change possible in education.

The field is growing but it is as yet nascent. The Tower of Babel ARG overcame many of these obstacles. It had a promoter, it had motivated teachers, it had students, if the participants were not always the most technologically adept, they were willing to try. The Tower of Babel ARG made use of a web-based platform and e-mails to engage the students. However, many students had never participated in online forums or blogs. Teachers needed to help students unaccustomed to independent navigation or online collaboration using in-class sessions. Furthermore, students for the most part were not accustomed to taking initiatives to discover information. This value is highly educational but not typical in certain EU learning cultures. ARGs depend on students having this capacity.

In the first part of the paper we have considered what an ARG is, in the second part, we have considered how educational values have been derived in recent precedents. In the third and final part of this paper, we will attempt to draw some conclusions. How and why then are ARGs relevant to teaching method for any one discipline?

3. The canons of method

To return for a moment to what a paper on method within a particular discipline would typically do: respect curricular conventions, assume or propose theoretical tenets within specific fields. Within formal, state-sponsored education systems, methods respond to empirical systems of evaluation. Teaching approaches are conceived to be carried out in class, situated in a room, with a teacher applying a series of techniques or specific material on a group of students, observing their effectiveness on student progress. In formal education systems at secondary level teachers are qualified and authorised to work one or two specialist subject fields.

3.1 Discipline and interdiscipline

The first question that any teacher may ask, is to what curricular subject may ARGs be applied? The answer to this is they may be applied to any one or a combination of subjects. Games are not necessarily divided into history and geography, or English or French, they can involve a mixture of both. As ARGs are collaborative, inherently communicative and multinational, they have, however, a clear potential and application for language learning. The primary target of the ARG is not to teach a language. Language learning and use may take place in a motivational and real context. This, however, is a secondary outcome. ARGs are perfect media for Content Language Integrated Learning (CLIL) curricula and courses. However, in the Tower of Babel ARG, game designers and pedagogic experts collaborated to make languages inherent to the target, context and form in the game. Thus, many quests centred on languages.

3.2 Method in ARGs

When it comes to ARGs, however, most of these givens about method are taken away. Firstly, the context is a game, not a class. Secondly, the physical space of an ARG is the world, cyber and real, not a room. Thirdly, the target knowledge and skills, generally stipulated by educational authorities and experts in a curriculum, can now only be partially written into the design of the game. Fourthly, we can presume that in a cyberspace that is multilingual, players will need to be plurilingual to participate. It will be players themselves who will define some learning targets because ARGs are open ended. Fifthly, evaluation and feedback will be continual and performance based, but not overtly from a 'teacher', possibly from other players. This leads us to the best bit, *ex cathedra* disappears: not only is there no symbolic and authoritative chair, there is no teacher at all.

Didactically speaking, in an ARG there is the figure of 'the puppetmaster' a digital leader, who can be consulted and someone to whom questions may be formulated. This figure can help players make their own discoveries; and players may help other players. Game targets are achieved by the formulation of appropriate questions. Knowledge is acquired in the first instance by the formulation of appropriate questions. This is not modern; it is as ancient as Socrates. Depending on the ARG, and depending on the players, the questions posed by players to one another may be as profound as interpreting a mystery programming language, the calculation of coordinates or as gossipy as 'will Johnny get back together with Jenny?´. It all depends on the particular ARG. The effectiveness of any resource will depend on its quality and relevance. ARGs are a resource to be tapped for educational purposes. In this paper we attempt to determine to what extent we have already tapped them and to suggest further ways in which they may be exploited in the future.

3.3 Roles in the Tower of Babel ARG: who is the student? Who is the teacher?

Teachers might be forgiven for wondering what is the point of their presence in an ARG: we have already told them they do not officially exist in the game and that students become players. As far as technology goes, we can certainly talk about role reversal. Most school students are already adept at chatting, know more than their teachers about negotiating Web 2.0, uploading and downloading files (image, text, video or sound), compressing files, recording, doing searches, and so on. In the feedback questionnaire, one teacher becries "*Almost all my spring vacation I spent trying to prepare myself for the game. Unfortunately without a success. I think It would be better if, for example, all teachers of a given country whose students are playing the game get together for a day or two before the game and have 'face to face' preparation for a game. Thus the game would not be so stressful.*" Most teachers involved however, did not find participation in the game quite so stressful, as 74% stated they found the training and instructions acceptable.

However, as an adult with detailed subject knowledge, the role of the teacher may be to design web quests, to select relevant links, suggest online action, orient, monitor interaction and guide students over obstacles.

It is perhaps less useful to think about what is the best way for people to teach, than it is to think about what is the best way for people to learn. Some aspects of ARGs are neither new nor revolutionary for any teacher: motivation, targets, learning by doing, stimulation, discovery, collaboration, learning by playing, omnipresent in ARGs. "*My students expected the game to last forever*."

4. Pilots of the Tower of Babel ARG

The scenario of the ARG game related to languages and communication. Consistent with this scenario, the Tower of Babel ARG had some clues and information only in French, some only in Spanish and others only in English. It was set at B1 level in these languages. To find the answer to some quests they needed to collaborate with each other. Although it might have been French or Spanish, the principle language used to communicate was English, perhaps because it was the language that most students were practising. Participating students in the first mini pilot came from Bulgaria and in the second mini pilot from Spain and Bulgaria, and in the third large-scale pilot students came from 17 countries. In the first and second mini pilots, students were encouraged to use the possibilities of Web 2.0 to participate. They were asked to upload sound files, but got as far as lyrics. Nobody uploaded a video file. Few uploaded JPGs. Students did manage to successfully complete information based quests.

The third large-scale pilot, due to successful dissemination, was a very different story. 328 students and 95 teachers participated from 17 different countries. The quantitative statistics indicate massive participation, with a total of 862 sound, image, PPT and text files uploaded and thousands of answers sent in for quests. Students formed guilds and collaborated across the EU to find answers and simply to inter-relate. To cite just one comment on a teacher forum here, one spoke of her normally laconic and disinterested group, rushing in before the bell to continue playing the ARG.

5. Conclusions

In ARGs we can see subject content targets are now set only partly by teachers or course designers, they are replaced, in part, by targets set by students and, in part, with totally new learning process targets, what we might define as tapping the knowledge of others, collaboratively and collectively. This latter lofty and worthwhile educational target is evident in the Tower of Babel game design, with blog, news, forums, and instant message systems. It attempted to promote collaboration and independent investigative skills. Many students succeeded in discovering answers, they may have done so together. In the first and second pilots, there was no evidence to support multinational collaboration. However, by the third pilot, forums and guilds were commonplace. Online collaboration and the use of Collective Intelligence, probably can be taken much further by developing less two-dimensional, one-answered quests, quests that would be harder to solve. Players can go a little further than: "What's the answer?" queries to one another, and move on to the plane of "what's the best answer and why?".

The potential for ARGs in education is enormous. The principal case scenario exemplified in this paper was centred on languages and language-learning, but scenarios could be designed around many different worlds, worlds with sick eco-systems, worlds without electricity. Players could discover chemicals, laws of physics, mathematics, and so on. Learning targets appropriate to certain levels can be integrated into any creative fantasy. Collaborative tasks could be set at lower and higher levels. Curricular teachers may need to be prepared to move outside their expert fields and experiment with being multidisciplinary. As one teacher commented after the game, "I have always thought games may be helpful but here I have seen a lot more chances to use the language in a game and I had never thought that Moodle might be used also like this."

In the final game pilot, teachers interacted with one another and made contact via the platform writeboards. Participating teachers received training in the game, which gave them confidence and familiarity with the platform. Some teachers expressed the need for face to face training. The potential of a multinational group of teachers to grade, indeed design quests for the game was clear, although untapped. Groups could be trained to edit and trained to grade. Teachers could also be trained in how to monitor forums. E-mails from teachers querying the cultural content of some of the quests, demonstrated that they were being keenly analysed. Teachers also wished to observe how their students were doing.

Occasional technical glitches with solutions gave rise to some of the most extensive and interesting interactions in the forums.

> *"No offence, but your group should first get to know what Yugoslavia was. Slovakia was NEVER part of it. And they were never good at skiing. But if you have mistaken it for SLOVENIA, that is even more sad" Friday, 24 April 2009, 09:31 PM Quest Forum*

We might conclude that there is a lot to be gained from proposing deliberately incorrect or ambiguous solutions.

Integrating game and education presented a challenge throughout the ARGuing project. In the final version of the Tower of Babel game, fantasy scenario and educational tasks retained their somewhat dual and disparate origins. They might have been integrated more. However the game did demonstrate that with the capacity to invent a story and intersperse it with correlated tasks, on a platform that allows teenagers do what they like to do online, teachers have a massively motivational and potentially very powerful educational tool with which to improve and create a 3rd millennia teaching method.

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The Role of Games in Facilitating Preparation for Future Learning

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Abstract: This paper, after exploring the importance and relevance of learning transfer to the development of and research into games for learning, presents a reconceptualisation of learning transfer as "preparation for future learning" (Bransford & Swartz 1999) and goes on to describe efforts to develop a web-based space game to facilitate learning transfer in this sense to a series of novel learning tasks presented as part of an innovative interactive astronomy exhibit for children. Discussion is offered with regard to the game design and development process – the latter based on the Adobe Flash CS3 environment – and with regard to results of the pilot of a "proof of concept" game prototype with a group of 26 boys aged 10-12. Some initial conclusions are drawn with regard to necessary improvements to both game design and research design; issues such as frequency of practice and cognitive fidelity are proposed in closing as important conditions for game-based preparation for future learning.

Keywords: Arcade games, asteroids, astronomy, serious games, games for learning, learning transfer, preparation for future learning, Flash CS3, learning transfer from games

1. Background: learning transfer and games

1.1 Learning transfer

Learning transfer is, variously, "knowledge being applied in new ways, in new situations, or in old locations with different content" (Schunk, 2004, p. 217); "The process that enables people to make previously learned responses in new situations" (Gage & Berliner, 1998, p. 299); or, more broadly again, that which occurs "when learning in one context or with one set of materials impacts on performance in another context or with other related materials" (Perkins & Salomon, 1992). Controversies regarding the concept are not limited to how it is defined but ultimately to whether it really occurs at all. Empirical evidence is generally not for it; Detterman for instance at the end of his overview of the history of research into the phenomenon offers two conclusions, "First, most studies fail to find transfer. Second, those studies claiming transfer can only be said to have found transfer by the most generous of criteria…" (1996, p. 15).

Yet a belief in transfer predicates our systems of education and training: we, as educators "hope that students will transfer learning from one problem to another within a course, from one year in school to another, between school and home, and from school to workplace." (Bransford, Brown, & Cocking, 2003, p. 51).

The recent renewed interest in the use of computer and video games for learning, seems to have brought with it a renewed interest also in the somewhat neglected phenomenon of learning transfer as well as, potentially, a new perspective and new set of research instruments with which to return to a debate at least as old as Thorndike's still influential research into transfer between "mental functions" over one hundred years ago (Thorndike & Woodworth, 1901).

A number of factors may be suggested as key to this interest game-based learning transfer. Many of the key research questions regarding the educational potential or pedagogical effectiveness of games for instance seem ultimately to be – or can at least be parsed ultimately as being – questions about learning transfer, i.e. they are questions which can be reframed as questions of the kind, "Is there is specific learning gained 'in there' [i.e. in the game world] which can be of use 'out here'?" or "Does the behaviour games encourage in their world somehow end up influencing our real world behaviour?".

Anecdotally we often hear of learning transferred over from games. A famous story *Wired* magazine ran last year, told of how the victim of a serious car accident was most likely saved by the medical care provided by an onlooker with no other medical training than that which he'd gained from playing

America's Army (Cavalli, 2008). The media, of course, commonly run stories linking violent crime, most prominently shootings, to video and computer game play – though of course other contributing factors often emerge later (Mileham, 2008, p. 157).

Vendors of serious and conventional entertainment games alike also tend to make explicit or implicit claims about the ability of their products to promote transfer: one thinks here of brain training games most obviously but also business and tycoon games, fitness games, and popular entertainment game titles with strong "sim" elements; in addition what might be termed "professional" or "vocational" games and simulations appear to have reached a fairly high level of penetration in certain training sectors in particular those to do with the fields of health/medicine and defence.

1.2 Research into transfer from games

The authors are not aware of any meta-analyses of transfer from game research but if the pedagogical effectiveness of games in general can be held up as a kind of first premises for their transfer effectiveness then the report is, at very best, a mixed one. Hays, for instance, in his review of the literature on the pedagogical effectiveness of games (Hays, 2005) concludes that, "In most cases, the research shows no instructional advantage of games over other instructional approaches" (2005, p. 43). Slightly better are the conclusions of Randel et al. (1992) who in a meta-analysis of studies comparing the pedagogical effectiveness of games with that "conventional classroom instruction" found 38 of 67 studies showed no difference between games and face-to-face teaching while just 22 (=32%) favoured games (Randel, Morris, Wetzel, & Whitehill, 1992).

There are a number of frequently referenced studies which come out in favour of transfer from games. Daniel Gopher's research into the transfer of skills from the computer game "Space Fortress" to real flight (Gopher, Weil, & Bareket, 1994) is a good example but there are just as many studies which find against it. Sometimes, confusingly, very similar-sounding studies produce conflicting results. Danish researcher Egenfeldt-Nielsen for example concluded in a 2003 study of eye-hand co-ordination transfer from Sega's *Super Monkey Ball* that his results did "not support any connection between eye-hand coordination skills and computer games" (2003) while a more recent study by Rosser et al found, by contrast, a very high correlation between game skills in *Super Monkey Ball* and more specific laparoscopic surgical skills and suturing ability (Rosser Jr et al., 2007).

1.3 Transfer as preparation for future learning

The kinds of definitions of learning transfer offered at the outset of this paper may be said generally to invoke the idea of a specific unchanged piece of learning getting reused or reapplied at some later date. Bransford and Schwartz (1999) speak of this approach to transfer as a "direct application" (DA) theory of transfer, a tradition they blame for the preponderance in the literature of "sequestered problem solving" (SPS) experiments where research subjects, like sequestered juries, are cut off from "contaminating" forms of information and communication and generally given only one-shot tries at producing looked-for transfer solutions. These SPS experiments have traditionally failed to find or promote transfer under such conditions and their negative results are indeed sometimes referenced as part of arguments not just to rethink the nature of and mechanisms underlying transfer but to more or less abandon the concept entirely (e.g. Detterman, 1996).

Bransford and Schwartz argue that rather than expecting learners to exhibit direct transfer to and, thence, complete and immediate mastery of every new learning scenario, the best we should hope for is a certain level of "preparedness" for new learning challenges, a preparedness that makes itself apparent in a number of quantitative (e.g. the speed of their learning) and qualitative (e.g. the quality of their learning/understanding etc) ways. Some of these manifestations of preparation for future learning (PFL) transfer would be entirely missed in a SPS approach, e.g. any promising questions learners might ask when faced with a new learning challenges.

In classic SPS experiments subjects are sequestered from information sources, in studies based on a PFL reconceptualisation of transfer, research subjects would – no less or more than in the real world – be given access to information-rich environments; would be encouraged to discuss problems with peers and others; would presumably be allowed to make mistakes; they would be given the chance to, in Bransford and Schwartz's words, "bump up against the world (p. 93) for a while. Gradually over time and in response to these conditions their knowledge base and so forth would become more and more differentiated as they came to progress through and grapple with a new set of learning challenges.

How can learners be “prepared” in this way? How can a game support this more nuanced view of transfer? How would we know if we’d been successful in facilitating this kind of transfer using games? In the remainder of the paper some initial attempt to develop and pilot just such a game are described.

2. The development of a game for future learning

Blackrock Castle Observatory is an observatory and astronomy research centre based on the outskirts of Cork city in the SW of Ireland. The centre is, inter alia, home to an innovation interactive science exhibition entitled “Cosmos at the Castle” which makes use of cinema-sized video screens to explore a range of astronomy and general science topics. In 2008 the exhibition was the recipient of the Themed Entertainment Association's (TEA) Thea award for *Outstanding Achievement in The Creation of Compelling Places and Experiences* (Science Center, limited budget category). Cosmos at the Castle tours culminate in an interactive cinema installation, entitled “Comet Chaser”, where visitors are invited to virtually save the earth from the impending doom of an approaching large Near-Earth Object (NEO).

Figure 1: The Comet Chase installation

The process of developing an educational game with this exhibition acting, so to put it, as its target setting began when two researchers from the Cork Institute of Technology, interested in using and developing games for learning were invited to meet and discuss collaboration possibilities with staff of the observatory. The Comet Chaser immediately suggested itself as an interesting focus for development work, it incorporated perhaps the most impressive and advanced multimedia content of the entire tour; it was in concept and subject matter exciting and dramatic and was also continuous with themes and settings of a wide range of classic and contemporary computer and video games.

The Comet Chaser exhibition was also task-based, and moreover incorporated tasks/problems with right and wrong solutions. This might not seem to recommend the exhibition much in light of Bransford and Schwartz’s criticisms of those transfer experiments which focused too much on the production of “right answers”, but it was decided that data concerning direct application transfer “success” might offer a useful counterpoint to more qualitative data concerning subject preparation for future learning. In addition the nature of the tasks – combined with the “urgency” of the mission – was thought to hold promise as a prompt for group discussion which could be analysed for promising trajectories of learning. The exhibition and tasks involved in it finally offer something of the kind of knowledge-rich environments Bransford and Schwartz place an emphasis on in their PFL theory.

In order to help explicate some of the game design decisions outlined latter below, a broad overview of the Comet Chaser exhibit is offered here first.

2.1 The Comet Chaser exhibition

The installation begins in “mission control” where a female figure tells users about “strange readings” she has received from a nearby satellite. These strange readings transpire to indicate a “Near Earth Object” (NEO) heading at “high speed towards the earth”. This sets the storyline for 6 tasks users are invited to complete using their touchscreens, as follows:

- Use sensors on an ESA satellite to analyse the NEO (which transpires to be a comet)
- Track the orbit of the comet and confirm its trajectory
- Plot a course for a vehicle to land on the surface of the NEO to probe the comet core
- Conduct spectral analysis matching of the core samples
- Decide whether to use an ion drive to push the comet off course or a missile to deflect or destroy it

The final task is really what lies at the heart of the exhibition. Spectral analysis will reveal the comet to be either predominantly rock or predominantly ice: icy comets can be safely destroyed using the thermo nuclear rocket – the rocket, it is postulated, would blow the outer rocky layer away and cause a substantial heating effect which propagates through to the icy core, essentially melting it – but blowing up a rocky asteroid would leave the same mass would hurtling dangerously towards earth (just in smaller pieces); in this latter case then nudging the asteroid using an ion drive is held to the preferred option.

2.2 The game development process

2.2.1 Preproduction

Given the nature of the project, and concomitant limitations in terms of time and resources, it was early on decided the game would need to be rather basic, 2D, and likely – primarily to keep development cost/time down, but also to assure a tried and tested playability – based on an existing widely-ported/emulated title for which code and/or tutorials might easily be obtained. The original *Asteroids* game with its the wrap-round 2D view and rotate-and-thrust controls as well as the various clones and related titles that have succeed it – Xbox Live hit *Geometry Wars* for instance bears more than a passing resemblance to *Asteroids* –eventually emerged as a kind of framework within which we brainstormed and ultimately developed a game prototype. An initial basic game design document included a suggestion to develop for online multiplayer functionality as well as for the ability of the ship to conduct a sort of on-the-fly spectral analysis of different types of asteroids and other space objects and phenomena in an open world environment. It is still hoped to implement these and other ideas but for purposes of developing a proof of concept product just three essential interrelated features were added to the basic *Asteroids* framework as follows:

- A distinction between two different types of asteroid, one rocky and one icy, with distinct properties (see b. below but also 3.2.1)
- the ability of the ship to take samples from icy asteroids
- the inclusion of a number of in-game action/context-sensitive information points.

These augmentations were made very much with Bransford and Schwartz's PFL approach in mind, and were meant collectively to change the emphasis from the more or less purely visuo-motor challenge of shooting and dodging asteroids to making informed decisions, based on knowledge of the two kinds of asteroids, about when to shoot, when to dodge and when gather samples.

2.2.2 The development process

At an early stage Adobe Flash was decided on as the development and distribution platform for the game. This decision was based essentially on considerations such as its ease of deployment and the minimal installation requirements, these two points were considered key in light of the plan to deploy the game in primary schools where it might not be possible to gain computer admin rights and where even the most basic performance requirements could not be relied upon. An early version of the prototype which integrated various 2D art assets – developed on foot of a very basic game design document – also incorporated an early version of both the probe and in-game message features and proved a very useful reference point not just for members of the development team but for subject matter experts in Blackrock Castle Observatory whose input to and validation of the various game mechanics and educational content was essential throughout. Storyboards also proved useful in sharing the vision for the game and defining various input requirements while also serving as an art style guide.

The game was produced by two software developers, who coded the game logic and graphical interactions and two graphics designers who developed the various graphical assets and the cut scenes. The loosely coupled nature of the software framework allowed both teams to work more or less independently, with communication between the sub-teams carried out via email and web. Daily updates were made to the asset library by the graphical design team, allowing the developers to compile and deploy the latest game version to the web for feedback by the project managers. This allowed the game to be developed in using an agile approach, meaning any issues could be readily identified and addressed. The Adobe Flash CS3 development environment proved adequate to requirements, although other RIA development platforms such as Microsoft Silverlight are also thought by the developers to hold great promise for the development of basic online games: our game in point of fact is currently being redeveloped in Silverlight so that the technical performance and production pipelines of both platforms can be compared.

3. The game

To date a proof of concept prototype has been developed with a relatively basic game mechanic. Based on the broad *Asteroids* framework, players of our "*Asteroid Chaser*" game, control a spaceship with the task of collecting samples from passing icy asteroids. The ship, as well as firing sampling probes at asteroids, can also fire on them with thermo-nuclear rockets. As with the Comet Chaser exhibit, firing on an icy asteroid simply destroys it but firing on a rocky asteroid breaks it into smaller pieces which can still damage the ship. Although the original design document suggested players would have to analyse the asteroids to determine their composition the two asteroid types are meant to be distinguished visually in the current prototype of the game.

There are three missions in all, each based around the collection of a certain number of samples from a limited number of icy asteroids using a limited number of probes; only mission one differs significantly from the others insofar as it does not include any of the more dangerous rocky asteroids. The missions are woven together as part of a storyline conveyed primarily through a series of basic cutscenes in which an astronomer directs the player to collect samples from the icy asteroids; a storyline which concludes with the possible discovery of life on an icy asteroid in the Kuiper belt. Rather than crowding all the educational content into the cutscenes – the modus operandi of many would-be serious games – the game itself is designed to be a knowledge-rich environment where interactions with various in-game objects prompts action/context-sensitive and gameplay-relevant messages and information from the astronomer figure.

Figure 2: A cutscene from the game

Figure 3: An in-game message

In terms of the final target context the key ideas it was intended players should glean from the gameplay were: (a) the key distinctions between the two main type of asteroid, and (b) a broader related idea that some a process of analysis or identification should generally precede action (i.e. ask questions first, shoot later, not the other way around). The central task required in the Comet Chaser exhibition, i.e. the decision whether to use an ion drive to push the NEO offcourse or use a missile to destroy it – has no equivalent in the game: the idea was not that a solution should be presented to players of the game which, it might be anticipated, would later be transferred into the observatory context but that playing the game should facilitate enough relevant preparation for future learning to at least give rise to some relevant trajectories of learning.

4. The pilot

A rather basic pilot of the proof of concept prototype was undertaken in May 2009. The key objectives here were to establish if the game would appeal to the age group we had in mind for it, to ensure it had adequate playability and fun factor – in other words that it worked as a game – and finally to establish if it could be said to provide a mechanic and framework to facilitate learning. Since, for a number of financial and operational reasons, a visit to the observatory was not feasible for the participant group, an evaluation of the transfer or PFL effectiveness of the game was not from the start envisaged, though, as described below, a questionnaire administered after the pilot group played the game included one question based on the Comet Chaser task in the observatory. There was in any case no control group or pre-/post test included in the research design, though it is anticipated a more extensive study based on a revised version of the game and a much more sophisticated experimental design methodology will be conducted before year end.

In all 26 children from a local boy's primary school took part in the pilot. With little preamble or instruction participants were asked on the day to try to play the game, after which they were asked to complete a short questionnaire. There was also some short discussion. Feedback and discussion is presented below.

4.1 Questionnaire results

Two initial questions were set to establish the game playing habits and experiences of the group. 23 of the 26 participants indicated they play computer or video games outside of school, of these a reasonably high percentage (65.4%) indicated they played games either a "a few times a week" or "everyday" and a very high proportion of the group (88.5%) played at least "once or twice a week".

Opinion with regard to the game itself was mixed but generally positive with 16 of the 26 participants answering they either liked the game "a bit" or "a lot" (the two highest points of a five point scale). In addition, 24 of the 26 participants indicated they would "*like to play a game like this again"* and, encouragingly, all participants – even those who stated they would not like to play a game like ours again – returned to play the game once more after they had completed the questionnaire.

All participants managed to finish the game within the time available – about 10 minutes of gameplay time – though there were some noticeable differences in how quickly the children were able to begin fully engaging with the game at first. This variation relates to learning transfer from previous game experience, another type of learning transfer which it is planned to investigate in a future study.

After these two initial questions respondents were asked quickly to list what they considered to be the main differences between the two types of asteroids in the game. Apart from just one out rightly false answer ("Rocky asteroids moved faster than icy ones") and some confused statements which yet evidenced promising trajectories ("Icy asteroids are in different places"; "Icy asteroid has slippery edges, the rocky one has rocky edges" or "Rocky asteroid needs a missile to blow it up but an icy asteroid needs a probe to blow it up") the results here indicated a good grasp of the key learning the game was designed to facilitate.

One or two of the answers (e.g. that only "rocky asteroids can damage the ship") moreover point the way forward in terms of avoiding possible points of confusion through modifications to the game mechanic, scoring/victory conditions, interaction design, visual feedback etc.

The table below represents an attempt to categorise responses under five main headings. As can be seen the vast majority of responses could be described as being either "substantially incorrect but linked to or based on some aspect of the gameplay", or "partially correct but a 'low level' insight based on e.g. tautological statement or circular reasoning".

Table 1: Categorisation of suggested differences between two types of asteroids in the game

Comprehensively correct answer	0
More or less correct answer but with minor inaccuracy/misapprehension	3
Partially correct but a "low level" insight based on e.g. tautological statement or circular reasoning	10
Substantially incorrect answer, but linked to or based on some aspect of the gameplay	12
Incorrect answer	1

The final question in the survey related directly to the transfer context of the Comet-Chaser exhibition and asked participants what they would do if an asteroid was heading towards earth. There was no media offered in support of the question and no other hint condition (e.g. "In answering this question think about the different kinds of asteroids you know about) as often appears in studies of problem solving transfer or analogical reasoning (e.g. Gick & Holyoak, 1980). Answers were quite varied but showed a number of "correct solutions" as well as useful learning trajectories.

One undeniably "correct" answer made by one of the respondents was simply that "the game didn't tell me this", while another said, quite sensibly, he would have to first tell his "dad". Ten of the respondents still offered some solution based more or less on the tactic of just blowing the approaching asteroid up but of these two indicated that the "bits" or "shards" should then be pushed or propelled out into space, and another one that he would first "first make everyone on earth take cover".

The table below represents an attempt to categorise responses to the transfer question under five main headings:

Table 2: Categorisation of suggested differences between two types of asteroids in the game

"Correct" positive transfer solution, likely based on gameplay	2
Largely complete/workable solution but missing one or two elements	6
Partially helpful or partially complete transfer solution; or solution evidencing interesting learning trajectory with apparent link to gameplay	8
Unhelpful or largely incomplete transfer solution but with evidence of transfer/inference from gameplay or other source	6
"Incorrect" or negative transfer solution	5

The questionnaire obviously did not allow for the kind of "bumping up against the world" that Bransford and Schwartz's reconceptualisation of learning transfer endorses, it did not allow the young participants to learn from mistakes, from results – such as damage caused by a blown-up rocky asteroid – which might have prompted them to think deeper, based on their experience of the game, and arrive at a more appropriate response. The administration of the questionnaire in addition did not allow for any discussion between participants – very much part of Broudy notion of "learning with" (1977) a strong influence in its turn on Bransford and Schwartz's theory of transfer.

Another consideration for more extensive research was suggested by one of the staff from the observatory who indicated that in his experience boys interacting with the Comet Chaser exhibition show a marked preference over girls for blowing things up, even, he suspected, if they were aware of a more appropriate choice of action. In future research the team will likely endeavour to include both boys and girls to take sex into account as an extraneous variable.

4.2 Some further analysis

In order to determine if there was a relationship between game playing frequency and transfer as exhibited by scores on the final question, we analysed the data using Pearson's product moment correlation coefficient. The correlation coefficient of 0.13 is not statistically significant at the 5% level for the sample size of 23. Similarly, we analysed the relationship between game experience of game play and participant's enjoyment of the game. Again the Pearson correlation coefficient of 0.21 is not statistically significant at the 5% level with a sample size of 23. While correlations can never prove a causal relationship they can help to establish the validity of such a claim: in this case, the analysis of data suggests that there is no relationship between these variables: experience of computer and video game playing, enjoyment and scores on the transfer question.

5. Discussion and conclusions

This paper began with an exploration of the importance of learning transfer and the renewed interest in the topic from the perspective of games for learning. The claims, explicit and otherwise, made for the transfer power of games was referenced and some related literature briefly reviewed. In this context a reconceptualisation of learning transfer as “preparation for future learning” (Bransford & Schwartz, 1999) was offered, after which efforts to develop a web-based space game to facilitate this kind of transfer to a children’s interactive astronomy exhibit was described. Above, initial data was offered from a first crude pass at piloting the first fully playable prototype of our astronomy game. Although the research design was very basic and some key features of the game have yet to be implemented – in particular the incorporation of online multiplayer functionality and more open world exploration – results may still be said to have been largely positive. The product worked as a game, it demonstrated playability and fun factor. It also appears to work on some level as an educational tool, at least insofar as participants appear to have grasped some of the key factual knowledge it was designed to facilitate. Results with regard to the game’s ability to promote transfer are more mixed but the administration of a questionnaire was never intended to work as an instrument to gather valid and reliable data in this regard: the research environment moreover, as already indicated, allowed no opportunities for peer communication and more “open-world” exploration which would support Bransford and Swartz’s account of preparation for future learning.

This crude first pass at evaluating the game was also problematic insofar as it involved no control group and no pre- and post-test which might at least have allowed an analysis of learning and transfer effects specific to the game: it also emerged during piloting that the majority of participants had some time previously already visited the observatory, a condition which would have invalidated most attempts to draw conclusions from the data, even if a more robust and sophisticated research design had been followed. Nonetheless results, even for the question relating to transfer, prompt useful ideas for further modifications to both game and research design.

On the subject of requisite modifications to the game it was also observed during the piloting that a number of the participants had difficulty reading and comprehending the various texts that appear throughout the game, similarly many of them were seen to just click through the cutscenes. One way forward here would be to replace or supplement the texts with audio narration – a relatively inexpensive modification – or to try to make the cut scenes and the in-game messages more engaging and more central to successful gameplay.

5.1 Conditions for transfer

A majority of participants also complained that they found the game both too easy and too short: this, on a trivial level, is largely a question of balancing certain variables (e.g. number of available probes versus number of probes to be landed): the team also have plans to add a number of extra space objects and phenomena which will have the effect of increasing both complexity and duration of gameplay. In another way however complains as to the brevity and simplicity of the game go beyond fundamental game design decisions right to the heart of the transfer research. One of the authors for instance has elsewhere (O Suilleabhain, 2008) argued frequency or extent of practice may be a key condition for transfer, i.e. that transfer may be a conservative mechanism with its own in-built protection, based on a kind of successful case history, against over-generalisation or inappropriate/unproductive attempts to transfer.

Fisch, Kirkorian and Anderson (2005) in an article to do with learning transfer from educational television similarly see various learning transfer solutions vying as it were for position in new learning contexts and suggest the likelihood of one solution from the many being applied in any given situation is a “function of the associative strength of that content relative to all of the other competing material that is stored in memory." (2005, p. 383). The concern then with regard to the brevity of our space game is that it is simply too short to facilitate the development of the right level of associative strength, that if transfer and/or preparation for future learning, rather like, say, the development of expertise, is dependent on extensive and even considerably extensive levels of practice then one cannot perhaps expect to promote transfer or PFL with what is at base a short casual game.

Another related issue raised by comments regarding the simplicity of the gameplay is the issue of what is, in the simulation-based training field, termed “cognitive fidelity”, i.e. the “degree to which scenario content is similar in cognitive demand (i.e. difficulty)” to the transfer context (Elliot, 2004, p.

122). Our Asteroid Chaser game is a basic one and makes few cognitive demands on the player, or at least the cognitive demands it does make seem to be of a different and lower order than those required by the Comet Chaser. In addition to simply cranking up the difficulty levels of the game and developing more levels to ensure longer gameplay it may be the development team needs to revisit some of the underlying issues with regard to the game mechanic in an effort to match the cognitive demands of the Comet Chaser exhibition or any other hoped-for transfer context.

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Storytelling and Serious Games for Creative Learning in an Intergenerational Setting

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Abstract: In this paper a concept based on an innovative combination of Storytelling and Serious Games to promote knowledge sharing in an intergenerational setting is presented. This work is being carried out in the scope of the "E-VITA: European Life Experiences" project, which aims at developing and testing Serious Games that allow younger generations to "live" true stories told by older people. Thus the complexity of the past can be experienced directly and understood while playing a game that once was a very individual, real story, resulting in a very innovative way of creative learning. The authors are designing an approach that allows transposing life-experiences collected from the narratives of older citizens to Serious Games to promote Game-Based-Learning that is most motivating for younger generations. The historical timeframe is set before the European Union was established (1993). The stories potentially relate to different topics like work, holidays, migration, and any kind of cross-border experience, both from the cultural and the practical point of view. Besides the occurrences also the emotive side of the involved characters is being considered and integrated through the Storytelling approach. The chosen methodology offers gamers to actively be engaged in the past happenings and to directly live the experience as the main character. To elicit profound insights into the historical situation and about the dynamics regulating the setting, it is fundamental to catch expectations of the younger generation and to address them in such a way that these potential players feel attracted by the games: their creativity must be able to run free, while they are involved in the story. To reach this objective, a participatory design approach was chosen. In the scope of E-VITA the different actors are involved in the design process. One on the one side seniors telling stories based on life-experience and on the other side potential gamers, namely teenagers and young adults are asked to actively participate in the design of the Serious Games, by expressing preferences and expectations and give feedback through all the stages of the design process. In this paper the outcomes of the first round involving potential users in the game developing process is presented in detail and the follow-ups are briefly discussed.

Keywords: Serious Games, storytelling, creative learning, intergenerational knowledge transfer, participatory design approach, motivational requirements

1. The E-VITA project

The E-VITA project – European life experiences, www.evitaproject.eu - co-funded by the Education and Culture DG under the Lifelong Learning Programme - aims at developing and testing Serious Games that allow younger generations to "live" stories told by older people. In this way the complexity of the past can be experienced directly and understood while playing a game that once used to be a real story. The younger target group has initially been defined by the project consortium around 14-22 years.

Figure 1: Four dimensional framework

The E-VITA project wants to test and investigate new ways of knowledge sharing and knowledge transfer in an intergenerational setting combining Game-Based-Learning and Storytelling techniques for the creation of different Serious Games focusing on the transfer of life experiences of older people to younger ones.

To do this a four dimensional framework (see Figure 1) has been defined to cover the different phases of the participatory design approach, namely:

TELL: Experts on knowledge transfer and management recognize that stories can be faster and more easily understood than abstract and theoretical explanations. In E-VITA, the stories are providing context, they embed knowledge into a concrete gaming situation; not only do they comprise pure facts; they also provide connections and emotions. The approach is holistic; it does not focus on merely transposing factual knowledge, it targets a connected, experienced knowledge creation. Therefore, in this phase “Storytelling” concepts are used to gather stories from the older generation.

SHARE: E-VITA uses a Community of Practice approach in which community members reflect and collaboratively explore their life experiences, reasoning how their "established knowledge“ can be transferred or exploited within a group, organization, or community. Effectively, this leads to the constitution of a “Community of Storytelling”.

PLAY: The E-VITA project focuses on Game Based Learning (GBL) to encourage learning. Games are deeply motivating and engaging and make it possible to learn and train important skills like adaptability, self-direction, risk-taking, interactive communication, prioritizing etc. that are difficult to teach within conventional approaches. This is also the most natural and intuitive approach for the younger generation.

LEARN: The superordinate aim of the project is to promote intergenerational learning: seniors tell the stories, younger generations play the games. They can also share impressions and knowledge in a continuous interchange thereafter. The pedagogical and technical environment will be developed to support the exchange amongst the different generations, to ensure that learning is reciprocal. This method allows younger generations to experience emotions lived by older people and thus to understand their point of view of life better, but also the reverse process may take place. Intergenerational relationships should benefit from the possibility to swap roles for once, i.e. the opportunity for younger people to step into the shoes of an older generation.

2. Participatory design approach for games

User participation in E-VITA development is considered essential for achieving games implementation success. The project E-VITA looks at new ways of promoting knowledge sharing amongst the generation. For this aim it is essential to understand and conceptualise information in relation to the needs and expectations of the target group for the games, namely teenagers and young adults.

Since this is a rather ambitious aim, that can only be achieved if potential gamers are involved in the design process right from the beginning. Implementing a participative E-VITA design (according to the concepts of Schuler, Namioka 1993), where users are advisers of the development team, requires not only choosing an appropriate methodology but also organizing the participation process in a way that is tailored to the particular situation in order to achieve the desired results. A general approach to this question is presented in *figure 1* and explained in the follow.

The phases of the participatory design approach for Serious Games that support knowledge sharing and information transfer amongst the generations

- **Initial phase: Focus groups and interviews with target users:** In the first phase a small sample of potential gamers was interviewed to get detailed insights on overall gaming interests and specific topics and game concepts that could be of interest for the target group. Teenagers and young adults were approached separately. For teenagers a focus group approach was adopted, young adults - in this case University students - were approached with a questionnaire-based survey. Results of this first phase are presented and discussed below.
- **Initial phase:** Pedagogical concept: The concept is based on the four-dimensional framework (4DF) **for Serious Game design, which has been developed by the applied research group at the Serious Games Institute** (de Freitas, S., & Jarvis, S., 2006). The framework has been successfully applied in the development of past projects such as TruSims’ “Triage Trainer”[1]. It emphasizes the four dimensions of context, learner, pedagogy, and representation.
- **Initial phase: The story of the game, a story telling approach based on life experiences of senior citizens**. The E-VITA Serious Games are based on true stories from older Europeans. With the support of the E-VITA partners, local communities of practice (CoP) involving senior citizens develop a storyboard for a Serious Game according to a storytelling based concept.

[1] Triage Trainer official website: http://www.trusim.com/?page=CaseStudy

Storytelling differs from abstract information transmission by the stimulation of processes of projection, identification, empathy, imitation and imagination on the receptor side. On the storyteller's side it enables expressing subjective points of view, feelings and personal relevancies about events. In the last years several theoretical frameworks and approaches for storytelling have been developed and storytelling is nowadays applied as an innovative technique in informal and formal educational settings, in organisational development and corporate knowledge management. Storytelling has several implications for learning and application in educational settings. Stories are usually faster comprehended, better kept in mind and easier transferred than abstract explanations. Related learning processes promote not only knowledge, but also social and emotional intelligence. Storytelling techniques can additionally effect motivation for learning by potentially providing personal valences for learning instead of giving general assessments. Stories can be a resource for learning from role models especially if stories refer to individual experiences and describe how problems within learning processes have been successfully overcome. In the CoPs, senior citizens share their experiences and use their expertise to contribute to the project (and hence to safeguarding experiences and community learning). In each of the seven countries involved, namely Italy, UK, Germany, Poland, Spain, Greece and Portugal (multicultural dimension) a CoP will edit storyboards for each Serious Game that they envisage. The E-VITA stories refer to four main topics: Tourism, Traveling in Europe and hosting Tourists; Working, Business Trips and Migration. Recreation in a world without mobile phones, Internet, computers is unthinkable. And finally East and West bloc, experiences from a divided Europe. To each games a set of educational aims is added that relate to socio-political, economical, historical, geographic and most of all intercultural competence. The aim of the games are in the first helping and encouraging younger generations to develop a consistent and positive feeling towards European Citizenship. Different studies point out (Edye 2002) that this is not yet the case, being an "European" is in some countries not always seen positively.

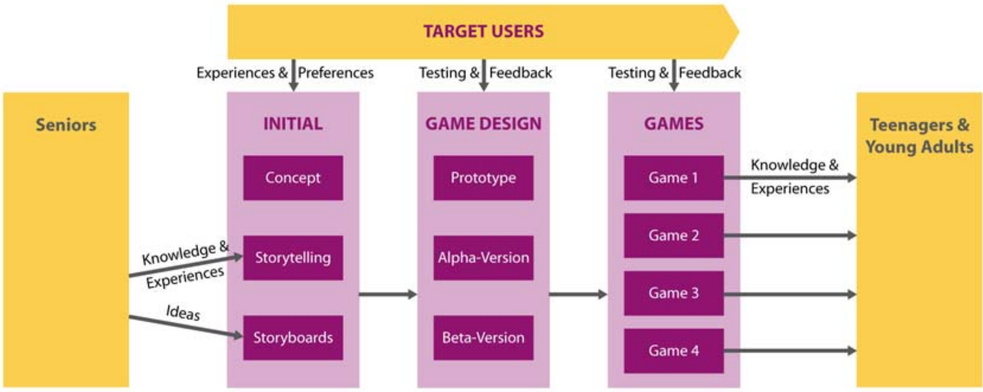

Figure 2: Participatory Serious Games design in E-VITA

- **Game design: Prototyping - 2nd round of focus groups and interviews** The storyboards are then transformed into Serious Games according to preferences stated by the target groups, and according to the pedagogical concept - the 4 Dimensions framework and of course including the stories of the seniors. These games can be used either by individuals online or by formal educational organizations (e.g. secondary schools) to teach history, geography, social sciences, economics, intercultural competence focusing on Europe and the EU. Real stories are transmitted from the old generation to the young, thus providing an intergenerational aspect in the project. In this third phase of the project the prototype games will be closely evaluated again by potential users - teenagers and young adults. Focus groups, usability testing, observation and user tracking will be used to evaluate the games and further develop them.
- **Game design**: Improved version of the games. In the game development process multiple activities will be performed to test the different versions of the games and get detailed feedback from the target users. In this phase of the process a 3rd round of focus groups with intensive gamers observation and users-questionnaires shall be performed and the results and user feedback will again be used for improving the games.
- **Game design: Localization of the Serious Games will be carried out for use in other countries**. Thus, as a further aspect of the project, users will have the possibility to compare experiences in other countries or to live some situations from the point of view of another country,

which provides an intercultural experience that would otherwise not be possible. The project will end up with a set of games in each language of the project team, used to “virtually live” some experiences of the older generation with real cross-border experiences in Europe.

- **Final Games version** - with a continuous collection of users feedback and specific analysis on knowledge creation. All games shall be available online for promoting knowledge and experiences transfer in-between the generations.

3. Phase 1 of the Serious Games participatory design activities in E-VITA

The chosen participatory design approach (started with several interviews with students groups, both teen-agers in the 14-18 years age group and university students and was carried out both in Italy (Milano) and in Germany (Erlangen) as starting point to engage these generations. The teen-agers were interviewed particularly about their gaming interests and potential interest in the E-VITA Games. The survey with university students focused on individual interests towards games. European Citizenship, and expectation on E-VITA.

In the following sections, the results of this survey are presented.

3.1 Young teen-agers: interviews in form of focus groups

Italy: 3 seventeen-year-old boys

The interviewees stated to find a game involving if it encourages them to set up a strategy to reach a certain goal. This should be the basic principle for the development of the game. Several scenarios were considered, and all share the same features: the game should allow the player to “manage” a situation and perform different “active roles” (from the politician to the worker).

The theme of a cross-border journey in Europe before the integration can be interesting only if integrated in wider and more complex context, such as the story of a journalist that has to collect testimonies to write an article on this subject, or the story of a spy fleeing from one country to another.

The boys seem strongly motivated in performing games where they can: 1) entertain themselves with fighting; 2) learn new competencies in terms of economics and political management (such as being a President and make decisions about the country, or being an important businessman making choices about economics/import-export strategies); 3) assuming the point of view of other soldiers (e.g. from others factions) in a war-context; 4) assuming the point of view of students or workers in Poland during the 80’s (even though less exciting than the previous points).

The basic assumption is that it is necessary to have a sort of long-term story or objective in their minds. Moreover the boys seem more interested in knowing past events of their own country rather than of foreign Countries.

Germany: two 16 year-old boys, one 13 year-old girl and one 11 year-old girl

The boys, both age 16, pointed out that Strategy Games based on role playing are more interesting and engaging. A very concrete aim as well as competitive aspects are absolutely crucial to engage in a game situation. Multi-player games are more attractive, the social aspects of playing are extremely motivating. The attractiveness of the user interface is equally crucial – 2D games are seen as boring and unprofessional. Immersive environments are very important to really engage in a game situation. A pressure and rewarding system, as usually integrated in Role-Playing Games are essential for motivating games. The educational intention behind a game should never be obviously learning, but rather hidden in the game. They dislike the name “Serious Games”, and see it as a contradiction, since a motivating, engaging game can not be “Serious” but should be funny, in a certain way interesting topics should take place: Younger ages as 2nd world war, historical events they already know about, e.g. The “hot” seventies in Germany, the cultural changes in the late 60’s and the Fall of the Berlin Wall.

The younger girls (Ages 11 and 13) described that the control upon a game character or a gaming situation in which they have to care for something (e.g., Pony) are most engaging. A very concrete aim as well as competitive aspects are absolutely crucial to engage in a game situation. Multiplayer environment is not crucial for an engaging game. The rewarding system keeps up the motivation for further playing. Also solving tasks or collecting different items are seen as very motivating in a game situation. A competitive situation either based on scoring or development of the character played or levels oriented is expected in an interesting game. Regarding interface design a 2D as well as 3D approach is accepted. The educational intention behind a game is seen as positive, especially if it can replace boring standard classes. Topics of interest: visiting a certain country, as a spy, journalist or even a politician. Also something like “Who wants to be millionaire” with an explorative part, where you can find the correct answer for the questions.

Even if the number of interviewees is very low, the German results show the difference in perception of several functionalities and characteristics between boys and girls. Italian and German boys pointed out exactly the same aspects.

3.2 University students

In Italy, 37 students of Communication Psychology and 33 students of Education Science were interviewed. The average age is 21,6; 63 were female and 7 male.

In Germany 20 students from different departments of the Human Sciences faculty were interviewed. The average age is 24,8; 12 were female and 5 male.

None of the interviewed students has previous experience with Serious Games. A majority has experiences with video games.

Experiences with video games

In the first part of the questionnaire students were asked four generic questions about video games, their experiences and interests. In the following the respective graphical representation is shown.

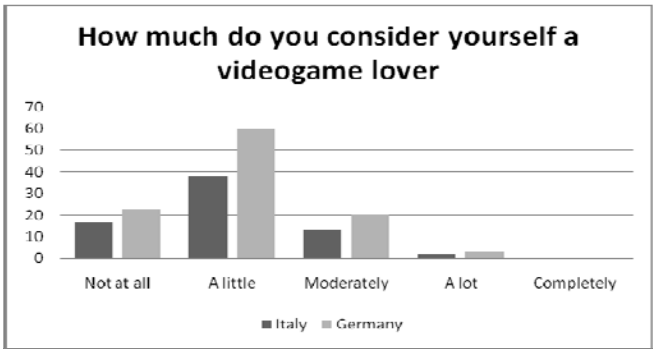

Figure 3: Experiences with video games

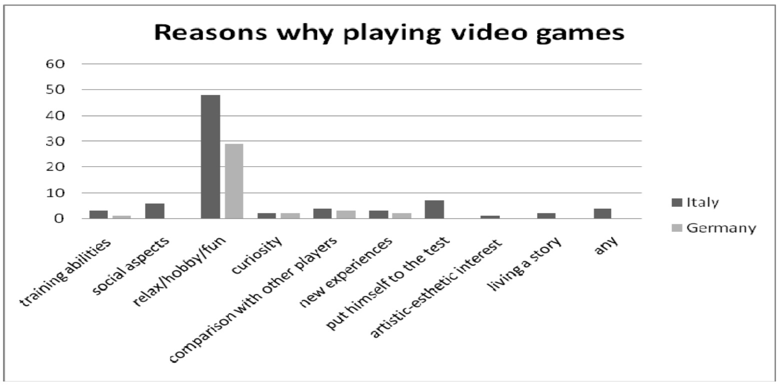

Figure 4: Reasons for playing video games

3.2.1 Key words for game development

Asked about the attributes of a video game they are appealed by, students mentioned in the first place “funny” and “easy to handle”. Further important attributes are “rewarding” and “low time investment”, i.e. small games for short time amusement. Features like “for free”, “strategy development", "non-linear" and "complex" were often pointed out as important for an interesting gaming experience.

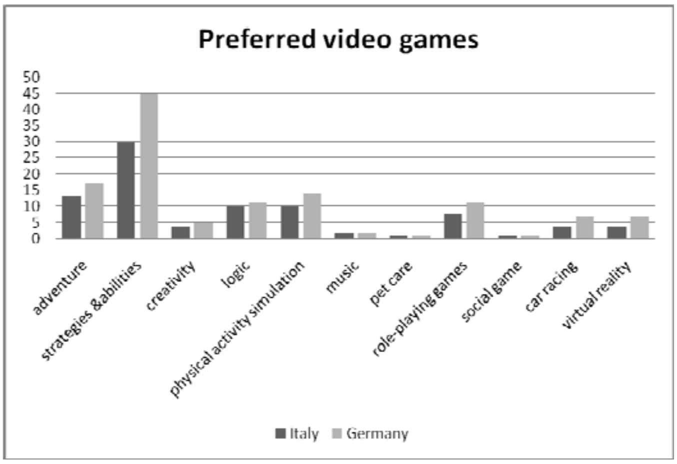

Figure 5: Preferred video games

3.2.2 Interests and preferences for E-VITA games

In the second part of the questionnaires the questions focused on the E-VITA project.
Students were asked about their potential interests and preferences to play E-VITA Serious Games in the future:

The listed reasons for positive interest are: curiosity; new experience; experiencing different lifestyles of the past and cultural aspects; stepping into the shoes of other persons; appreciating the current advantages and disadvantages regarding the European Union; becoming aware of the differences before and after the European Union and between different countries; acquiring new knowledge; just experiencing a Serious Game; playing is always fun!

Italian and German students generally seem to have the same reasons.

The listed reason for not being interested is the indifference to European Union issues;

Students who are not sure believe they cannot "visualize" the games and thus they cannot state their interest.

At this stage they were asked about their interest about their special interest in different periods (it is quite clear that interests are distributed with the same curve in the two countries) as well as about the potential topics of interest.

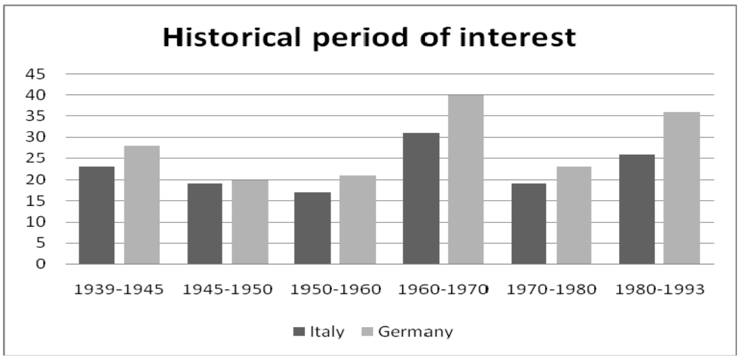

Figure 6: What historical periods are students most interested in

These curves are similar enough if one takes into consideration that a bit more than half the interviewed Italian students study Communication Psychology, which obviously brings that topic higher, whereas in Germany students come from different, mixed courses, but all in the context of human sciences (educational science, psychology and sociology).

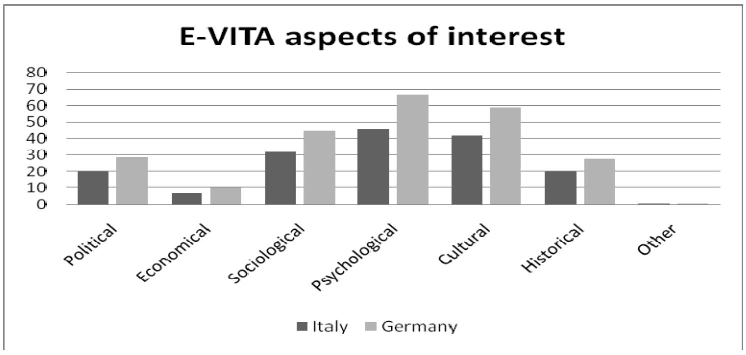

Figure 7: Aspects of interest for E-VITA games

3.2.3 Summary and follow-ups

Thus, both Italian and German students expect that E-VITA Serious Games focus mostly on psychological and cultural aspects. Therefore, facing these learning demands, the E-VITA games should allow players to actively participate in different daily cultural past situations focusing on characters' thoughts and emotions, in order to promote the participatory appropriation of alternative cognitive-emotional and cultural models (Rogoff, 1990). As a consequence, players will have the opportunity, not only to become aware of the European Union advantages, but also to multiply their cultural models and cognitive constructs finally increasing their cognitive complexity and flexibility as well as to increase their emotional competence (Hong, Morris, Chiu, & Benet-Martinez, 2000).

Sociological aspects have also been evaluated of interest, possibly to complete the psychological and multicultural aspects within a broader sociological framework to deepen human social structures, norms and processes within groups, associations and institutions.

Students would also be interested in political and historical aspects even though in a lesser extent.

Finally, only a minor part of the interviewed students expressed specific interests in deepening economical aspects within the E-VITA Serious Games.

The most complex part was finding out about their perception, about potential characteristics of the "ideal" E-VITA Serious Game.

Participants were asked to imagine and describe the ideal E-VITA Serious Game, specifying the ultimate aims, the game's goals and scenarios, characters, graphics and feedbacks.

Participants highlighted that, besides the sensitization to the European Union integration process, the ideal E-VITA game should have adjunctive aims such as raising awareness to multicultural issues and to traditional past values and lifestyles. Original scenarios have been proposed by participants, as for example:

- an elderly person and a young adult have to walk along the same path towards some places of interest (like squares, parks, trenches on the mountains, etc) and going back in the past;
- going by car with other foreign mates to a European foreign country: crossing borders and speaking a foreign language to talk to the travels' mate;
- coping with a specific problem in a past daily life context taking the point of view of a foreign citizen;
- helping an immigrant to integrate himself/herself in our culture before the EU union.

As far as games' characters are concerned, participants expressed the preference to customizable human characters with anthropomorphic features. These results are in line with the uncertainty reduction theory, which posits that people's primary goal in an interaction, be it real or virtual, is to reduce uncertainty about the person they are interacting with, in order to understand and predict people's behaviour (Infante, Rancer, & Womack, 1997). In the real world people generally rely on information provided by visible physical cues within the person perception process (Burgoon, 1994). The same implicit need is relevant even when people interact with or within computer-mediated interfaces, involving a process analogous to the one they have learned to reduce uncertainty during their interactions in natural environments (Nowak & Rauh 2005).

The majority of subjects showed preferences for a 3D immersive graphic. Most of them would assign feedbacks and scores, suggesting the presence of different levels to make the game more challenging.

3.2.4 Comparison between the results

The authors are aware that the sample is biased by the fact that most of the students are female. Therefore another interview should be carried out with male students in order to balance the figures and be sure to collect characteristics and expectations for a broader target group.

Although the figures are quite unbalanced, the authors feel confident to derive from the collected information that expectations and preferences of the groups do not change on a “cultural” basis: results from (northern) Italy and (southern) Germany are quite comparable and close enough to be able to be considered a “whole”.

Of course with the age groups, more requests and expectations change: here the challenge will be to find a way to satisfy both age groups with a sole set of games. One possibility will be to give the users the possibility to activate a sort of help (probably in the form of the learning companion (Kapoor, Mota, Picard 2001; Kort, Reilly, Picard 2001) with different depths, according to the confidence they have with the topic as well as with the interest to know and learn more.

The research project is in its first phase (3 semesters out of 4 still to work on it) and more conclusions will be possible in the next period.

4. Conclusions and outlook

Game Based Learning strategies are attracting increasing attention in recent years. As a new digital lifestyle finds its way into households Game Based Learning constitutes an approach that just feels natural to today’s generation of teenagers who grow up with new technologies like the Internet and take the possibilities offered by them for granted. The concept of Serious Games avails itself of young people’s openness towards new media and can help to convey knowledge in a way that feels natural and unobtrusive to them. The E-VITA project utilizes this concept for the transfer of knowledge enclosed in older European’s experiences from one generation to another.

The findings from the first interviews with teenagers and students showed a great general interest in video games of different types. As shown by the fact that almost all respondents have experiences with computer games Game Based Learning should be a learning approach that matches the habits of the target group. As far as the game design is concerned some key factors can already be determined that decide if a game will eventually be accepted. Equally important and difficult is the task to develop a game that is not only educating but also entertaining. The graphics are an important pillar for the game’s credibility. They can be either 2D or 3D, what matters is that they are immersive and serve to convey the right mood for the overall setting. However, a majority perceives 3D graphics as more convincing.

The most popular game types are adventure and strategy games as well as simulations and puzzle games. For most respondents games should allow for short, easy to access periods of entertainment without the need to invest a lot of time into learning the game controls or into following the plot of the game. On the other hand, respondents who are more into video games wish for more complex plots and games that offer many hours of entertainment. As most important characteristics as evident from the interviews a Serious Game should offer fun and rewards for in-game achievements. As mentioned above it is a critical problem to balance fun and educational value.

As regards content teenagers and students are interested in different time periods as well as in different subjects and aspects like culture, psychology, sociology and politics. The survey showed a general interest in the history of the European Union and in the study of stories about cross-border experiences.

E-VITA has just completed the Initial phase of participatory Serious Games design, future work will focus on the design and implementation of the games involving at all stages target users and storytellers. At the end of the project methodology and implementation procedure for using Serious Games as a vehicle for knowledge and information sharing.

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Developing Games for Higher Education

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Abstract: "Serious" games aimed at professional training or teaching students in further and higher education have recently seen a surge in demand. With trainees and students expressing continuous disapproval of traditional teaching methods who fail to attract and / or maintain the interest of the attendees, educators are looking at games to offer a solution. Over the past decade there has been a considerable improvement in the way role-playing games have embraced education at higher levels. Despite major breakthroughs and achievements there is still the feeling the expectations have not been fully addressed and there is much room for improvement. Educators and students look at the way players / students engage with the game and how this fulfils the needs and meets the ever rising expectations of gamers as these are fuelled by experience with entertainment games. Achieving the educational objectives as well as maintaining the entertainment value through advanced playability of the game is the primary concern of the developers. Seeking ways of engaging the user in the development process and ensuring that the game undergoes rigorous review sessions and extensive testing throughout the development cycle is a way forward. Trying to do this within a restricted budget and time for development and without compromising the educational content and value is the main challenge. Test-Driven Development is a methodology currently employed in many disciplines of computing, including the games industry with notable levels of success. Exploring its use and effects on developing games for higher education is the key theme of this paper. The author reviews two educational game development projects that have been implemented under his direction and management. He discusses the use of TDD and story-test-driven development in the more recent of the two projects and highlights the effects of the approaches, with projections as to future developments.

Keywords: Educational games, games in HE, test-driven development, story-test-driven development, games development

1. Introduction - computer games in Higher Education teaching

As computer based games, whether single user, multiuser, computer, console or mobile device based, increasingly capture bigger audiences across a wide range of ages in society their role and esteem in education increases on a daily basis. Educators in the Higher Education sector have over the past few years realised the true potential of digital games in their work space and are trying to capitalize on the effect games have on the younger generations in particular (von Wangenheim and Shull, 2009).

Generally, digital games have been used in education to teach specific skills in earlier stages of a learner's educational cycle rather than that of Higher Education. Most games aim at teaching learners by allowing them to learn while doing something. This is easier achieved when it involves practical skills whose learning involves some form of hands-on experience. However when a game addresses a more theoretical concept it is always difficult to implement the right features that would make it both attractive to the gamers / students who would be playing it and at the same time achieve the learning outcomes aimed to be realised by the educators (Akili 2006, Pimenidis 2007).

Educational games (or serious games) are designed to teach learners about a certain subject, expand concepts, reinforce development, or help them drill or learn a skill or change their attitudes as they play. Higher education has often turned to simulations rather than games to provide learners with a more real life situation compared to the virtual environments provided by games. Simulations resemble games in that both have some underlying model, allowable actions that the learner can take, and constraints under which these actions should occur. Additionally, learners observe their actions' consequences (Bayne 2008, Caspersen 2008, von Wangenheim and Shull 2009).

Squire and Giovanetto (2008) argue that new models of schooling are becoming essential to educational systems which are struggling to appeal as attractive and modern to young generations born and raised in the digital age. They discuss the concept of gamers / learners entering an online game as players but leaving as designers, contributing to the game's enhanced rule set. It is argued that such a participatory ethos is central to learning systems in a digital age. It would provide a means of sign posting the way forward for development and utilization of games used in Higher Education, but would also influence the way learning is designed, delivered and assessed for the students emerging from the digitally equipped classroom (Kendall et al 2006).

The toughest challenge to any educational game and any developer, is that paused by the need to continually update the learning content to ensure that learners are kept up to date with new developments in the area of learning supported by the game. This maintenance and continuous development of the game has to take place in a sensitive balance with preserving the key learning features of the topic and capturing those elements of fun in the game that would make it attractive. The rest of the paper considers a specific methodology used in developing games in a Higher Education Institution in the United Kingdom. The author discusses the key features of the methodology and provides a brief comparative analysis of two games that were recently developed at the institution. The benefits of the chosen methodology (Test-Driven Development in combination with Story-Test Driven Development) are summarised in the concluding section.

2. Development approaches used in educational games projects

2.1 Test-Driven Development

Test-driven development (TDD) is a design and programming activity in which development follows in response to a series of tests programmers write before starting the coding phase of their work. Hence it is not a testing activity but the combination of thorough design effort that would respond positively to a specific test. The testing aspect of TDD is largely confirmatory, through the regression suite it produces. Professional testers must still perform investigative testing. In the past most developers programmed by writing code first and then testing it. Tests were often performed manually and often gave only a cursory look at whether we had broken any past tests (Beck 2002, Koskela 2007)

With TDD, things are different than traditional development and testing routines. Automated tests specify and constrain each functional bit of the program. While these tests tend to prevent errors and detect them when they do occur, when an error does come up, the best response is to write the test that was missing—the test that would have prevented the defect. (Jeffries and Melnik, 2007)

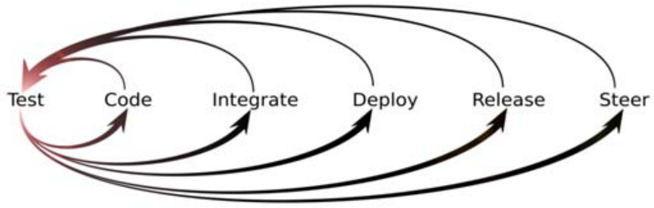

Figure 1: The Test Driven Development process

TDD can be broken down into the following simple mental checklist that is also illustrated in figure 1 above:

- • Think about what you want to do.
- • Think about how to test it.
- • Write a small test. Think about the desired API (Application Programming Interface).
- • Write just enough code to fail the test.
- • Run and watch the test fail. Now you know that your test is going to be executed.
- • Write just enough code to pass the test (and pass all your previous tests).
- • Run and watch the entire tests pass. If it does not pass, something is wrong - fix it now since it has to be something that has just been written.
- • If there is any duplicate logic, or inexpressive code, refactor to remove duplication and increase expressiveness -- this includes reducing coupling and increasing cohesion.
- • Run the tests again, this should still result in all tests being successful. If the code fails in any of them, then you made a mistake in your refactoring. Fix it now and re-run.
- • Repeat the steps above until no more tests that drive writing new code can be found.

One should note that the first item is by far the most difficult, followed by the second item as they embody the whole philosophy of TDD. The rest of the list is really pretty easy, but the first two are critical (Martin 2007, Koskela 2007).

TDD is not to be considered a panacea with many developers considering it to be counterintuitive.

The extremely short cycles between writing a test and making it pass go against their practice of writing whole modules and testing them manually afterward. They also argue that all that test writing would be too much work.

Martin (2007) argues that TDD developers must follow the three “laws” below:

- You may not write production code unless you have first written a failing unit test.
- You may not write more of a unit test than is sufficient to fail.
- You may not write more production code than is sufficient to make the failing unit test pass.

He believes that these three laws are followed within reason and that the whole activity follows in cycles that are just a few minutes long, then seeing all the tests run is never more than a few minutes away. This means that any bugs that might exist in the system (game) that is being developed will be detected within minutes. Hence no debuggers are required as the developers will know exactly where and when the bug exists as it would have been added in the past few minutes.

Thus if the above three laws are followed within reason, code will be written in response to a failing unit test. This means that most of the code written will be, by definition, testable. The only drawback though is that a function cannot be tested, especially if it calls others that have unknown or deleterious effects. This however can turn into an advantage since it forces designers and developers to decouple the functions and test them independently of the other functions. This adds value to the design of the system as it allows for easier maintenance and upgrade, which is particularly important in games and especially educational games like those intended for use in HE where frequent revisions will be essential and the time and budget available to implement them are mostly limited.

2.2 Story-driven design in games development

Story-test-driven development is a complementary form of TDD, but applied to overall system development. In story-test-driven development, customers write comprehensive story-tests for each scheduled “story” in a system from the perspective of business domain specialists, business analysts, product managers, and system testers. The story-tests produced provide answers to questions about the system in relation to its business context.

Thus story-tests are an alternative to detailed requirements documentation. They are produced instead of writing general statements about the business domain, while customers use a set of specific examples to clarify the general case. Also, instead of trying to cover the domain’s full complexity from the start, customers develop the story-test set over time (Mugridge 2008). This is particularly useful in educational games development where the concept continuously evolves as the educator attempts to capture new developments drawing examples from recent research or from reports of best practice.

Mugridge (2008) further argues that in modern development methodologies like Extreme Programming (XP), the customer role has domain expertise and assumes responsibility for directing the overall development from a business perspective. The customer uses high-level release planning to select the next release’s work, which developers carry out in time-boxed iterations. Each business-level increment is called a story. Developers estimate each story’s effort and the customer schedules a set of stories for the next iteration based on cost-benefit analysis.

Writing story-tests is often a collaborative effort among team members and involves a range of skill sets. This is particularly suitable for educational games development and in particular those targeting HE. Educators have particular requirements, targets such as learning outcomes to meet and expert knowledge which has to be conveyed in a story test. These are not always fully understood by the developers, and at the same time not all educators are experts in writing story-tests. The evolutionary nature of this approach helps customers tease out what is valuable and possible from their own case scenario, allowing them to fully reflect their objectives in such a way that these can easily be turned into fully automated tests. Thus story-tests promote collaboration and in the process clarify the domain and scope for all project participants, enabling conversations that build shared understanding among team members. Executing story-tests as automated tests can help developers determine when new functionality is complete and to understand whether any existing functionality has been broken. Story-tests help developers drive the overall, iterative implementation of new functionality. They form the major vehicle of communication between business (the educator for the purposes of this work) and development-oriented team members. Developers take a story-test as the starting point for their next piece of work, using TDD when they implement changes into the application code. Questions that arise from the different iterations in TDD would lead the educators to augment their story-tests to cover cases they have missed or to clarify or refine the terminology, appoint which often causes confusion amongst developers which might not be familiar with the field of study or the topic addressed by the game under development.

Story-test-driven development and TDD share several similarities. They depend on advanced automated testing techniques as well as traditional testing approaches, including tests for non-functional requirements. What makes them particularly attractive to educational games development is their common emphasis on evolution and emergent design, since both approaches focus more on designing than testing. The combination of the two approaches allows for innovative development which can be managed on tight deadlines imposed on small and flexible development teams. The cases discussed in the next section of this work, reflect the use of both approaches presented above. The benefit of using these approaches is in fully addressing the need for the educator to be directly and continuously involved with the project. Thus the educator can write the story-tests and if their expertise allows it educators can write tests for TDD. In this way any misunderstandings by developers can be avoided or identified early enough, leading to projects executed in a very efficient mode and achieving fast completion times. The involvement of the educator though is not a panacea since developers will still have to write the majority of the tests and the code and the success of the project will depend on both the management of it as well the effective interaction between the major stakeholders. The founding principles of TDD and story-test driven development provide the platform for this to happen (Jeffries and Melnik 2007, Mugridge 2008).

3. Developing educational games at the University of East London

In 2006 the University of East London embarked upon an ambitious project of creating a game for teaching library skills to new students. That project and its end results have been discussed extensively in previous work by the author and his colleagues (Pimenidis 2007, Ngozi-Okolo et al 2008) and the details of it are beyond the scope of this paper. The game took much longer than expected to complete and despite the enthusiastic commitment from all stakeholders in the project, the excellent feedback received from various groups of users / testers and ultimate success in achieving its objectives, it proved a real struggle to accomplish.

Two years later the author led another team in developing a new game with a specific academic content. This work is still in progress (in its final stages of development) and is expected to be available for wider use in January 2010. The aim of the game is to assist in improving student understanding of project risk, its management, in order to develop a thorough understanding of the role of risk management in project planning and project management. Although the prime emphasis is on teaching games development students and computing students, the nature of the game is such that could easily adapted to the needs of other academic disciplines.

The use of games in teaching “hard” subjects like software engineering is gaining momentum as reported by von Wangenheim and Shull (2009). However, despite the widespread belief that using games can yield substantial benefits such as, increased learning effectiveness, interest, and motivation as well as reduced training time and educator load, these claims are questionable and haven not been rigorously debated by established researchers.

Whitton (2007) argues that not all students find games motivating and she adds that there is no established link between a person’s motivations to play games for entertainment purposes to his or her motivation to use games as an aid to study and learning.

A similar view is expressed by Tychsen et al (2008) who explored the different factors of motivations behind people playing games. They could identify particular links to work practices or study needs although they had identified clusters of motivation factors that could possibly lead to an established link between motivation of play and motivation to study and hence support the argument that games in HE could be the way forward for improving the way learning is supported in HE.

3.1 Applying the two development approaches to games projects

For the first game development project referred to above (the Library Game) a small group of students was utilised as developers under the direction and project management role of the author. The team assumed a prototyping methodology in developing a simple game aiming to teach users basic library skills. The size of the team (restricted due to resources available and a limited budget) meant that each of the several versions of the game required thorough testing and rework by the same people (Pimenidis 2007). At the same time the need to move from role to role and support various stages of development work (e.g. design, coding, documentation, etc) meant that the duration of the project was lengthened and the time between the different prototypes was becoming longer. This often led to compromises in the design and eventually reducing the functionality of the product risking the appeal of the game and eventually its uptake and usefulness in meeting the required learning outcomes (Ngozi-Okolo et al 2008). Despite the lengthy process and the various obstacles the game proved a success, receiving excellent feedback both internally at the University of East London, when demonstrated in other locations in the UK and abroad where the author has presented it on four different occasions in three countries. This success though was not a result of a sound process but the outcome of determination and unselfish commitment by the development team, something that cannot be expected in every project.

Aiming to improve both in terms of the completion time and the efficiency of the process the latest project (the risk management game) adopted the TDD approach, combined with story-test-driven development. The author acting both as the project leader and one of the major stakeholders (being the educator directly involved with the topic) noted considerable improvements. Leading a different group of students, of the same size and undertaking a task slightly more complex than the previous project considerable savings in time and major enhancements in quality were achieved. Overall the learning objectives of the game were realized at a much higher level than the previous project. Students that used the prototype game as a tool in their learning process reported better understanding of the topic supported by the game and achieved better assessment outcomes than those of previous years.

The saving in effort time, measured in development team effort hours reached 30% - when compared to the first project. This amounted to less rework of almost 38% which translated into shortening the development time by 25% a saving of three months. This in turn allowed for the developed game to be prepared and included in the next academic year's teaching package, satisfying the educator's requirements for timely delivery and setting the precedence of being able to complete it within an academic year. This would prove particularly useful when revisions to introduce new knowledge on the topic would be required. It would also allow for improvements due to feedback from one cohort of students to improve the game and the learning content to reach the next cohort and thus induced an added benefit to the game.

Further added value for the students through their involvement in the project students is reflected not only on the achievement of the completion of the product (game), but on the opportunity taken to put in practice the actual content of the material they have been taught at class. A much wider benefit for other students who would be using the game is that because of the methodology followed in developing it they could be improving the game by adding their own short improvements based on their findings through playing the game, writing and using story-tests to specify the particular requirements for improvement and following TDD for swift completion of a cycle of modifications to the original one.

The above case provides some indication that possibly TDD is an appropriate development methodology to adopt in games development and in particular in educational games projects. The evidence though is limited as there are very few documented results in scientific literature to support this argument, to allow for strong conclusions. In the case discussed here the project size and the development team size are small and possibly this works in favour of the use of TDD, should the project size increase the multiple roles adopted by the educator might prove a source of conflict that could outweigh the benefits of TDD.

Further work is required to establish any justified conclusions on this issue. Currently the author, working with a group of colleagues, are collecting data from suitable projects that they expect to use in evaluating the potential benefit of using TDD in educational games development and more specifically on such games targeting the higher education sector.

4. Conclusions

Games for subject specific use in Higher Education appear a promising prospect. However their direct contribution to motivation for studying and learning has not been fully established, although the current indications from research appear encouraging and worth experimenting with new games and approaches to learning.

Developing educational games for use in HE is often a very challenging project to undertake. Limitations on resources and pressing needs to meet academic deadlines for utilizing the games at the right time during an academic year put high demands on developers. The author has experimented with adopting the combination of two established development approaches, with a good record of success in the corporate world, in developing a game targeting learners in HE. The results from the project management point of view and from that of the educator as a stakeholder in the game have been very encouraging. The combination of using TDD and story-test-driven development has reduced the development effort required and has yielded a shorter project completion time considerably when compared to a previously completed similar game. These results reflect the experiences and results recorded in literature when the combination of the two approaches has been applied to other application domains.

The work is ongoing, further work, the collection of experiences from other developers and potentially a further experiment with a new game would be required to confirm these early results and establish TDD and story-test-driven development as an appropriate development vehicle for games targeting HE learners.

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Does Game-Based Learning Exist or is it Merely Game-Based Teaching?

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Abstract: With increased interest by academic institutions in game-based learning, and the introduction of cognitive training games into the classroom, the question should be asked what the students are learning through playing these games. Some suggest that an increase in cognitive skills such as working memory ability, significantly improves academic ability, and that cognitive skills are greatly improved by playing computer games. However, others state that games do not foster learning at all, cognitive skills nor knowledge acquisition, and it is purely the context in which they are used that stimulates any learning to take place. This paper discusses the question of whether the game playing increases player's cognitive skills or if people with high cognitive ability immerse themselves in the games environment. Findings from independent studies that relate cognitive abilities to playing computer games are detailed and the player's perception of learning from games is also noted. This paper suggests that the meta-game surrounding game play is paramount to learning and hence explores the value of collaborative role-play environments for Game-Based Teaching (GBT). The creation of role-play scenarios is discussed and a comparison of available e-learning platforms is provided.

Keywords: Game-based teaching, cognitive abilities, collaborative learning, e-learning platforms.

1. Introduction

Much has been in the press, and in academic forums, about the train-your-brain aspects of digital games. It is said that cognitive abilities such as memory retention and analytical skills, are improved by repeated play of digital games; even to the extent of assisting with the offset of learning disabilities (Klingberg, Forssberg, & Westerberg, 2002) and diseases such as Alzheimer's (Korczyn, Peretz, Aharonson & Giladi, 2007). However, there are just as many academic publications refuting these claims (Wainess, 2007), as there are to support them.

Published research suggesting that academic achievement can be predicted through the use of cognitive assessments include the tests of working memory, pattern matching, and cognitive skills known as "chunking". This has led to the popularity of games and products such as *Brain Training* and *Mind Fitness*. Sadly, all these games appear to do is to teach the player how to pass the cognitive test. They use methods such as the standard digit-span test and the *Stroop* test, available from any 1st year psychology textbook. Yet many institutions have introduced cognitive training games into their classroom in the belief that it will improve the cognitive skills (Miller & Robertson, 2009), and hence increase the academic achievement of their students. As we know, practice makes perfect and by practicing a cognitive test, the participant will always improve and achieve higher scores. However, it is contentious whether or not it is the cognitive games that lead to improved academic achievement or if the environment provided by the game is simply motivating the student to practice these skills and pay attention in the classroom. There is no empirical evidence that these students will achieve better results in the long term, nor is it certain if it is the game itself or the meta-game surrounding the lesson-plan that motivates the learner to be more involved.

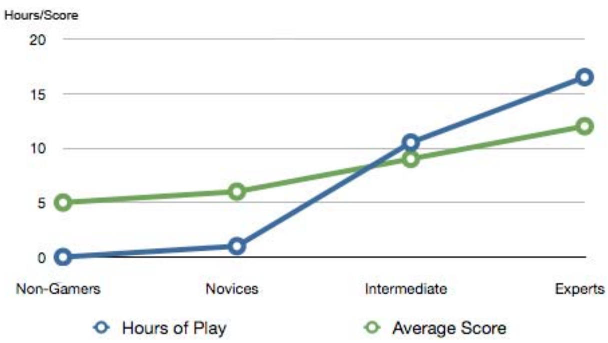
In support of the cognitive training games, Doman (1986) argues that "how well we learn is a direct reflection of how well we receive, process, store and utilize information", all cognitive functions of working memory. Jaquith (1996) also suggests that a one-digit increase in score from a working memory test correlates to a significant increase in academic achievement, specifically an improvement in an individual's academic function relative to their suggested grade level. The increase of working memory is what train-your-brain games like Nintendo's *Brain-Age* focus on; but is the player increasing their cognitive skills or simply learning how to do the tests more efficiently (Pivec, 2009a).

2. Player perceptions

In a study conducted in late 2008 (Pivec, 2009b), results suggested that experienced game-players have an above average level of cognitive ability in tests of working memory. An accepted digit-span forward test (Lichtenberger, Kaufman, & Lai, 2002) was completed by 238 of the participants, 165 male and 73 female with an average age of 32 years. Those who played games scored an average of

40% higher than those who did not. Participants, who considered themselves as *Novice* players, averaged game time of less than one hour per week and scored the similar as those who did not play games. Those who considered themselves as expert players averaged 16 hours game time per week and scored higher than intermediate players *(Table 1)*, showing a correlation between cognitive ability and hours of play.

Table 1: Correlation of game time and test score



Based on this study, it cannot be concluded if the game playing had increased their cognitive skills or that people with high cognitive ability immerse themselves in computer games. However, those who scored the highest it the working memory test (10 and above, when the average is 7), considered themselves to be expert game players, and those who scored the highest in the working memory test were all role-play game players.

In a subsequent study of 510 participants (Pivec, 2009), less that 25% had ever played an educational game, and only 5 participants had ever player *Brain Training* games. In addition to that, more than 70% of the game players in the survey believed that little or nothing was learnt from playing computer games. When asked if they would consider playing games for learning and what would motivate them to do so, over 50% suggested better game play with multiplayer learning being a desired feature. A common believe is that students require rich 3D graphics to play an educational game, however less than 10% of participants suggested better graphics as a motivational factor.

Although many teachers who use game-based learning believe that the learning, both declarative knowledge and cognitive skills, comes from the game itself, the players suggest that it is the environment, or meta-game, that provides the improvement in abilities (Pivec, 2009). They believe that it is the collaboration with other players, either in a multi-player game or the social environment outside the game, which provides the motivation to persistently re-engage, giving the “practice makes perfect” scenario. This suggests that it is the use of games within a teaching environment that facilitates learning and not merely playing a game – hence the term *Game-Based Teaching*. If learners support a game environment to provide motivation to learn, collaborative role-play scenarios or real-life simulations would be more suited for education than providing a *Nintendo DS* to practice cognitive ability tests. Role-play scenarios can be structured to impart declarative as well as procedural and strategic knowledge, and provide the refection-on-action needed for effective learning.

3. Role-play games for learning

Salen and Zimmerman (2003) define computer games as systems where a player engages in conflict regulated by a defined set of rules and the result is a defined outcome. They argue that while games and role-plays share the key features that define them both as games, they are different in one critical respect; role-plays do not always have a defined outcome and are not simply practicing to improve test scores. However, Salen and Zimmerman concede that this depends on the framework or platform that provides the role-play but suggest that role-plays are more suited towards effective learning.

Kelly (2005) argues that simulations have an enormous impact on education and many products such as Microsoft’s “*Flight Simulator*” are real-life simulations and are not games. Linser (2008) suggests that for pedagogical purposes, a role-play is closer to a simulation than a game, and argues that with the acquisition of real world knowledge, and the understanding and skills acquired by the player, a role-play is designed as an attempt to simulate processes, issues and conditions that exist in the real world.

Linser (2008) concludes by stating that while he considers role-play as a simulation, given the right environment and delivery platform, a role-play can include all the engagement, immersion, and motivation that are inherent in the computer game environment. Fortugno and Zimmerman (2005) agree but suggest that many games to not include sound pedagogical principles in their design. However, do they agree with the game players in that it is the teaching environment in which the game is used is what stimulates learning to occur.

4. Game-based role-play

When introducing *Game-Based Teaching* into the curriculum, many barriers need to be overcome, the initial acceptance of a computer game in the classroom being one of many. The level of technology to support the required software, the pre-requisite knowledge required by the teacher or facilitator, and the financial and licensing issues, all need to be considered. A meta-game surrounding the computer game itself also needs to be conceived and activities to promote thought, communication, and collaboration must be created.

A role-play using a game, or designing a game (Pivec & Pivec, 2009a), provides the necessary pedagogical structure, and can be done without the introduction of a commercial recreation game into the classroom. An e-learning platform for a collaborative role-play can be created using freely available or purpose-built software. Cummings (2000) defines the sequence of steps to conduct successful collaborative learning in the form of a virtual debate as follows:

- The Instructor selects controversial topic with input from class.
- The Instructor divides class into subtopic pairs.
- The Instructor assigns subtopic pairs.
- Critics and defenders post initial positions.
- The Learners review all initial position statements.
- The Learners reply to at least two position statements with comments or questions.
- Each learner rebuts opposing initial statement or individual in his/her pair.
- Based on a review of all statements, comments, and questions, learners formulate personal positions.
- The Learners post personal position statements in private forums.

Pivec & Pivec (2009b) suggest that mapping these steps to an e-learning environment provides a collaborative game-based role-play scenario.

With the narration the Instructor sets a scene i.e. a context of the situation and introduces the debate topic.

The Instructor selects controversial topic (with or without input from learners, as preferred).

The Instructor divides class into teams (2 or more) based on the topic scenario.

The Instructor defines and assigns player roles or the learners choose their own.

Each Player/Learner researches its role.

Subsequently the Learner posts initial position statements from the viewpoint of their role.

The Learners review all initial position statements of each team.

The Learners each take a position within their team based on their individual role.

The Learners research and discuss, post statements and provide input to private team forums.

Based on a review of all statements, information, and questions, learners formulate individual positions based on their roles and within their teams.

Team leaders summarize the team position via chat and/or videoconference and confront other teams with their arguments and proposed options.

The Team leaders post team position statements in public forums.

Learners responsible for specific topics debate with other team/s via chat and/or videoconference.

The Instructor or team leaders decide if an agreement has been reached, who has won or if a win-win agreement was elaborated

Critics suggest that an e-learning platform cannot be compared with a game, as it does not include the extensive graphical environment that game players have come to expect. However, as previously stated over 50% of the 510 surveyed participants perceived compelling game-play as more important than rich graphics. Jenkins (2007) argues that game players see past the eye candy of modern games and look for the affordances that allow them to progress through the objectives. With mapping of e-learning debate activities to a role-play game-based environment we have shown that interaction and participation can be activity rich, inspiring, and very intense. Hence a game-based e-learning platform can provide an environment that takes advantage of the motivational and immersive properties of games, yet with the features and facilities of e-learning software.

5. Considerations for role-play platforms

Game-based role-plays can be achieved without using a purpose built platform. Scenarios can be played using email, online forums, and Video conferencing software such as Skype. However, these applications will have limitations that may impact on the learning outcomes of the game. *Table 2* shown below, compares some of the features that need to be considered for an online collaborative role-play.

Table 2: Online role-play platform comparison (Pivec & Pivec, 2009b)

	Freely Available S/W				Purpose Built Platforms		
	Email Only	Open source Forum	Email & Forum	Email, Forum, & Skype	UWA Simulation Builder	Fablusi™	The Training Room™
Online Administration Tool					✓	✓	✓
Allow Learners to customize roles						✓	✓
Anonymity of Learners						✓	✓
Collaboration between Teams	✓				✓	✓	✓
Separate Role communications		✓	✓	✓	✓	✓	✓
Role Specific Access Rights					✓	✓	✓
Role Specific Resources	✓		✓	✓	✓	✓	✓
Team Specific Resources					✓	✓	✓
Audio/Video Resource upload							✓
Multimedia Resource Library							✓
Multiple Meeting Places						✓	✓
Private Communication between Roles	✓		✓	✓	✓	✓	✓
Private Chat by invitation				✓		✓	✓
Always available Team Chat Rooms							✓
Always available Public Chat Room							✓
Audio/Video Chat				✓			✓

	Freely Available S/W				Purpose Built Platforms		
Audio/Video Conferencing							✓
Public Multi-user Whiteboard							✓
Team Multi-user Whiteboard							✓
Separate Debriefing Area		✓	✓	✓	✓	✓	✓
Online logs for Debrief session		✓	✓	✓	✓	✓	✓
Online Feedback for Learners							✓
Online Feedback for Trainers							✓
Modification of Scenario during Game	✓	✓	✓	✓	✓	✓	✓
Modification of Roles during Game	✓	✓	✓	✓	✓		✓
Automated Timer for Game phases							✓
Role Assessment Tools						✓	✓
Team Assessment Tools						✓	✓
Multiple Games with Same Scenario						✓	✓
Customization for reuse						✓	✓
Database of Learners for future Scenarios							✓
Online repository for Scenario Sharing							✓
Personalized Scenario Creation (by Contract)						✓	✓

6. A collaborative game-based platform

When choosing appropriate environment for game-based e-learning, it is important to support multiple modes of communication and collaboration within and outside the groups. The environment should also foster structured reflection and allow the learner to take responsibility for participation thus promoting learning.

Using a platform such as *The Training Room* (2009), teachers can define their own game-based role-playing scenarios and provide the opportunity for learners to apply factual knowledge and to gain experience through the digital world. Teachers can define new games or adopt and modify sample games without any programming skills. The platform provides a variety of communication means within the scenarios; players can communicate with the use of discussion forums, text and voice chat modules as well as through multi-user video conferencing. An important feature of this product is the collaborative learning design, which allows participants to exchange information as well as to produce ideas, simplify problems, and resolve the tasks. In this product, the teacher can be an active partner, teacher and advisor of the educational process, or take a passive role and just observe.

In order to play a game, learners are assigned into or form several teams. Each learner can also select a particular role within a team which the can build upon and teams are able to communicate by entering the team rooms for discussions, text chat or audio/video. Each team has to create a strategy for the discussion. Each member of the team takes a subject that he/she is responsible for. Because each team has to discuss all proposed subjects, to encourage the participation and share responsibility within the team, each player is responsible for at least one subject. This player will prepare arguments for the discussion of the defined subject in the Virtual Conference Room. Every player of the team has to participate actively in a preparation for the discussion at least for one subject, preferably for more. The teacher defines the duration of teamwork i.e. time necessary for preparation for the Virtual Conference, as well as the time allowed for each discussion.

Playing time can fluctuate from several days to many weeks and depends from the difficulty of the theme and basic skills of the learners. The overall game theme can be seen as setting the scene of the role-play. Game flow and various stages of the game are presented to the players in the form of an introduction. The introduction can be based on narration and extended with a variety of multimedia material e.g. clips of news reports, interviews, newspaper articles, public opinion polls, and similar. In the game, basic stages can be distinguished as follows: (i) introduction to the game and role assignment, (ii) teamwork: team preparation and research time, (iii) general discussion, (iv) player feedback, and (v) discussion of the game in the debriefing room.

During the teamwork phase, players develop a game strategy, collect and select valuable information and prepare for argumentation. Teams communicate and exchange information in the Team Space (Team Forum, Virtual Conference, Content Library, Player Profile). The consultant, i.e. team member responsible for the particular subject, posts a position statement on the subject and all relevant collected information into the Content Library of the Team Room. The Content Library caters for audio and video postings as well as URL bookmarking. When the search for information is completed, the team has to organize a Team common session. This session enables learners to discuss all the problems of each subject and have all information for argumentation (for the case that they choose that only one will be speaker and argue their positions in General discussion, or if any of the learners will be unable to attend discussion). At the end of the team preparation time, teams have to present their final point of view within the game platform and outline their general position.

The next phase of the game starts with allocation of the weight factors: defining the importance of each of the subjects and balancing it with the win chances. Each team has to decide which subjects are more important for them and what percentage they wish to allocate on the chance of achievement. Each team will allocate a percentage to three or more subjects depending on the scenario. This must be done within a specified time. All game time limits are displayed within the game status panel of the screen. During the game, the percentage weighting to each of the subjects can be seen by the players, but the players do not see the allocation of other teams. The teacher has all the information about allocated weighting factors of all teams.

During the general discussion, all teams meet in a Virtual Conference Room to discuss subjects within a given time. Discussions can be moderated or freeform. The aim of discussion is to reach an agreement on each subject or goal within the scenario. In a moderated scenario, the role of a teacher is to formalize the reached agreement and to support the constructive discussion. In a free form scenario, the tutor takes a passive role. The team’s score is based on whether or not agreement was reached in their favor in each topic and what percentage factor they allocated to that topic. More than one team can win the game depending on how the scenario is structured and if the teacher permits a win-win situation.

7. Game-based scenario design

As with all scenarios, the storylines may be fictitious, however the places, items, and/or concepts should be real allowing the players to research the background and learn factual knowledge about the included topics. Pivec & Pivec (2009b) provide examples for project management, risk assessment, problem solving, and culture sensitivity training.

When designing a game-based scenario, various aspects should be considered to achieve the desired learning outcomes. Pivec & Pivec (2009b) list the following points:

- Are there clearly articulated learning objectives within the scenario?
- Are there clearly definable goals that can be solved?
- Are both the learning objectives and scenario goals achievable within the given timeframe?
- Is the storyline able to be described adequately for the players?
- Is there additional resource and research information available to the players?
- Are there sufficient roles within each team for individuality and equal opportunity to participate?
- Can the workloads of players be adequately balanced?
- Does the scenario allow for cross-team collaboration and is this desirable?
- Does each team have sufficient power within the scenario to achieve the stated objectives?

Additional guidelines related to introducing game-based scenarios as a supplement to traditional teaching methods, can be found in Pivec, & Moretti (2008).

8. Conclusions

The improvement of test scores through the use of cognitive games does not harness the potential provided by the game-playing environment. It has not yet been proven through accepted empirical research if these games increase any abilities or knowledge other than that needed to play a particular game. Furthermore, critics such as Wainess (2007) advocate that games do not foster learning at all, cognitive skills nor knowledge acquisition, and it is purely the context in which they are used that stimulates any learning to take place.

Undoubtedly, the game environment provides the motivation necessary for persistent re-engagement by the player and hence achieves the “practice makes perfect” scenario. However, most game players do not play educational games, as they do not believe they learn from such games and do not find them to be compelling in the game play employed.

Games for learning, or serious games as they are often called, vary from single player to multiplayer games. Different types of games have different sets of features that have to be considered in respect to their application for education. The use of collaborative game-based role-play for learning provides an opportunity for learners to apply acquired knowledge and to experiment, get feedback in form of consequences thus getting the experiences in the "safe virtual world". In interdisciplinary learning domains where skills such as critical thinking, debating and decision-making, and the ability to work, communicate and achieve set goals in teams are in the foreground, Game-Based Learning concepts and approaches have a high learning value. Envelop all this with a well structure collaborative role-play scenario and you achieve Game-Based Teaching.

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Game-Based Teaching – Dimensions of Analysis

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Abstract: Games are often classified as if they were entities with only objective characteristics. Games thus seem to consist of rules, goals, options etc. However these characteristics do not make sense independently from playing persons. The player's perception of the game is rather added as an external super-characteristic. Particularly concerning educational games this approach is not satisfactory. The focus on learning requires even stronger to take account of the player/learner and the kind of his immersion into the game. There are of course less objectivist approaches to games which differentiate games according the basic playful experiences they provide. Differentiations are also not sufficient to analyze games regarding the implied learning processes. Thus it is necessary to find an integrative way to describe games between the basic affective/motivational experiences they provide, their seemingly objective outlooks, and their educational function. For this purpose we distinguish four dimensions of meaningful interaction with games: fact, time, social and education. The fact dimension of interaction relates to the 'objective' characteristics of the game, i.e. its rules, the roles, goals etc. This dimension includes learning because game experience is dependent on the level of learning/understanding of the rules etc. The time dimension relates to temporal aspects like the representation or story or an action in a game, which gives a certain meaning to roles, goals etc. To understand this meaning cultural/social learning is involved. The dimension of social interaction implies where, when, how … to cooperate or to compete with potential other players, i.e. processes and decisions which are cognitively demanding. Concerning educational games there is a crucial fourth dimension which has to be taken into account: The educational dimension of the transfer from inside of the game to its outside. What is transferred (skills, knowledge, social competences) is part of the game and then of the outside. However in relation to this fourth dimension there is also an occasional paradox which refers to the possible contradiction of the two goals inherent in educational games: playing and learning. The player/learner knows that he ought to learn while playing or vice versa.

Keywords: Game based learning, game analysis, game design, play anthropology

1. Introduction

In 2008 the authors started to develop an educational game funded by the Lifelong Learning Program of the European Union. This game ought to foster entrepreneurial attitudes (not only restricted to business contexts but also to the general aspect of taking life into one's own hand). The project or working title is 'SEE A Game – Stimulate European Entrepreneurial Attitudes Game' (http://www.seeagame.eu). Our basic didactical approach includes on one side the identification of the relevant attitudes (and competences) for successful entrepreneurship and the assessment whether and how these attitudes (and competences) are trainable as well as on the other side the analysis of the educational effectiveness of games (i.e. not only business games). On this ground we construe the general framework for the intended game.

While reflecting on the educational effectiveness of games from a didactic point of view we found, first, that there are many ways to classify games and their educationally relevant elements. A second problem we encountered was that it is still a desideratum of educational game studies "to know what features of games correlate with educational effectiveness." (Randel et al. 1992; cf. also Fletcher 1971, Bredemeir/Greenblat 1981, Garzotto 2007, Wilson et al. 2009) In general "the empirical research on the effectiveness of instructional games is fragmented. … The research literature is also filled with ill defined terms, and plagued with methodological flaws." (Hays 2005) Accordingly there is scarce empirical evidence regarding significant relations between game attributes and learning outcomes. If there is some evidence it shows mostly a neutral relation. In spite of the scarce research literature and some skepticism regarding the educational effects of games it can however be stated, that games can have at least some attitudinal learning effects. Among affective learning outcomes mainly ‚motivation' and ‚attitudinal valuing' show some positive effect (Wilson et al. 2009). Also the research review done by Greenblatt (1981) some empirical support could be found for claims that games improve learner motivation and interest. Hence playing games can increase learning motivation. "It has been shown that aspects of games, such as learner control and realism, led to more positive attitudes toward learning versus traditional training methods." (Wilson et al. 2009) Another review came to the same conclusion: "In 12 of 14 studies … students reported more interest in simulation and game activities than in more conventional classroom activities." (Randel et al. 1992) Particularly the element of 'challenge' inherent in games leads to higher motivation (Wilson et al. 2009). What is however more important than pure learning motivation: further evidence exists that games can change learners' attitudes about the subject matter – however not always in the intended direction, i.e. it can also harm the attitude in regard of the intended learning target (Greenblatt 1981: 149). Also the relation between attributes and outcomes is highly context (or game) dependent.

Against this backdrop the remainder of this paper presents our first tentative steps in this scientific field.

2. Analysis of educational games

There are many ways to classify games in general and educational games in particular. Many of these classifications try to view games as an objective entity with objective characteristics (e.g. Prensky 2007: 117ff; for an overview Garris/Ahlers 2001 or Salen/Zimmerman 2004). Usual definitions look like that: "A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome." (Salen, Zimmerman 2004: 80) Or: "A game is an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that is located in a specific context." (Hays 2005: 15) The play thus seems to consist of rules, goals, options, conflicts etc. There is even an approach called 'game-ontology', which targets at a hierarchical classification of games. The top-level consists of interface, rules, goals, entities, and entity manipulation (Zagal et al. 2005). Though these characteristics do not make any sense independent from acting/playing persons, the player's perception of the game is – if at all – rather added as a kind of external super-characteristic. Particularly in relation to educational games this approach is not satisfactory, because the focus on learning requires even stronger to take into account the player (or learner) as a subject perceiving and acting in a specific situation with his specific affective (and cognitive) conditions.

This calls for a deeper, more anthropological approach to playing educational games. From early childhood on people usually know exactly whether they are playing or not. There is a conscious change of frame of reference creating specific meanings for respective actions (Bateson 1972). One major (developmental) reason to play is to transfer competences, i.e. dispositions for actions, from one frame of reference to another, from inside of the play or game to the 'real' outside. The experience of playing a game (or something else) is thus fundamental for the determination of a game. A game that is not played is not a game. Whether something is really a game is dependent from one or more persons meaning to play it, i.e. making the specific change of frame of reference. In this respect game-based learning spaces also provide security by there specific not-real frame of reference. "Games can provide a training environment in which users can perform tasks without facing the real-world consequences of failure. Moreover, games that employ progressive difficulty levels allow the user to gain familiarity and build skills in complex or novel task environments in a graduated manner." (Garris et al. 2002: 453)

There are of course less objectivist approaches to games. Also in German we do not differentiate between play and game (both is 'Spiel'), but focus on the common playful or 'ludic' experience. However we do not consider this a cultural prejudice of ours as there are different similar approaches to analyze this experience. E.g., Suits (1978: 34ff) clearly states as four necessary elements of games: ends, means, rules and 'the lusory attitude'. Whereas he sees in games the use of rules which "prohibit more efficient in favour of less efficient means" (i.e. constitution another frame of reference), while this lusory attitude is necessary to accept these specific "constitutive rules" and give meaning to them. Also Caillois (1962) proposed a more phenomenological approach to playing differentiating it in accordance to the specific playful experiences it provides. As often cited, he differentiates 'mimicry' as plays of imitation and taking roles, 'agon' as games of competition, which are constituted and secured by rules, 'alea' as games of chance, and 'ilinx' as plays of vertigo, i.e. the mellow experience of oneself, mainly one's body. In regard of the intrinsically motivating characters of games Malone (1981) considers more personal elements of games: fantasy, curiosity, challenge and control. Obviously most given games relate to more than one of these dimensions.

Accordingly also educational games can include different affective or motivational dimensions – though concerning Caillois' differentiation mostly mimicry and agon – depending on the learning target. Such differentiation does however not sufficiently allow to analyze them regarding their way of structuring learning processes. In regard of the educational function these distinctions are to coarse and unspecific as they miss the specific aspect of transfer into the 'real' world. It is necessary to find an intermediate level between the basic emotional or motivational experiences, the outlook of games and their educational function. The problem is to find the level where the learning processes in games can be described.

3. Four dimensions of meaning in games

As we consider the relation of playing and learning a question of meaning we distinguish general dimensions of meaning for the analysis of game-based learning. In his advanced analysis of the generation of meaning Luhmann (1995: 75) distinguishes three fundamental dimensions: fact, time and social:

- he fact dimension relates to the difference of inside and outside. You can always proceed making meaning by relating something actual to something (more) inside or something (more) outside. Obviously this way of questioning generates things, structures, causal relation etc. Thus this dimension relates to the seemingly characteristics of the game, i.e. its rules, the possible roles, the given challenges, goals etc. Already this dimension includes learning because these characteristics need to be present in order to play the game. And game experience is dependent on the level of learning/understanding of the rules etc.

- the temporal dimension relates to the difference of past and future. You can always proceed by relating something to something before or after or respectively to something variable or constant. This dimension opens the cultural dimension of (inter)action and thus relates to the possible representation or story of the game, which is to be interpreted in relation to the cultural context and might give a certain meaning to roles, goals etc. (Particularly Huizinga 1944 pointed out that games and culture have a developmental interrelation.)

- the social dimension relates to the difference of ego and alter ego. You can always proceed by questioning whether something is the same for ego as for alter: do we mean the same, do we use the same frame of reference. So games form a specific – partly learning related – frame of reference. The frame of a specific game implies questions particularly like where, when, how … to co-operate or to compete with potential other players.

Concerning educational games however a fourth dimension has to be taken into account, because learning transcends the frame of reference of a game. This makes learning such an essential part of playing:

- the educational dimension of playing relates to the difference of playing and learning. You can always proceed by relating some action/communication to fun or to usefulness. This dimension reflects the provision of skills, knowledge, social competences, attitudes etc. acquired while playing the game for real world usage.

4. The fact dimension

The fact dimension of interaction is closest to the mentioned objectivist definitions of games. Due to its causality structuring function this dimension – if its well structured – provides the possibility to experience autonomy and competence which are two fundamental aspects of intrinsic motivation (Deci/Ryan 1985; the third is connectedness, see below). Interestingly Gee considers learning as a 'lens' for the design of games in general, i.e. also for non-educational games. The built-in ways of how players learn to play a game is an important quality criteria for him (particularly in relation to commercial computer games): "… whether they know it or not, good game designers are practical theoreticians of learning, since – at a beginning or advanced level – what makes games deep is that players are exercising their learning muscles, though often without knowing it and without having to pay overt attention to the matter." (Gee 2004, cf. also Bopp 2006) The process of factual interaction with a game can thus be very complex and will include much learning.

Rules define the specific frame of reference of a game in which immersion (flow) is possible. The rules of a game however can be found on different levels (Salen/Zimmerman 2004). There are the 'operational rules', i.e. the literary rules of the game. These rules define the specific actions one can or has to take and to to interact with other players. A main aspect of these rules is the determination of the specific goal or task, which makes the game. There also 'constitutive rules' which refer to the mathematical structure of the game. The sets of actions, options, consequences etc. can be abstracted from the operational rules and analyzed accordingly. This process is a learning process leading to mastery of the game. However there is also the third more general level of implicit rules, like e.g. fairness or possibly the will to learn, which guide the conduct of actions not fully defined by the operational rules. The question what is fair in which game relates directly to the dimension of social interaction and social learning in a game. Many simulation games e.g. in fields of politics, ecology etc. built on this aspect.

It has been pointed out that the goal is a crucial characteristic of a game, and that it has to be well defined in order to allow immersion (e.g. Garzotto 2007; Prensky 2007). Is should not be too easy and it should not be too difficult, but “pleasantly frustrating” (Gee 2004) "Ideally, the optimal amount of challenge embedded in a game should create ‘motivational tension’. In other words, motivation is maintained by creating uncertainty about goal attainment." (Wilson et al. 2009: 16) Accordingly in a learning game the issues of factual interaction should stimulate cognitive curiosity and provide constructive feedback so that the experience of autonomy and competence are possible.

We do not consider it practical to fully operationalize the rather abstract dimensions of meaning in regard of educational game design. However they might serve as an analytically guiding tool in the design process: does the game design provide enough meaning for playing and learning. E.g., in relation to our game we had to question ourselves if we are discussing rules etc. that require and foster specific entrepreneurial attitudes and competences. Without going into details it showed that from a didactic perspective the complex set of attitudes which makes up the entrepreneurial mindset cannot be reasonably integrated into one rule-goal set, i.e. it would have produced more dissonance than meaning. Due to that it was decided to develop two different game modules: one which is highly competitive and one which necessitates negotiation and (strategic) cooperation in the same business context (catering).

4.1 Temporal dimension

The temporal sequence of games, particularly educational ones, can tell a story or make reference to specific real world action with its temporal structure. Thus the rules, goals etc. of a game do not determine (the causal relationships and) the experience of the player completely. The structure of a conflict can be represented as a war or sports (… once upon a time …) and the game experience of this conflict will change accordingly (cf. Salen/Zimmerman 2004) and in accordance with the background of the player. From this hermeneutic point of view the temporal dimension (of an interpretationally rich game) thus directly relates to cultural representations.

The concepts of narratology and ludology comprise the distinction between the story told and the rules defined in a game (Henriksen 2006). This distinction also relates to the distinction of cooperation and competition which is crucial for the social dimension of game interaction (see below). Competition will be rather found in a context of rules while cooperation often needs a richer context to allow for cooperative activities. The narratological approach can be used to provide facts, sequences, etc., in order to acquire specific information, showing specific skills for a specific context, improve declarative knowledge and reach the next level. With a focus on rules the ludological approach can be rather used to experience and to explore social or technological skills and processes and thus to show effective/efficient acting in the framework of a certain rule set based on strategic/social competences. For us this distinction was relevant in relation to different set of attitudes which can be addressed with such different approaches.

A game represents a cultural issue. Accordingly games are also rather culture and age specific. "Representation means that the game is about something. This can be abstract or concrete, direct or indirect." (Prensky 2007) It can be fantastic or a simulation of a certain field of action in the real world. (The better the simulation however the more complex the game, the greater the danger that immersion will not be possible anymore.) This dimension thus provides meaning and a frame of reference for possible different learning targets. To know about the target group is thus crucial to successful game design. (Prensky 2007) Gee (2004) makes it a principle that “people learn skills, strategies, and ideas best when they see how they fit into an overall larger system to which they give meaning. In fact, any experience is enhanced when we understand how it fits into a larger meaningful whole.” Hence relevant content, i.e. the cognitive dimension of learning, can particularly be viewed in its relation to the general representation of the game. A good (educational) game design should be focused – particularly in relation to representation/content – in order to give fun and reduce distraction.

Two ways of how the content is related to the game and its representation can be distinguished. The endogenous approach which includes content elements directly into the game and which thus makes the content part of the immersive process. And the exogenous approach which differentiates between the content and engagement in the game, e.g. taking external content as means to proceed a certain step in the game (Henriksen 2006; these two approaches have also been called intrinsic and extrinsic, Prensky 2007).

As already mentioned the relevance of the temporal dimension for learning implies also the dependence on previous knowledge for the educational effectiveness of games. Bredemeier et al. (1982) found that a game designed to change college students' attitudes on dogmatism and ethnocentrism was effective when used in an anthropology class. However when it was used in a philosophy course did not result in the same degree of attitude change. We take this as a hint to consider this dimension seriously in relation to our aim of teaching certain attitudes with a game.

For our game modules the content was not of primary importance. However we use an overarching business context also to integrate some methodological skills (basic accounting, presentation, etc.). Due to our heterogeneous European target groups, which the members of our consortium are confronted with, we choose a context we expected everybody to know something about: catering – everybody has to eat and eating means something to everyone.

5. Social dimension

Learning itself has a social dimension which relates to playing. On the one hand the common change of frame of reference inherent in playing is an important anthropological issue which is present already in mammals as a signal to con-specifics in a context of learning (Bekoff 2002: 124ff); on the other hand playing is interrelated with learning to take roles in a complex way (Mead 1934: 149ff).

This also refers to the third of three reasons of the intrinsic motivation which all can be found in playing games: the feeling of social relatedness (Deci/Ryan 1985). This aspect also gives insight into the nature and development of social games. Before there were computer games solitair-games formed a real exception. So it is not astonishing that "despite the [game] industry's initial (prenetworking) focus on single-player games or games played against the machine (an era on which we are still involved), just about all of today's computer games have become multiplayer in one form or another." (Prensky 2007)

Playing a (social) game almost naturally creates the feeling of relatedness, of being part of a social group or community. These are features which also strengthen self-recognition and learning attitudes. So a game can "support means to discuss strategies and solutions with others, which is a way 'to make thinking visible' and to create a more tangible context for what has been learned, building the conditions for situated learning.' (Garzotto 2007).

As already mentioned there are different forms of social interaction which may promote the immersion into a game and the educational effectiveness of a game. The main spheres of social interaction in games are: in general connection, and specifically cooperation and competition (Garzotto 2007). To make cooperation in games useful for game experience and for learning it needs clear shared goals in the cooperative phases. The need for more than one person to be involved has to be obvious to the players, i.e. the mutual benefits of working together have to be visible. The cooperation should e.g. not affect too much the pace of the game; i.e. the need to cooperate should not force a suspension of other activities. The desire to compete with others is a very common impetus (that motivates individuals also to cooperate). It has already been remarked that challenge – which can be compared to the achievements of others – is one of the most effective game elements in relation to affective learning. This does not only apply to the winners, even – in a fair game – losers can uphold their enthusiasm for the game.

As already mentioned our two modules use different interaction patterns with specific aspects to learn. In the competitive part we want groups to compete for profitable 'contracts' with different attitudinal relevant specificities in different rounds. So we have relatedness in the groups and strict competition between them. Due to this set, there is common understanding of the forms of interaction and thus the motivational dimension is obvious. The interaction design in the negotiation module is more complex. The players are alone (depending on the group size they have however the opportunity to discuss their negotiation strategy with other players with same 'role'). During negotiation they continually have to generate a common understanding of the way they are going to cooperate with the other players, i.e. they have to create their own (meaningful) field of action.

6. Educational dimension

Main aspects of the educational interaction dimension have partly been discussed already. It is the differentiation of the exogenous or endogenous relation of learning content and the game which reflects the specificity of the forth sphere. This differentiation clearly shows the crucial issue of transfer from inside to outside. Hence the meaning in this dimension is created due to its use outside the context of the game in regard to the learned skills, attitudes etc.

This conscious extra-ludic aim concerns the complex relation between immersion and reflection of the learning process. Particularly in more formal learning contexts reflection or debriefing is a salient part of game based teaching. While immersion is crucial for the inside game experience, reflection takes place at the outside in between or after a game (immersion can only be re-presented there).

For educational games both sides are essential, thus "rather than choosing between the two approaches, the game-design should be able to switch between them, thereby utilizing immersion and reflection in a fruitful combination. Game immersion should be used for staging a problem relevant to the participants, after which the problems are conveyed to the participants, who will then solve the problem." (Henriksen 2006) The specific phase of educational reflection after the game or between different turns is conceived as debriefing. Such a phase gives the learners the opportunity to reflect on their experience under the guidance of an instructor/teacher. It is particularly important to foster understanding of how the game experiences support the instructional objectives (Hays 2005).

For our game modules we will thus develop debriefing manuals for the trainers which will be specific for the different target groups. In regard to our general aim to foster entrepreneurial attitudes a main aspect of debriefing will be to provide transfer scenarios, including redirecting possible frustrations (of losers, of inefficient strategies etc.).

Depending on the course of the game the debriefing also has to discuss an occasional paradox inherent in this fourth dimension. There is a gaming-learning paradox which refers to the possible contradiction of the two goals inherent in educational games – seen from the player's/learner's perspective. Educational games are usually introduced as such. They might be used in the framework of formal learning or it might be written on their packing. Thus the player/learner knows that he ought to learn while playing or vice versa. "As we adapt games for serious purposes, we must be aware of this tension between the world of play and the world of work. Thus, in one sense, the term instructional game is an oxymoron. Game play is voluntary, nonproductive, and separate from the real world. Instruction or training is typically non-voluntary, undertaken to achieve certain learning outcomes, and related to life or work skills." (Garris et al. 2002) Thus, even if the game allows for playful immersion (which is of course the major problem of so called educational games) there will be an ambiguity whether the conceived goals of learning and playing do sufficiently coincide. Particularly a strong content-orientation might be detrimental to the goal-orientation of a game. “When looking at the current supply of educational games, most of these are based on an assumption that the mere exposure to educational material creates learning, framing the purpose of the game as keeping the participant occupied or entertained with the game.” (Henriksen 2006)

7. Conclusion

The different spheres of meaning and especially the complex dialectics of the fourth dimension – always in danger of being detrimental to immersion, i.e. to the game itself – need thorough reflection during the development process of an educational game. In the further process of our project, the concrete game development and its evaluation, we further want to systematically reflect on educational game design and to further differentiate our analytical approach particularly in order to judge the educational effectiveness of game elements. “Because of its status as an emerging discipline, game design hasn't yet crystallized as a field of inquiry. … Games are one of the most ancient forms of designed human interactivity, yet from a design perspective, we still don't really know what games are.” (Salen/Zimmerman 2004: xv)

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Evaluating Serious Games in Higher Education: a Theory-Based Evaluation of IBMs Innov8

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Abstract: With the emergence of new technologies on a continual basis, it is imperative that Educational Institutions integrate these new technologies as subject matter and learning tools in their curriculums. One of these emerging technologies is Digital or Serious Games, and is receiving widespread attention from educational institutions because of its multi-faceted application potential. The success of Serious Games within an educational environment is, amongst other factors, due to their engaging and entertaining nature. Learners are also more comfortable with Gaming technologies because they are already familiar with similar technologies on a day to day basis. There are a number of Serious Games currently being used by educational institutions in this regard, one of these being IBM®'s Innov8. Innov8 is a serious game which was developed by IBM® as part of their Academic Initiative programme. The author's institution registered for the programme specifically to gain access to Innov8 as they wanted to explore the possibility of implementing relevant Serious Games across its Information Systems curriculum. The game employs a first-person role-playing approach where the player assumes the role of a consultant within a company that is experiencing challenges. The two primary aims of the game are to teach players who come from a more technical background about business processes and more specifically about Business Process Management (BPM, while at the same time immersing them in a three-dimensional world which is closely aligned to real-life scenarios. The author's have conducted an extensive evaluation on the first version of Innov8 for use within their university's Information Systems curriculum. The purpose of this paper is to explain the evaluation criteria that were used as well as highlighting the findings of the evaluation. This evaluation draws from established theoretical frameworks, from the education and psychology fields including: Bloom's Taxonomy, Gagne's Event's of Instruction and Keller's Attention Relevance Confidence Satisfaction model.

Keywords; Serious Gaming, Bloom's Taxonomy, Gagne's Event's Of Instructions, Keller's ARCS Model, Innov8, Digital Game-Based Learning

1. Introduction

Using gaming as a means to learn is by no means a new occurrence. Games have been part and parcel of our daily-lives for the majority of our existence. During the 20th century certain traditional games were transformed into digital versions and new digital games were created spurned on through the introduction of the computer, the internet and mobiles phones which have put these digital games within the reach of billions of people around the planet.

The pervasiveness, as well as the engaging and entertaining nature of digital games has led to concept of digital game-based learning (DGBL). Kirreimur (2004) argues that the motivational power of digital games as well as their ability to let learners 'learn by doing' makes then very attractive learning tools. As such, digital games are no longer viewed as simply being of value for entertainment purposes but also for educational purposes (Van Eck, 2006). This has lead to DGBL receiving widespread attention, both in corporate and educational arenas. According to Pivec *et al.* (2004) digital game-based learning provides universities not only with innovative learning methods but also with a competitive advantage. Pivec (2004) also suggests that game-based learning should be introduced for adult education and that universities can and should use digital gaming as a new form of innovative learning. According to Metello et al. (2001) since the introduction of the digital gaming industry, it has grown to a substantial industry that has an important role to play in the evolution of the curriculum for any Information Systems courses.

In order for educational institutions to take full advantage of the opportunity presented by digital-games in terms of their potential as complimentary educational tools, an evaluation must be conducted before integrating these games into the classroom and across the curricula. The purpose of this evaluation is to assess a games potential as an educational tool, and needs to cover a number of different dimensions as learning itself is multi-faceted. Kirreimur (2004) states that while research into the use of digital games in education is relatively novel it is growing rapidly. However, despite this growth, digital game evaluation models are still relatively immature. As such, the authors have selected three theoretical frameworks spanning both the education and psychology fields in order to conduct an evaluation on IBM's® Innov8 game. These theoretical frameworks have been selected as being most appropriate as part of this evaluation because of their congruence with the learning and motivational potential of digital games given their engaging and entertaining nature. The three frameworks which have been selected are: Bloom's Taxonomy, Gagne's Nine Events of Instruction and Keller's Attention Relevance Confidence Satisfaction (ARCS) model.

1.1 Serious gaming

Susi et al. (2007) define serious games as "…digital games used for purposes other than mere entertainment." Serious games have become attractive to industries such as education, medicine and the military to name a few because of the mainstream adoption of digital games for entertainment purposes and the continuing decrease in hardware costs (Metello, 2001). According to Susi (2007) serious games are also becoming "..ever more important in the global education and training market, which in 2003 was estimated at $2 trillion."

1.2 Digital Game-Based Learning

Prensky (2007) defines digital game-based learning (DGBL) as "…any marriage of educational content and computer games" and further refines it to be "…any learning game on a computer or online". This definition assumes then that learning achieved through DGBL means can be equally, if not more, effective than traditional learning methods. The reason why DGBL learning is effective can be attributed to three primary reasons (Prensky, 2007):

- Added Engagement
- Interactive learning process
- The way i) and ii) above are combined

According to Prensky (2007), introducing DGBL into the learning environment generates a number of advantages, being:

- Engagement
- An interactive learning process
- Adaptability to the subject matter
- A learning style suited to modern learners

Smith (2007) argues that digital games can be used to augment learning in almost any subject. According to Corti (2006, p.1) game-based learning/serious games "is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills".

2. Bloom's Taxonomy

An important aspect of designing and using a curriculum is to ensure that learners are not only expected to memorise facts, but are required to apply and then even furthermore be able to make judgements and evaluations within the specific subject domain, especially at a tertiary education level. The evaluation of a curriculum or teaching technique according to Bloom's Taxonomy ensures that learning occurs beyond a superficial level seeing as Bloom's Taxonomy of the Cognitive Domain consists of six levels according to which a learner's skill can be organised, as shown below:

Table 1: Bloom's Taxonomy (adapted from Gunter et. al.)

Competency	Skills
Knowledge	Learner can recall information.
Comprehension	Learner can explain and predict.
Application	Learner can solve problems and use information.
Analysis	Learner can see patterns or concepts and organizational structure may be understood.
Synthesis	Learner can build a structure, put parts together to form a whole, with emphasis on creating a new meaning or structure.
Evaluation	Learner can compare and make judgements about the value of ideas or materials.

In the evaluation of Innov8 done further on in this paper, the authors will discuss which aspects of Innov8 provide opportunities for Learners to deepen their learning along each level of Bloom's Taxonomy.

3. Gagne's Nine Events of Instruction

Another important consideration in curriculum or teaching tool design is the completeness of the curriculum in terms of ensuring all possible interactions are used to engage the learner. Gagne's Nine Events of Instruction refer the necessary conditions and interactions that are required for learning to take place. The following table is a summary of Gagne's Nine events of Instruction as adapted from Becker:

Table 2: Gagne's Nine Events of Instruction (adapted from Becker: 2005)

1. Gaining attention (reception)
2. Informing learners of the objective (expectancy)
3. Stimulating recall of prior learning (retrieval)
4. Presenting the stimulus (selective perception)
5. Providing learning guidance (semantic encoding)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing retention and transfer (generalization)

In curriculum design, using DGBL, it is important to realise that the Digital Game only forms a part of the curriculum and thus cannot fulfil all the Events of Instruction as mentioned in the table. Therefore the evaluation presented later takes into consideration that there will be a number of the Instruction Events that are not covered by the Digital Game.

4. Keller's ARCS Model

The final important consideration, in the scope of this paper, in curriculum and teaching tool design is learner motivation. Keller's ARCS Model (described below), details four steps through which learner motivation can be achieved and fostered.

Table 3: ARCS Model (adapted from Keller, Suzuki)

Gaining and sustaining the learner's *attention.*
Building *relevance.*
Creating learner *confidence.*
Providing *satisfaction.*

One of the main justifications for using Digital Games for education is the motivational and captivating factor, i.e. the ability of a Digital Game to engage and encourage learners in the learning process. Even so it is important to evaluate this capability and thus learner motivation, using Keller's ARCS model, is included in the final evaluation of Innov8.

5. Innov8 from IBM

Innov8 is a serious game which was developed by IBM® as part of their Academic Initiative programme. Numerous corporate and educational institutions across the globe are enrolled in this programme and the University of Pretoria chose to enrol during quarter three of 2008. This institution registered for the programme specifically to gain access to Innov8 as the authors at the Department of Informatics wanted to explore the possibility of implementing relevant serious gaming across its curriculum. According to Gupta and Sharda (2008) by integrating such tools into the classroom, students will be able to relate better to the tool as it simulates real-life scenarios and is also a more engaging and entertaining way of interacting with ones' students. The authors became aware of Innov8 after it had been presented at a number of conferences of which the authors obtained the proceedings.

The game employs a first-person role-playing approach where the player assumes the role of a consultant within a company that is experiencing challenges. The player is given a goal which he/she must achieve in order to successfully complete the game. The goal is to re-engineer a call centre process for the company in order to make it more efficient and effective. In order to achieve this goal, the player has to complete certain tasks which evolve as the game progresses. The two primary aims of the game is to teach players who come from a more technical background about business processes and more specifically about Business Process Management/Modelling (BPM) and vice-versa in terms of roles, while at the same time immersing them in a three-dimensional world which is closely aligned to real-life scenarios.

6. Comparison of Innov8 to the theoretical models

The data collection involved in evaluating Innov8 followed a 3-pronged approach: namely surveys, self-evaluation and facilitative participatory observation. The authors evaluated Innov8 by playing it themselves as well as observing and facilitating a group of IS educators in playing the game. This group also completed a survey with a series of questions regarding their experiences of Innov8 as an educational game. A facilitative participatory observation method was selected because of its relevance as a data collection technique within IS Action Research as discussed by Baskerville and Wood-Harper (1998). The evaluation process was also informed by various case studies and other sources detailing the nature of Innov8 as well as other institutions and companies experiences with it.
In order to conduct the research, the authors selected to use an existing research laboratory at the Department. The authors did so because the laboratory was specifically designed for action research and as such was deemed conducive to this research experiment. Twelve people could be accommodated in the laboratory at the same time so a number of two-hour sessions were scheduled to accommodate the staff of the Department.

The authors selected a paper-based questionnaire containing four questions, three of which were closed-ended and one being open-ended. The questions are as follows:

- Did you enjoy the experience (Yes/No)?
- Do you think that you could use this game in the classroom (Yes/No)?
- What aspects of the game are conducive to education in your opinion?
- Ease of use of the game (Easy, Medium, Hard)?

Fifteen staff members participated in the research experiment and these findings are incorporated, with the data from observations and self evaluation in the comparisons below.

6.1 Comparison to Bloom's Taxonomy

Table 4: Comparison to Bloom's Taxonomy

Competency	Evaluation	Example
Knowledge	Yes	The player is required to recall information pertaining to task completion in the game. For example: the player has to locate certain characters within the game based on information given to them by other characters.
Comprehension	Yes	The player is required to create a series of diagrammatic “Swimlanes” explaining the flow of a process within the Call Center based on the information obtained earlier in the game.
Application	Yes	The final challenge of the game is for the player to interactively manage the Call Centre Process based on a number of variables (e.g. cost per call, number of operators etc.) to achieve a desired outcome in terms of the Call Centre’s efficiency.
Analysis	No	N/A
Synthesis	No	N/A
Evaluation	No	N/A

From the above comparison it is shown that the Innov8 game has a number of built-in features and functions that allow and encourage learning to take place at the Knowledge, Comprehension and Application levels. In order to achieve learning at the Analysis, Synthesis and Evaluation levels the curriculum within which Innov8 is being applied will have to be adapted accordingly.

6.2 Comparison to Gagne’s Nine Events of Instruction

Table 5: Comparison to Gagne’s Nine Events of Instruction

Event	Evaluation	Reasoning/Example
1. Gaining attention (reception)	Yes	One way of ensuring the learner’s attention is to make the game engaging and entertaining. From the survey 100% of the participants indicated they enjoyed playing the game, which indicates a high level of reception towards the game by the learners.
2. Informing learners of the objective (expectancy)	Yes	At the beginning of the game the learner is informed of the actions required to finish the game as well as how they are expected to perform these actions.

Event	Evaluation	Reasoning/Example
3. Stimulating recall of prior learning (retrieval)	Yes	In order for the learner to successfully complete certain tasks they are required to recall information given to them during the course of the game. One example is a BPM tutorial that is given to the learner to instruct them in the use of the BMP tool within the game, which they use throughout the game.
4. Presenting the stimulus (selective perception)	Yes	The challenge within the game is given by the tasks the learner has to complete in order to advance within the game. One example is the collection of information from characters within the game about a call-centre process.
5. Providing learning guidance (semantic encoding)	Yes	The game provides continual guidance in what needs to be achieved and how to achieve it. An example in the game is an updated “to-do list”, indicating what objectives are still required to be completed.
6. Eliciting performance (responding)	Yes	The very nature of the game, i.e. a first person role-playing approach, allows the learner to actively participate in the learning process.
7. Providing feedback (reinforcement)	Yes	The game includes a progress bar showing the completion of the game by the learner as well as various instances of feedback from the in-game characters based on your performance.
8. Assessing performance (retrieval)	Yes	The final task of the game, managing the call centre-process, essentially assess the learner’s knowledge at this point seeing as the failure of this task results in “losing” the game while success results in “winning”.
9. Enhancing retention and transfer (generalization)	Yes	From the survey a number of participants indicated that the fact that the game involves a “real life type scenario” is one of the reasons why it would be conducive to education. This realism allows the learners to generalize the knowledge and skills they have acquired to practical examples (whether in the game or in the classroom).

Due to the interactive nature of Innov8 the opportunities for feedback, assessment and engagement are inherent within the game. There is thus less need to create these opportunities or events as an addition to the game. While there is a need to link up the learning done within Innov8 to the rest of the course material in question, to an extent the learning done within Innov8 is self-contained as it fulfils the requirements for all 9 of the events of instruction.

6.3 Comparison to Keller’s ARCS model

Table 6: Comparison to Keller’s ARCS model

Categories	Evaluation	Reasoning/Example
Gaining and sustaining the learner’s *attention.*	Yes	As previously mentioned the enjoyment factor of the game assists in gaining and sustaining the learner’s attention. Innov8 achieves this through a number of varied strategies, e.g. unresolved tasks, graphics and animation and elements of conflict and challenge.
Building *relevance.*	Yes	Due to the real-life nature of activities within Innov8 the learner gains a perspective of what their future work environment could be like and the possible challenges and conflicts they could face.
Creating learner *confidence.*	Partially	The Innov8 game has the possibility to both enhance and dilute learner confidence. While there were participants in the observations who managed to complete the game, there were other participants who struggled not only to complete the final task but to understand what was required of them. Other participants also struggled with the controls within the game, lessening their confidence in being able to complete the required tasks. (73% of the participants

		found the game to be on a 'medium' level of difficulty and 7% found it at a 'hard' level of difficulty).
Categories	Evaluation	Reasoning/Example
Providing *satisfaction.*	Yes	By providing an element of immediate feedback to the learner in terms of the tasks they complete, Innov8 can provide satisfaction in terms of the learner being able to know how they are progressing within the course.

Generally the great advantage that Digital Games in Education have is that by their very nature they motivate learners to get involved in the learning process, because Digital Games have the ability to make the learning process engaging and entertaining. Even so, due to the multi-facetted nature of motivation within education, one cannot assume that a Digital Game exhibits all the necessary facets of motivation. It is for this reason that the ARCS model was used to ensure that the necessary motivational factors do exist within Innov8.

7. Findings

During the evaluation performed in the previous section the authors have approached the issue of Innov8 within an IS curriculum on the basis of three aspects of educational theory. These aspects are: depth of learning, motivation and completeness of the instruction process; each which has been expressed using the theoretical frameworks of Bloom, Gagne and Keller.

To illustrate the overall evaluation of Innov8 within an IS curriculum, according to the aspects mentioned above we present the following chart (Figure 1):

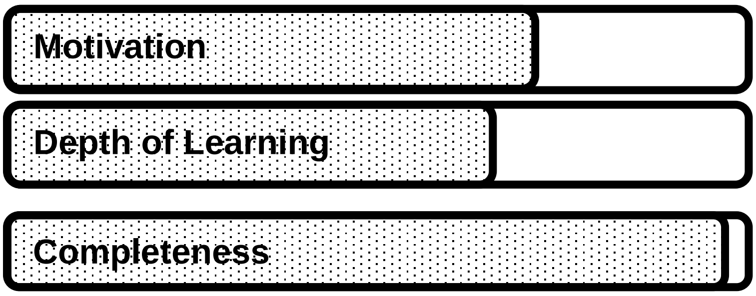

Figure 1: Chart to illustrate the overall evaluation of Innov8 within an IS curriculum

Innov8 fills most of the requirements necessary to ensure adequate motivation within the learner playing the game. It was found that certain aspects within the design of the game (e.g. ease of use) could have a detrimental effect on the learners confidence in their ability to master the game itself which could have an impact on their ability to absorb the material presented. This could in turn possibly lead to a lower level of overall motivation for the learner, depending on their familiarity with first person role playing games.

While Innov8 does not have all the opportunities within the game itself to ensure a very deep learning experience, it is important to keep in mind that not all curricula or subject matter require such a depth of learning and that Innov8 should not be used within a vacuum. If necessary the appropriate learning opportunities can be used in conjunction with Innov8 to ensure depth of learning.

The design of Innov8 creates the possibility for nearly all of the required learning or instruction events to occur to ensure completeness of the instruction process. Innov8 has the ability to engage the learner initially and then ensure that learning can take place by providing opportunities for stimulus, feedback and assessment amongst others.

Based on the author's analysis and evaluation Innov8 can certainly be considered as an effective complementary educational tool specifically within the context of BPM. The authors are of the opinion that Innov8, like any other Digital Game for education, requires careful thought and consideration in its evaluation and implementation to ensure congruence between the learning objectives of the curriculum in question and the game itself.

8. Conclusion

When considering implementing serious gaming as an educational tool within an IS curriculum at a higher education institution, a number of aspects of the games need to be taken into account. One of these aspects is the educational potential of the games. In order to assess games' educational potential, research into the educational psychology field must be examined to explore which frameworks best lend themselves to this analysis. This is of particular importance because it lends itself to the creation of synchronicity between the entertaining nature of games and the engaging nature of certain contemporary learning methodologies.

The authors are of the opinion that whilst a theory-based analysis does provide valuable information about a game's educational potential, additional practise-based analyses must be conducted in order to evaluate the game holistically.

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3I-Approach for IT Educational Games Development

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Abstract: The problem of training highly skilled software engineers is currently under discussion. Analysis revealed that educational game development for software engineers is a very promising and perspective research area, but there is still a huge demand for educational games for software engineers. We suggest a 3I-approach for IT educational games development. It is based on three I's: course material must be *Introduced* through a game world; learners must see *Interpretation* of solutions in a game context; learning results must *Influence* game results. We use this approach for IT educational games, though it could also be used in the other areas. In our approach the learning process is represented in a game in the form of a spiral. We elaborated a game-related course description for use in learning games and techniques for the integration of learning components into a game. We applied our approach in the development of educational games for learning programming languages, because it is a fundamental subject for software developers. We developed a game called 'Graviman' for learning Object-oriented design and the C++ programming language. We use two techniques for checking programming code: verification (checking source code using corresponding rules) and running (executing source code and checking the result). The verification method is based on regular expressions. A specialized library has been developed for matching program code. For visualization of a runnable solution the code of the solution is compiled and then executed. A player can see the result of his coding directly through game character behavior. Game architecture is based on common game engine architecture, but it is extended for use in educational games. It consists of two high-level subsystems: a game engine and a learning engine. The game engine is based on the graphical engine Ogre3D and enlarged with game logic and an advanced user interface (for advanced text display and editing). We consider that using this approach allows the creation of attractive learning games that can be used at universities and schools and also for individual learning. Using such games can help students to gain and improve knowledge and skills in computer science, and can also raise the motivation to study.

Keywords: e-Learning, computer games, educational games, software development

1. Introduction

Software development is a continuously expanding area. There are more than one million computer software engineers in Russia at the present time. They are employed in most industries but their largest concentration is in the area of computer systems design and related services. Computer software engineer is one of the occupations projected to grow the fastest in the coming years (Bureau of Labor Statistics, U.S. Department of Labor 2009). Demand for computer software engineers will increase for a number of reasons. From the other hand the IT labor market growth contradicts a predicted shortage of quality computer engineering IT skills (Alsmeyer 2008). The economic crisis has changed the situation in Russia and all over the world, staff reductions are taking place in different areas as well as the IT area, but those of lower professional skill are the first ones being laid off. Thus the problem of training of high-quality software engineers remains urgent.

Teaching computer software engineers presents some specific problems. A set of basic skills needs to be understood and applied at once from very early in the learning process. The IT field is dynamic and under constant change, and sometimes trainers are behind the time and behind their trainees. The new generation of trainees find today's training (and education) so incredibly boring that they don't want — and often refuse — to do it (Prensky 2007).

There are a number of approaches to make the education easier and more appealing, and a remarkably promising one is using computer games. The game-based approach achieves high learning results in areas that are difficult to study and where gaining skills is of importance. To a great extent it can be applied to the computer science disciplines. Subjects which demand the acquiring of skills, such as algorithmization and programming, artificial intelligence, computer graphics and so on are particularly appropriate for consideration when using the games approach.

2. Related work

Game-base approach is used for teaching and learning in different fields of science. We have analyzed the state of the art in the field of educational games for software engineers. Software Engineering Process Game (based on single player game SimSE) (VITAL Laboratory 2009) created by VITAL Lab is a multiplayer online game inside the virtual world of Second Life. Players can form teams and learn about the software engineering process through the use of role-playing. In (Connolly 2007) a computer game for teaching software engineering concepts is presented. In (Wei-Fan Chen 2008) a work in progress on a Game-based Learning System for Software Engineering Education is described. The subject of these games is software engineering process in a whole. Analysis revealed that educational game development for software engineers is a very promising and perspective research area, but there is still a huge demand for educational games for software engineers.

3. 3I-approach

Courses for software engineers stand alone from other specialties. Basic subjects such as programming, databases, artificial intelligence, and computer graphics deal with formal (similar to programming) languages. We suggest a 3I-approach for IT educational games development. It is based on three I's: course material must be *Introduced* through a game world; learners must see *Interpretation* of solutions in a game context; learning results must *Influence* game results. We use this approach for IT educational games, though it could also be used in the other areas.

Introduction. Course material should be introduced through the game world and its inhabitants and should be developed as a part of a game scenario. Knowledge of course material is necessary for solving game world problems. Each problem solution needs knowledge of related course chapters.

Interpretation. Each task, a player meets while playing, corresponds to a real problem. Players must solve the problem and see the results immediately through its interpretation in a game context. Visualization of the results shows the player if the solution is right or wrong. Interpretation comes in two directions: from game task to a real world problem, and back from problem solution to its interpretation in game.

Influence. The player's knowledge and experience should have an influence on the gameplay in a similar manner to the game experience influence in non-educational games. Gaining knowledge helps the player to play a game and to become more confident in a game world and also the learning course. After a problem is solved the player receives new abilities in game which improves the process of playing the game. The player therefore has a better learning experience, play the game better and has more fun.

In general the idea is to immerse a hero into a new unknown world. At first the newcomer can't live in the world without any help. He needs to become familiar with living in the world. He needs to learn its rules, conditions, possibilities and specific features and must become experienced in solving problems specific to the world. In a learning game, knowledge of the specific learning course should be a natural condition for living in a game world, not only for a player, but also for any other game beings. To be more exact, the learner must know the course material since it is a necessary condition for his living in the game world.

The learning process evolves in a game in the form of a spiral. A player comes into a game world, starts to explore it and meets problems. Each problem is represented through its Interpretation in a learning course as an assignment. A player must solve the assignment. To do this the player needs to get an information on the assignment. The information is introduced through the game context. After understanding the corresponding material he is able to solve the assignment. In such a way he gets a new experience that influences his living in the game world. The feedback comes to a player as interpretation of his solution in a game context, and he can use this experience further for solving new problems (Figure 1).

We elaborated notation rules of a game-related learning course description. Course content is divided into theory information blocks (I-blocks) and assignment blocks (A-blocks). Each block relates to one or several chapters of the course. I-blocks are of two types: displayable information blocks (DIB) and reference information blocks (RIB). DIBs are the parts of the game script and were displayed for a player and introduced to a player at the correct time to help him to acquire the necessary knowledge about the game world. RIBs contain additional information on the corresponding chapter and are available for the player on demand. They are not game oriented. A set of DIBs and RIBs form the full learning course theory. Game assignments are described as A-blocks and include assignment description, solution description, and solution interpretation. Assignment description is a DIB, representing different kinds of quests. The assignment solution requires writing some text, answering questions, testing or fulfilling some other actions depending on the specific learning course. The solution is described with information blocks that contain solution examples (SEB) (this also depends on the specific learning course). Solution interpretation blocks (SIB) include right and wrong solutions visualization techniques or/and their influence on a gameplay. A course blocks' hierarchy is shown on the Figure 2.

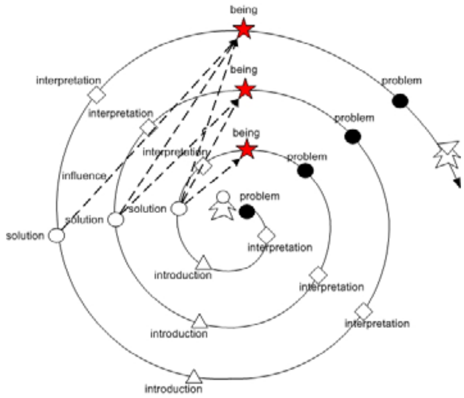

Figure 1: 3I-Learning spiral

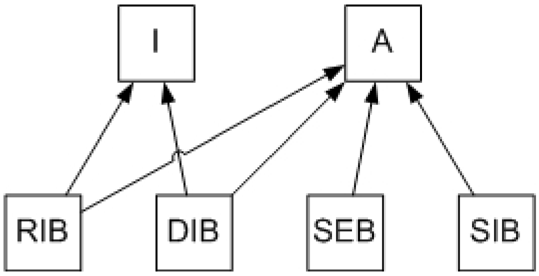

Figure 2: Learning course elements relationship

Course content (information blocks and assignments) is interpreted in a game context. Normally a game scenario consists of game levels. Each level includes several game quests. In educational game quests include some course information and assignments are included to allow the player to practice the game (Figure 3). Each assignment solution requires knowledge of related course chapters. On the other hand information and assignments are associated with a game story. Thus level completion forces the player to learn new course chapters and solve level assignments, so the game scenario relates to the learning course.

That correlation between game levels and course chapters allows using such games both for individual learning and for use at universities or at schools. Teachers might use the game level by level according to their studies, so learners would complete a game when they complete studying a course.

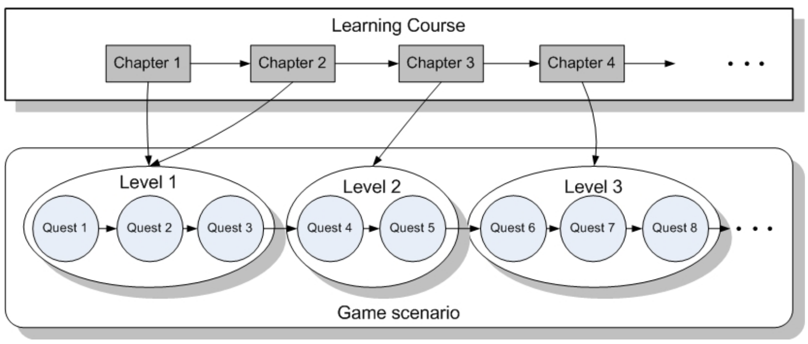

Figure 3: Relationship of game script and course chapters

Course description should be made by a course author and a game coder in three stages. The first stage is performed by a course author. At this stage game-based course content is described in natural language and the sequence of information elements and assignments are defined. The second stage is performed by the course author in collaboration with a game coder, familiar with learning game engine features. They divide the course content into blocks and describe them in a course description language (as DIBs, RIBs, SEBs). The game coder describes solution testing types and solution visualization techniques (as SIBs). The last stage is performed by a game coder. To code information blocks and links mark-up language is used. Block sequences, assignment interpretation and solution blocks are coded in an engine input languages (scripting language, text markup language).

We have elaborated techniques for the integration of learning components into a game (Table 1). The learning course is represented using formatted text (HTML) with hyper-links support. We use engine input languages, depending on the learning course, for solutions interpretation. Non-executable solutions are checked with regular expression matching techniques.

One of the modern tendencies in the field of e-learning is to use so called adaptive learning systems. Such systems can adapt to the needs of users and provide individualized learning. We planned to develop learning game that will meet the requirements of most users, so we decided to make it adaptive. We used the Bayesian approach for the estimation of learner knowledge level (Shabalina 2005) and a nonlinear story for adaptation of the learning process to individual users.

Table 1: Techniques for integration of learning components

Learning components	Techniques	Realization
Course presentation	Formatted text with hyper-links support	HTML
Gaining of skills	Solving assignments (using Input language)	Depends on the engine input language
Estimation of knowledge level	Solution verification (comparison with a set of correct solutions)	Matching techniques
Dependence of game process on the learning process	Only correct solutions enable the game process Nonlinear story	Adaptive techniques Bayesian approach

4. Implementation

We applied our approach in the development of educational games for learning programming languages, because it is a fundamental subject for software developers. Mastering programming is a difficult-to-learn subject. It needs a high-level of abstraction, without direct feedback to the real world, and includes the acquisition of skills. To a great extend learning programming languages means gaining skills in programming. We've found out that there are only a few examples of games aimed at learning programming, though this subject is very good for teaching through games. Such games, as "Robot Battle", "RoboCode" (open source multiplayer games), "KuMir", "ColoBot", "CeeBot" (commercial games) use specific built-in language. So called AI Competition Games need an advanced level of programming before they can be played. All these games are not oriented on teaching university programming courses specifically.

We developed a game called 'Graviman' for learning Object-oriented design and the C++ programming language (Shabalina 2008). Our concept is based on a Role Playing Game (RPG) genre in which a player associates himself with a main game character. The main game character is a crazy professor, who occasionally destroys his laboratory and due to an explosion is turned into a small child's toy – a transformer. He is required to adapt to his new appearance to survive in the world of big things and strange creatures born after his experiments. He must reach and recover his laboratory in order to become a human again.

At first a player must answer the question “Who I am in this world?” and this is interpreted in terms of the object-oriented approach as the definition of his class. After realizing himself a player attempts to move, but he can’t do anything before he implements it. The solution is the development of class methods. He then meets other habitants of the world and needs to adapt to this dangerous environment. He can use the ability of his character to transform into different shapes that have special characteristics. The player does this by writing program code. In this way a player learns programming. After he has developed some code fragment he can see the result of its execution. If his code is correct, the transformer can perform the corresponding actions, if not the transformer falls apart. This is shown in greater detail in Figure 4.

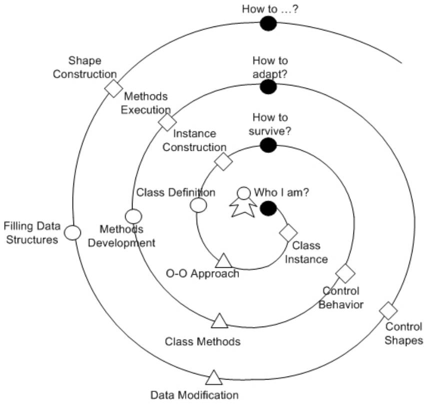

Figure 4: 3I-Learning spiral implementation in the learning game ‘Graviman’

As it was mentioned previously, each learning course has specific characteristics. For learning programming languages these are: input language for assignment solutions is the programming language itself and correspondingly the assignment solution is itself programming code. We use two techniques for checking programming code: verification (checking source code using corresponding rules) and running (executing source code and checking the result). We use verification for checking assignments that have simple solutions (simple code) for a player. Real implementation methods used for realization of solutions in the game are much more complicated. Interpretation of the right solutions of verifiable type uses real implementation methods. Methods, showing that the assignment hasn’t been executed, are called for interpretation of wrong solution of verifiable type. The verification method is based on regular expressions: to check program code we match it over a set of regular expressions. Each regular expression represents a kind of pattern that corresponds to a set of correct solutions. Existing libraries for regular expression matching are oriented mainly to text searching and simple template matching and are not convenient enough for program code matching. For example, program code can differ in identifiers names, block order or notations of mathematical expressions. Thus, a specialized library has been developed for matching program code. Although, even in this case we can check only those solutions provided by the course author. For visualization of a runnable solution the code of the solution is compiled and then executed. A player can see the result of his coding directly through game character behavior. Execution results can be either data (as calculation results) or actions (e.g., a game character moves to a given point using the elaborated code). Execution results are compared with correct solution results. Code execution allows solution checking for solutions not provided by course authors, but which provide the same results. Examples of checking approaches are shown in the Table 2.

Table 2: Examples of checking approaches

<table>
<tr><th>Assignment example</th><th>Solution example</th><th>Solution check</th></tr>
<tr><td>Write a method
“MoveForward”
incrementing variable x.</td><td>void MoveForward()
{
x++;
}</td><td>Verification using regular expression, for example:
^void\sMoveForward\(\s[void]\s\)\s
{\sx\s(=\sx\s\+\s1|\+(=\s1|\+))\s\;\s\}$
(checks x++; x=x+1; and x+=1;)</td></tr>
<tr><td>Write a program for
reaching a wall</td><td>while(!WallBehind())
{
MoveForward();
}</td><td>Run using C++ compiler and checking the result.</td></tr>
</table>

Game architecture is based on common game engine architecture, but it is extended for use in educational games. It consists of two high-level subsystems: a game engine and a learning engine. The game engine is based on the graphical engine Ogre3D and enlarged with game logic and an advanced user interface (for advanced text display and editing). The learning engine augments the game engine functions with learning process support, such as code execution and matching as well as current and final knowledge level testing.

Game implementation is based on free for commercial use libraries and utilities.

To develop learning games for other programming languages it is needed only to describe a learning course according to the course description rules. To develop learning games for other IT specialties it is necessary to elaborate a new world structure with its rules, restrictions and features, which could be interpreted in appropriate learning domain.

5. Conclusion

Educational computer games are an emerging area of research. One of the most important things in educational game development is how to integrate learning courses into a game process. We suggest an approach that can be used by game developers for creating attractive educational games. The approach includes the way of learning through playing and playing through learning, notation rules of a game-related learning course description, mechanisms of integration of learning process components into a game. Every component of our 3I-approach is important: Introduction helps to understand theory, Interpretation develops skills, and Inference motivates a learner. All those features allow learners to get best results. We implemented our approach in a game for learning programming language C++. Concrete learning results are to be documented in the near future.

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Interactive Whiteboards and Computer Games at High School Level: Digital Resources for Enhancing Teaching and Learning

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Abstract: The general potential of computer games for teaching and learning is becoming widely recognized. In particular, within the application contexts of primary and lower secondary education, the relevance and value of computer games seem more accepted, and the possibility and willingness to incorporate computer games as a possible resource at the level of other educational resources seem more frequent. For some reason, however, to apply computer games in processes of teaching and learning at the high school level seems an almost non-existent event. This paper reports on study of incorporating the learning game “Global Conflicts: Latin America” as a resource into the teaching and learning of a course involving the two subjects “Danish language learning” and “Social studies” at the final year in a Danish high school. The study adopts an explorative research design approach and investigates and analyses the learning and social effects that appear in the classroom as a result of this approach. The many interesting findings suggest that the incorporation of learning games at the high school level has much uncovered potential to offer processes of teaching and learning.

Keywords; Interactive whiteboards; teaching/learning in high school; computer learning games; digital dialogic learning

1. Introduction

The traditional ways of teaching and learning at all educational levels are being subjected to an ever growing pressure these years. This is to a great extent caused by the overall societal changes, as new skills and competences are required to solve the problems of a changing society. This process must somehow be mirrored in the ways, in which we continuously revise our educational practice. In other words, "change in education may now be thought of as a constant condition, rather than an event" (Fisher et al, 2006). In this picture, digital media is itself seen as an instigator of change, but simultaneously they can be appropriated as tools for coping with these changes (e.g. Sorensen et al., 2008). Among this ever widening array of different media, video games are increasingly popular, also inside the walls of schools. During recent years, researchers across the globe have been asking the same question: "How [can] computer games help children learn?" (Shaffer, 2007). As the body of research is growing, it is very reasonable to conclude that "computer and video games will have some part in education" (Squire, 2005).

What is often overlooked in these studies, however, is the importance of media in interplay. All too often, the questions asked are focusing quite narrowly on the learning potentials of games in relative autonomy (i.e. anticipating the game process equals the learning process). In the broader field of media studies relations between different media is a more common theme. In this regard, we are inspired by the Danish professor and internet-researcher Niels Ole Finnemann, who argues that “the arrival of a new medium does not mean that older media disappear” (Finnemann, 2001). In addition, he states that “it is not possible to understand the impact of a new medium - or of a medium at all - if it is not seen in its interrelationships with other media”. It is exactly this notion of *reciprocal reinforcement* we are adopting in this study, as we from the outset were very interested in the interplay between games and other media in the classroom.

Even so, a game must be selected from the very wide array of available games. The concrete process of identifying appropriate games is a frequently recurring theme when trying to adopt games as learning tools. This issue is so noticeable, that a very recent study rank "finding suitable games" the third most important obstacle for using games (Wastiau et al, 2009).

Taking all these issues into consideration, the authors set out to uncover how far the genre of "serious games" has come, and how a game from the newest "generation" of educational games (Global Conflicts: Latin America) could possibly instigate and support students' learning processes. One might argue that this is no great game when compared to contemporary commercial off-the-shelf (COTS) games, and in this we agree. Regardless, this discussion is of lesser importance in our case. Not only is such a comparison unreasonable, it is also a rather unconstructive approach. Games in learning are to be considered tools for learning, and as such, it might not be as important whether or not a game applies to the criteria of the entertainment gaming market.

2. Research design and problem investigated

As it stands, computer games in high school contexts are not common events. This study constitutes a piece of explorative research into the teaching and learning benefits of introducing and using computer learning games (serious games) into a high school setting. The design is best described as participatory action research, combining a number of various media.

It sets out to openly explore and identify signs of teaching/learning quality brought about by introducing a computer game into a learning environment constituted by a coupling of physical classroom and mixed digital media.

From an explorative optic formed by, on the one hand, the theoretical perspective of learning as a social endeavour, and, on the other hand, the learning goals and objectives associated with teaching of the two subjects, “Danish language and literature” and “Social Science” in high school, the authors identify and extrapolate a set of striking patterns implying what the authors view to be enhanced quality in the learning process.

Several research instruments were used to collect relevant data for this study.

- Two electronic questionnaires testing the students’ pre –knowledge of computer games and their view of the learning outcome after playing the game
- Video recordings of the students while playing intended to be used for reflection on the behaviour pattern of teachers as well as students.
- Student interviews (focusing on students’ views on learning by way of Serious Games, and carried out by a journalist from the teachers' magazine "Gymnasieskolen").

3. Analytical optic: learning theory and the role of games in learning

Our analytical lens consists of several sources of inspiration (e.g. Shaffer, 2007; Wastiau et al, 2009). But our overall understanding of learning as a social phenomenon rests on the learning position as maintained by Wenger (1998). These theoretical insights contribute to constituting the lens through which our analysis is approached.

3.1 Learning in social contexts

The notions of "participation" and "reflection" are commonly recognized as key features in a learning process. These key concepts are, therefore, addressed within many learning theories. One of the most recognized learning theories is the social theory of learning as presented by Etienne Wenger.

Wenger’s theory is truly and fundamentally social. He stresses that the mechanism that makes information knowledge empowering (i.e. the very mechanism that makes it “knowledge”) is the way and the extent to which it can be integrated and operationalized within an identity of participation.

It is an important part of the pedagogical design to incorporate narrative structures, which may support reflection e.g. on narrative structures (Fibiger, 2004). In a Wengerian perspective learning is a *response* to the pedagogical intention. Instruction creates a context – like other contexts – in which learning takes place. As noted by Sorensen, (2004), resources and negotiation are the important factors decisive for whether learning is going to take place. In Wenger’s wording:

> *In this regard, teachers and instructional materials become resources for learning in much more complex ways than through their pedagogical intentions. (...) Teaching must be opportunistic, because it cannot control its own effects. (Wenger, 1998: 267)*

The important element here is the interaction between the planned (predicted) and the emergent, in other words, the ability of teaching and learning to interact in ways in which they become structuring resources for each other. Thus, according to Sorensen & Ó Murchú (2004) important considerations in designs are:

- How to minimize teaching (the predicted) in order to maximize learning?
- How to maximize processes of negotiation of meaning enabled by interaction?

From a Wengerian perspective design therefore is about creating a proper balance of participatory and reificatory elements in the instructional design:

- Which elements to structure and make procedures for on the basis of prediction?
- To what extent the design should depend on de-contextualized knowledge?
- How to balance student initiative/ownership and pedagogical authority?

Wenger explains the negotiation of meaning as involving two constituent processes: *participation* and *reification*. These two processes exist in duality, affecting each other and being the source of development to each other. But since production of meaning is distributed inseparably across reification and participation in a shared practice, a dynamic relationship between the two must be established in our design and facilitation of learning. If not, the negotiation and construction of meaning may become problematic. If there is no negotiating of meaning, neither is there a practice to be part of. This is also a process that happens even though learning is not an issue of the practice.

In agreement with Wenger's position the basic learning theoretical assumption is that information turns to knowledge only through active dialoguing (Bang & Fibiger, 1998). This transformation takes place through mutual dialogic participation and collaboration.

3.2 Analytical lens

The above described theoretical position gives rise to a more operationalized and concrete set of quality criteria, some of which we will discuss the value of in this explorative approach, as these values gradually appear and emerge from the horizon. This set of criteria includes possibilities for assessing teaching/learning dimensions, such as:

- Obtaining digital literacy (necessary to participate)
- Role of teacher (facilitating the bridging teaching/learning elements)
- Negotiating (increased participation/dialogue, increased reflection)
- Accessing concepts
- Performing critique (meta reflection)
- Designing the learning experience (a balanced structure and non-structure that minimizes teaching - the predicted - in order to maximize learning processes of negotiation of meaning)
- Games as teaching tools
- Increased inclusion

4. Empirical data

The empirical data of our study consists of several kinds of information: The formal requirements associated with the two subjects taught, the pedagogical design of the teaching/learning environment, and the design and data from the teaching/learning session constructed around the mission chosen for our in-depth analysis.

4.1 Formal requirements in the Danish language and social science curricula

In the directions from the Ministry of Education in the teaching of Danish as a subject at upper secondary school level it is stressed that:

- "Students are to study texts appearing in various media in order to gain a broad knowledge of other cultures and ways of thinking in Denmark, Europe, and the rest of the world."
- The purpose is to sharpen the students' analytic and critical abilities, making them able to handle information and trace the layers of meaning in fiction as well as non-fiction. Moreover, the

command of the language enhances the student's ability to navigate and act in a modern, democratic, globalized society.

Students should be able to:

- Master the work on various electronic texts and understand the interaction between the written word and pictures.
- Master argumentation and basic concepts and methods influencing how to write and the final written product
- Become familiar with: news genres, visual ways of expression, documentary genres, communication theory.

In the directions from the Ministry of Education concerning the values/concepts in social science at upper secondary school level it says:

- Social science focuses on Danish and international social conditions.
- The subject provides the student with information based on empiric and theoretical knowledge about the dynamic and complex forces - that influence the growth of society - nationally, regionally and globally.
- By connecting the current social development with sociological, economic, and political concepts views and ways of reacting are enhanced.

When teaching international social conditions it is natural within social science teaching to use material that deals with this topic e.g. books, articles, film, TV programs, or computer games.

4.2 Pedagogical design of the learning environment

In order to test the learning potential in serious games a multidisciplinary teaching scenario was planned, in relation to history/social science, Danish language learning, and ICT. The above extract from the Danish curriculum formed the basis for the test of the learning outcome in serious games i.e. "Global Conflicts: Latin America" in the third form (3c) of the gymnasium at Randers Statsskole, March/April, 2009.

The general pedagogical aim, as it can be seen in the design of the learning environment below, was to:

- Use the game as a gateway to the curriculum subjects (listed above).
- Make students understand the world of electronic games, i.e. the target groups, the risks associated with over-use, games as artistic and cultural expressions, etc.

Within social science, the aim was to help students to broaden their knowledge of power relationships, living and working conditions in Latin America.

The Danish Ministry of Education points out that the students' curiosity and speculation about current social problems and developmental tendencies should be used as the main elements in the thematic planning of the teaching. The students are to be involved in the planning of the teaching, influencing choice of problems as well as method of work.

Within the subject of Danish language learning, the aim was to familiarize the students with the working conditions of a journalist and the way news is created. At the same time, the set-up also intended to develop the students' writing (media/genre) skills as they were required to make notes not only for the final interview in the game but also to write a newspaper article that in some way highlighted problems that they had encountered in the game. The article formed the basis of an oral presentation during which the students stated their choices/ way of writing/ lay-out for the class and got comments from the class and teachers.

With respect to the role of ICT, the aim was to construct and facilitate a learning environment in which the students' ICT competences were activated. The ICT element of the environment consisted of:

- Global Conflicts: Latin America
- Interactive whiteboard, a "SMART Board" (the frame that served this purpose as it allows for a multi-medial pedagogical design)

- Blog (intended for students' reflections on the learning outcome while playing)
- Electronic note pad (Paper Show) for each group
- LinkQ + mobile device manager (free distance teaching programs /software enabling the teacher to switch between the students' screens and the teacher's screen)

Moreover, relevant film clips were chosen by the teachers to put the issues in the various missions into perspective and to fuel a discussion in class.

4.3 Specific use of mission MAQUILADORAS

The teachers stressed from the very beginning that the focus was on the learning outcome not on the game itself. The pedagogical scenario of the selected mission "MAQUILADORAS" was as follows:

A.
Brainstorming: What do you know about Mexico? Write keywords on the SMART Board.

B.
Students' assignments while playing:
You are requested to write in the blog commenting on the learning outcome of the game.
Once in every mission you have to send a mail with a newspaper article to your editor. Use the intranet or your electronic note pad and LinQ.
Consider the choice of newspaper and tailor your news and style to fit your knowledge of the readers of that particular newspaper.
Add a photo and suggest a headline for the article.
At the SMART Board you'll be requested to present and clarify the considerations you have had as regards your angle and the wording of your article.
Find examples of nepotism and corruption. Take a screen shot and transfer your examples to the SMART Board by way of LinQ. Explain your observations to the class.

C.
To put things into perspective, we'll look at a couple of film clips.

D.
Discussion of your reflections on the game in the blog.

5. Analysis and findings

The analysis of the teaching/learning session containing the selected mission MAQUILADORAS is inspired by the analytical criteria derived from our theoretical perspective. The set of criteria for discussion topics is listed earlier in the theoretical chapter.

5.1 Digital literacy

In the ongoing process of identifying which competencies are required in contemporary society, much attention is dedicated to the notion of "digital literacy", "media literacy" or "digital competencies". Earlier on, this was primarily considered a matter of skills and functional mastery (Buckingham, 2007). The concern was that in a digital world, no-one should be unable or reluctant to use the proper tools for solving relevant problems. By now, the notion of literacy in the area of digital media is being extended greatly, and – among other things - being literate means:

> *(…) understanding how media are produced, for what purposes, and to what effects. It means grasping how media organisations operate, how audiences receive and respond to different media, and how the exchange between media producers and consumers impacts on social relations and culture (Williamson, 2009).*

Many of these topics were included as rather obvious themes in this study, as the class had previously been working with new literary genres, like e.g. the text messaging novel and interactive fiction. Even though video games are wildly popular, and most young people play to some degree, playing surely cannot be equated with being literate in the broad sense of the word. At the departure of this study, many students actually declared themselves illiterate regarding video games. Playing the game and continuously discussing the learning processes initiated by the game, most students were eager to revise their initial perceptions of games:

> *I think I have had some biases disproved. I didn't think games could be that educational. This is something I now realize that they can to a great extent. (Student)*

> *You see, we had a student in our class who gave an introduction to computer games in general terms and that made me realize my prejudice about computer games being something where people are shooting each other. It can be something different than the prejudice you have about computer games, that's obvious. (Student)*

5.2 Entering the space of concepts

Even though there is no single unequivocal reason for implementing games as tools for teaching and learning, much attention in research has been dedicated to the concept of situated learning in authentic practices (Williamson, 2009):

> *In virtual worlds, learners experience the concrete realities that words and symbols describe. Through these and similar experiences in multiple contexts, learners can understand complex concepts without losing the connection between abstract ideas and the real problems they can be used to solve. In other words, the virtual worlds of games are powerful because they make it possible to develop situated understanding. (Shaffer et al, 2005)*

The game Global Conflicts: Latin America seems to provide such situatedness and, in principle, an authentic context. This context may be said to provide the learner with a possibility for understanding and “sensing” in a very involved “bodily” way the meaning of the concepts presented e.g. in the social science perspective. This is seen in the following student presentation, where they have clearly understood and “sensed” the consequences of closing the factory in the game:

> *But we'll also like to focus on the village, we think that there is a high probability that when a small village becomes so dependent on a factory then it is most likely that the village will go under when a factory closes down. That can be seen e.g. in Denmark, too. I'm thinking of e.g. the bacon factory, what's its name? There was a bacon factory that shut down some time ago. It can kill a whole village. (Student)*

> *Well, you might say, you could imagine a scenario where e.g. Grundfos in Bjerringbro moves all its production abroad, what would be left in Bjerringbro? (Teacher)*

> *And worst of all, when these factories they move, then all the waste they leave behind, they don't do anything about it. This means that the river in that small village will be very, very polluted. This means that they will have to get water from another place and this is only possible...was it a couple of times per week? (Student)*

It is clear that the students experienced a high degree of motivation and urge to participate through the experiential approach enabled through the involved mode of playing the game.

5.3 Increased inclusion

A consistent challenge in almost every educational setting is fulfilling the ambition of including every student in ongoing learning processes (e.g. Sorensen, 2004). It is obvious that a class of high school students is no homogenous group. On the contrary, they express different opinions, fields of interest etc. In the light of these issues, the degree of student inclusion and participation in this study was a very pleasant surprise. All along the course of the study, we experienced a very actively participating class, which was even observed by the students themselves in this discussion:

> *I think we have reached more students this way; more students have been participating. (Student)*

> *Yes, exactly. This (playing a game, ed.) is something, you have to immerse yourself in. (Student)*

> *Everybody has been a part of it. It's not like, three people did their homework, everybody participated in it. (Student)*

> *So in a way, the learning experience included everybody and that is clearly something, which we usually do not manage to achieve. And then we arrive at some far more interesting discussions, when more people are participating. (Student)*

> *The game forces you to take a stand and make up your attitude towards it. More attitudes and opinions lead to more and better discussions. (Student)*

Of course, we cannot completely disregard the possible influence of the so-called "hawthorne effect", which indicates altered behaviour as a consequence of participating in an experiment or special project. On the other hand, there are weighty indications that the widespread participation was caused by the game and the overall design of the course rather than just a flimsy and passing interest in a new educational practice. Rather, the increased inclusion and participation was probably fuelled by the possibility space created by the game, where not only the usual “strong students” could join in.

5.4 Designing the learning experience

It is very apparent from this study, that games are no "silver bullet", as researcher Kurt Squire has made clear (Squire, 2005). It is only by creating the right educational frame around the game, the game adds energy to the learning environment and vice versa. This has been described rather accurately by Williamson:

> *Viewing games as ‘teaching tools’ is a useful distinction because it highlights the key role that teachers play in defining the purposes for their classroom use, in planning activities, and in providing curricular context. Games are, in this sense, used as part of planned learning experiences rather than for their own sake or for flimsily conceived incentivisation purposes. (Williamson, 2009)*

Teachers have a pivotal purpose in the design process (Sorensen & Ó Murchú, 2004) also in terms of ensuring the connection between in-game experiences and the overall out-of-game learning situation as seen in this discussion:

> *There is also the relationship we hear about in the game with his father having worked at this firm and the grandfather has worked there, then it's just natural that when you start working then of course you should also work there. (Student)*
>
> *Exactly, that's a pattern for those squires, just get the families into accepting the pattern that then they just come to work at the firm (Student).*
>
> *If you try to put this into perspective, then you might say, that well, we think it's strange because that's not the way the Danish society works but we do not have to go back many generations before it was also that way in Denmark. Back then it was also customary that you got a job where your father worked. It could be at the sugar factory, or the distillery, the slaughterhouse, the brewery etc. Something has happened to the way society has developed in our part of the world. (Teacher)*

Both teachers involved in this study took active part in putting student experiences and dialogic comments in wider perspectives.

Furthermore, it was evident that the dialectic between playing and thus experiencing “in-game” and working with subjects from the game “out-of-game” created a valuable synergy strengthening the overall learning experience:

> *I must say that my view on this has changed, since we started, as I was not so….I thought it would be a bit boring. But it proved to be rather interesting, as one feels a desire to dig a bit deeper into it. Actually, I think it is rather exciting that one is allowed to write an article about it and present it to the class. (Student)*
>
> *And then also this…that both of us have learned Spanish…and have heard about how they emigrate to the USA. But we have not had any pre-history about it, but more about their travel and what is happening during the travel. We have not heard any pre-history about why things happen, why it has actually happened, and where they come from. And that, I think, is interesting. (Student)*

5.5 Stepping back – criticizing the game

Different types of “learning games” might face heavy criticism from students, as they are not on par with current COTS, and as such might seem outdated or insufficient. We expected criticism regarding the nature of the game, yet an impressive amount of the actual criticism was both well-founded and rather sophisticated.

> *And it is a source of criticism [of the game] that there are no consequences associated with the behaviour of the journalist. For instance, you can be both sympathetic and critical towards people, and still they are sympathetic and open towards you….a little too*

> *open. It is easy to get information! The characters [of the game] ought to be more reserved and shy, so the journalist would have to be more charming and act more charmingly and trustworthy. (Student, comment from blog)*

This comment highlights a very important element of learning (Bateson, 1976; Sorensen, 2008), namely the meta-learning that allows for a critical reflection at a rather high level.

The student's role in the game being a journalist also immediately activates the ability to collect, sort out, and critically work on the information the student achieves while playing. The learning method is so visible that students are able to reflect on the learning outcome e.g. in a blog while they are playing. Among other things, this led to a discussion of learning styles.

6. Conclusion/discussion

In this explorative study the authors have identified a number of theoretically based criteria of learning and discussed their various contributions to enhanced teaching/learning quality in a cross-taught game and ICT based curriculum in a Danish high school between the two subjects taught, Danish language and literature and Social Science.

It is beyond any doubt that learning through playing motivates students to learn. There is also no doubt, as clearly demonstrated by the analysis, that introducing a Serious Game into the curriculum has uncovered a number of enhanced issues in terms of teaching/learning quality. A high level of energy characterized the all in all eight hours where the class played the game. During the play (in pairs) there was a high degree of reflective dialogue unfolding, and an exchange of fruitful advice among the pairs of students.

Learning seems a natural effect of playing a serious game, and at the same time the game appeals to the students' competitive instincts. It is also evident that some of the students had an advantage being skilled players, but the inexperienced students were fast learners. Students with a visual learning style blossomed in this scenario, and due to the game all students became fully aware of their learning styles.

Computer games, it seems, take advantage of the curiosity and speculation mentioned, as the students after a short while discover that there are several layers to the game. This implies that the game opens for differentiation of teaching so both quick and slow learners can be met. Finally, the competitive element of the game forces everybody to perform in a way they would not have been able to in relation to a more traditional teaching material.

As for the teaching of social science the game opens for an insight into various types of problems in Latin America such as poverty, corruption, migration, and more general economic problems which the students can compare to national (Danish) and regional (European) problems. These comparisons provide the students with an enhanced knowledge and therefore more qualified ways of reacting. Pedagogically, the game allows the students to use some of the competences they already have, as it is presupposed that the generation within our educational institutions in the 21st century, has been raised with computer games as entertainment activities.

In conclusion, the game seems an interesting and promising tool in the teacher's pedagogical design palette of electronic tools and media within the topics Danish Language and Literature and Social Science. The students have had their knowledge of genres in journalism jogged, and they have broadened their knowledge of power relationships, and living and working conditions in Latin America. For a more general conclusion around the more principled effects of introducing games into high school teaching and learning, larger studies are needed.

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Deep Learning and the use of Spore™ in A-Level Biology Lessons

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Abstract: This paper examines the perceptions of sixth-form students towards the use of Spore™—a commercial electronic game— in their biology lessons. Findings of a focus group showed that the students welcomed the use of Spore™ as a medium of deep learning, although they regarded this as more beneficial to younger pupils. Two themes were found in their views on how the game relates to biology studies, which are the concepts of evolution and of a selective framework. The paper presents a comparison between the perceived advantages of game-based learning and the normal learning approach and how the students see teachers who use technology in teaching. The paper discusses the knowledge and skills associated with deep learning which were demonstrated by the students in the discussion. A gap was identified between the perceived usefulness of Spore™ in learning about the concept of evolution in biology and the possible desired learning outcomes. The paper considers the proposition that bridging this gap could be a form of deep learning—an approach that could develop meta-learning skills in biology.

Keywords: Deep learning, spore, A-level, biology, game-based learning

1. Introduction

Deep learning is an approach to learning that focuses on learners having the intention to gain a thorough understanding by making connections with previous knowledge and examining evidence (Entwistle 2000). Such an approach enables learners to transfer knowledge and skills gained in one learning experience to other situations through personalization of the learning process (Simms 2006). This personalization involves the transformation of role from passive recipient of knowledge to active inquirer. Entwistle (2000) identified deep learners as learners who

- play an active part in every facet of the change process, from design to implementation;
- approach knowledge and learning by relating new knowledge to previous knowledge, referred to as knowledge transformation;
- have the intention to gain a thorough understanding by making connections with previous knowledge and examining evidence.

These characteristics are echoed by Atherton (2005): ‘deep learners relate theoretical ideas to everyday experience; relate and distinguish evidence and argument; organize and structure content into a coherent whole; relate knowledge from different sources and they are self-motivated, flexible and independent and will succeed in a changing society’.

In terms of the six levels of Bloom’s taxonomy of the cognitive domain of learning (Bloom 1956), deep learners demonstrate learning outcomes that are related to application, analysis, synthesis, and evaluation.

This paper reports on one study carried out as part of the Becta project ‘14-19 Deep Learning with ICT’. Three research questions were addressed by the project:

- What knowledge and skills do learners need in order to be effective deep learners now and in the future?
- Which technology-enabled practices and structures in the 14-19 context support these goals?
- How and which practices accelerate the learning gains afforded by technology in the 14-19 setting and in what way?

The study reported in this paper involved a group interview of students who had played game-based learning (GBL) in A-Level biology lessons. GBL is a form of learner-centred learning that uses electronic games for educational purposes (Tan et al 2008). The teacher in this study used GBL within a dialogic teaching approach. The underlying hypothetical proposition of this study is that GBL supports the development of effective deep learning skills.

Based on what the sixth-form students knew about the use of games in learning, their knowledge and skills were extracted and categorized based on Bloom's taxonomy. The knowledge and skills were compared to the characteristics of deep learners drawn from the literature.

The study took place in a Science and Applied Learning specialist school in Essex. Spore™ (Electronic Arts Limited 2009), a commercial electronic game, had been introduced to the biology teacher by two students. Launched on 05 September 2008 in the UK, Spore™ is a single player, multi-genre game which combines the features of a 'god game', simulation of life and real-time strategy. A god game is a type of simulation game which allows players to control the lives of autonomous creatures or characters, hence the fantasy of having omnipotent power (Adams and Rollings 2006). As a real-time strategy game, the game playing does not progress incrementally in turns; while 'playing god', players are allowed to make optional interventions in the game world and control one or more artificial life forms, and the results of these manipulations are shown in real-time; the action-reaction takes place entirely within the span of the game playing and at the same rate. Spore™ allows a player to control the development of a species in five phases: cell, creature, tribal, civilization and space.

After exploring the game, the teacher decided to use it as a medium to facilitate deep learning among his sixth-form students. He selected the cell phase and the creature phase to be used as part of the teaching and learning. The game was played collaboratively in a science lab, several times during biology lessons, 20 minutes each, starting from October 2008. When playing Spore™ during the lesson, the students and the teacher discussed biological properties such as the features to be assigned to a species, and the impact of decisions made in the game playing, combining GBL with a dialogic teaching approach (Wegerif 2006). Playing Spore™ was also assigned as homework by the teacher to encourage further individual exploration of the game.

2. Data collection

All nine sixth-form students of the A-Level biology class, three males and six females, participated in a focus group discussion, which was conducted in a science laboratory for approximately 75 minutes. The biology teacher joined the discussion and acted as a moderator by triggering students to be participative. The discussion was initiated by the teacher informing the students about the general purpose of the focus group. A question sheet which consisted of ten questions was distributed to the teacher and the students (see Appendix A). After a brief introduction of the study and related ethical considerations, the discussion was recorded using digital voice recorders. At the end of the focus group, an informal 10-minute chat between the researcher and the teacher was held to gain the teacher's immediate feedback about the discussion.

The voice recording was transcribed word for word. The analysis of the verbatim transcription was done by adapting Creswell's (2008) qualitative process of data analysis, which involves two phases of iterative data coding—coding the text for description and coding the text for themes.

3. Findings

The findings of this study are organized into six sections, based on the questions asked in the focus group. Section vi is a collection of extracts that represents the students' experience of GBL and their attributes as deep learners.

3.1 Perceptions on how Spore™ is related to biology studies and things the sixth-form students think they learned from playing Spore™

The students generally agreed that only the first two phases of the game are related to biology studies. In playing and winning the game, the students applied knowledge of biology gained in the past, particularly when they were in Year 9,. Two themes—the concepts of evolution and of a selective framework — were found in their perceptions on how Spore™ is related to biology studies. The framework is a feature designed in the gameplay of Spore™ that allows players to determine the biological properties of a species.

3.2 How the students compared GBL and the way they normally approach their studies

11 themes were generated from the transcriptions that depict the perceived advantages of GBL as compared to the way the students normally approach their studies. These themes were classified into in four categories: enhanced visualization, easing reinforcement/revision, fun/interest, and knowledge transfer, as shown in Table 1.

Table 1: Classification of themes based on the perceived advantages of GBL as compared to normal learning approaches

Themes	Typology of themes
Interactive visual presentation (diagram) of game playing progress.	Enhanced visualisation
Attractive visual presentation (animation)	
Assist in visualizing learning experience.	
Reinforcement of previous learning experience	Easing reinforcement and revision
Ease revision	
Mnemonics for revision	
Extend concentration span	
Make learning more interesting.	Fun and interesting
Fun in GBL enhances effectiveness of learning	
Fun in GBL extends learning span	
Applying knowledge gained in the past in game playing.	Knowledge transfer

3.3 How the students perceived the usefulness of GBL as compared to the way they would normally study

The most active participant among the sixth-form students, M1, highlighted that Spore^{TM} is not useful for learning biology at A-Level:

> *it's not as detailed…it's not learning at A-Level standard…I would say it's more useful for Year 9 group and for us, it's just a fun game to play…students [in] Year 9 may are actually gonna be learning from what they are doing…we already know enough about evolution to understand it. I don't think it's that beneficial to A-Level, but as a Year 9 student, as I go home and then I can give feedback in the lesson.*

He also commented that Spore^{TM} did not have an explicit aim. On the other hand, this mimics the non-directionality of evolution. While playing Spore^{TM}, the evolutionary simulation in itself does not require that players have to survive, but implicitly players have to survive in order to continue playing. Among game developers, not having an explicit cost/benefit structure would result in a programme being described as a simulation rather than a simulation game (Prensky 2007). However, within the outside world, a simulation implicitly is understood to have either a good outcome or a bad outcome, hence the games developers' distinction between a simulation and a simulation game (Gradler 1996).

3.4 How the students perceived their teacher who used technology-enabled practices in teaching

According to the feedback given by the teacher over the post-focus group informal chat, the students welcomed the use of GBL in biology lessons. This statement matched the students' perceptions, as they were pleased to have game playing as homework and to have teachers who are open-minded to technology and willing to listen to their suggestions (see Table 2).

Table 2: Perceptions of teachers who adopt technology-enabled practices

	Transcription	Themes
M1	[He] actually said that our homework which is to go home and play Spore^{TM}.	Set game playing as assignment
M2	That's more enjoyable homework.	
M1	…I won't say anything to a teacher worrying about time for games in school curriculum. I'll show them the advantages, I'll explain the advantages if there were any, because I don't know other game, maybe apart from Spore^{TM} allows us, does have enough…educational value. I don't think many games have a massive worthwhile level of it.	Willing to listen to students' suggestion.

	Transcription	Themes
M1	…most of the teachers are quite open-minded about trying new things…Our teacher is trying to get us iPods so that we can watch video and listen to the Podcast. I mean this is very open-minded to technology…	Open-minded to technology
M2	Yes. They let us play Spore™ in the first place. I mean a lot of schools wouldn't.	

3.5 The perceived educational potential of GBL and other technology-enabled practices

The students suggested 16 different technology-enabled practices, and most of them involve GBL (see Appendix B). The perceived educational potential of these practices are shown in Table 3. Transfer of knowledge and skills was regarded as the top perceived potential of these practices.

Table 3: Perceived educational potential of technology-enabled practices

Perceived potential	Mentioned	Examples included…
Transfer of knowledge / skills	13	it's application of logic and knowledge at the same time.
Flexibility in combination	3	…like biology A-Level student add-on or Physics A-Level student add-on…
Challenge and competitiveness	3	Western culture is very about winning and being the best
Mnemonics	2	21st century mnemonics
Rule-oriented	2	The rules of the game should be the rules you are trying to teach them.
Virtual reality	2	First person shooter based inside human body…
Interactivity	2	It was interactive as well…
Communication tool	1	Like a discussion board, you can talk over.
Cater the need of non-game players	1	the BiteSize really needs a lot of passion…some person that plays more videogames it's not going to be as interesting
Visualization tool	1	…show it on vision
Remedial learning material	1	if someone doesn't understand something…

3.6 Extracts of knowledge and skills of the students as deep learners

Based on the data collected in the focus group, the knowledge and skills of the students were extracted and grouped under four advanced levels of cognitive domain of learning (see Appendix C). Six learning outcomes associated to deep learning were drawn inductively by referring to the meanings of the transcriptions:

- To apply knowledge gained in Year 9 when playing Spore™.
- To differentiate the degree of learning in biology between Year 9 and A-Level.
- To criticize the usefulness of Spore™ in the learning of A-Level biology.
- To construct understanding of game mechanics and relate it with knowledge gained in real life.
- To propose games and other learning activities that could be used in the learning of biology.
- To appraise the quality of games used in facilitating GBL.

4. Discussion

4.1 The use of focus group as a data collection method

Two fundamental assumptions were made when determining the choice of data collection method, which are:

- Games have beneficial effects on students' need.
- Only students really know what students think.

These hypothetical propositions were the specific foci of the study, a focus group was therefore chosen as the method for exploring these hypotheses. Despite being the population of A-Level biology students of the institution involved, the focus group was not meant otherwise to be representative. Not all students were actively participating in the discussion. One participant (F6) remained silent from the start till the end while another (M1) dominated the discussion most of the time. However, the choice of the focus group as a method of data collection was preferred in order to gather a variety of opinions or more consistent/contradictory voices from the participants in the available time. The researcher involved in this study was not a detached observer but an active participant in the discussion, therefore the interaction between the researcher and the participants, particularly the posing of questions, was taken into account during the data analysis. Being a participant allowed the researcher to explore specifically what the students think about the benefits of games, as clarification could be requested in the discussion.

4.2 Perceived usefulness of Spore™ versus possible desired deep learning outcomes

Despite the conclusive statement claimed by the students—playing Spore™ is not useful for learning biology at A-Level—the GBL they experienced was actually building their deep learning skills, as M1 said:

> *I think that will work really well to teach Biology for example if everyone of us wears goggles in the class, and then we see each other, and then say 'this is a dinosaur.' And everyone can walk around the dinosaur and have a look at the 3D model of the dinosaur, I think that will work really well…*

From the experience of playing Spore™, the students were able to propose ideas about how Biology could be taught using GBL. Such examples of evidence were given throughout the discussion. Students were not only able to synthesis biological concepts in solving problems faced during the game playing, but also able to suggest GBL ideas in biology. This could be an example of the desired deep learning outcomes for A-Level biology lessons. Other possible deep learning outcomes are listed in Appendix C. The difference between the perceived usefulness of Spore™ in learning biology and the desired deep learning outcomes generated a gap which could be bridged by developing meta-learning skills in biology. The goal of meta-learning, or learning how to learn, *'is to have people aware of how they learn and solve problems to optimize their approaches and broaden their repertoire of learning skills'* (Quinn and Connor 2005).

4.3 GBL with dialogic teaching approach in the 14-19 context

Although M1 mentioned that *'deep learning does not necessarily have to be computer games'*, the educational potential of GBL as a technology-enabled practice and structure that could support the knowledge and skills development of being deep learners in the 14-19 contexts is explicitly shown in the proactive participation of the students in this study. The GBL with a dialogic teaching approach requires the teacher to hold discussions before and after game playing. Herewith an example of what the teacher said in the focus group to facilitate the students in the discussion:

> *You have to have an element of research within it, won't you? To get to the next level, whatever the game might be, you would have to go and do some research to find the fact, to unlock the door, or you know, the secret or whatever it might be.*

In this example, the dialogic teaching approach provided a platform for deep learning to occur and the learning outcomes demonstrated by the students were encouraging.

5. Conclusions

The students were able to speculate about the relationship between playing Spore™ and their study in biology. In general, they welcomed the use of GBL and other technology-enabled practices in formal educational contexts, although they did not seem able to foresee the desired deep learning outcomes.

The gap identified between the perceived usefulness of Spore™ and the possible desired learning outcomes in biology could be bridged through meta-learning. To be effective deep learners in a subject, the knowledge and skills of meta-learning in the subject are needed. Such knowledge and skills can be made achievable through exposing desired deep learning outcomes. GBL using Spore™ with a dialogic teaching approach is worth using in developing meta-learning knowledge and skills in biology. Therefore, if commercial games are chosen carefully and associated with advanced level learning outcomes in cognitive domain, GBL with dialogic teaching approach is a technology-enabled practice and structure that could support the knowledge and skills development of being effective deep learners in the 14 – 19 contexts.

6. Appendix A: interview questions

- 1. When did you first start to play Spore™?
- 2. How does it relate to your biology studies? Can you give me an example?
- 3. How did your teacher use it in the teaching of biology? Can you give me an example?4. What do you think you learned about biology from playing Spore™? Can you give me an example?
- 5. How did this compare to the way that you normally approach your studies?
- 6. How useful was playing Spore™ in comparison to the way that you would normally study?
- 7. You are currently studying for A-Levels, are there any other games that might also help with learning biology or might relate to your other subjects? If so what are they, how could they help?
- 8. Have you got any thoughts on how games like Spore™ could be combined with other methods of teaching and studying?
- 9. What would you say to a teacher who was worried about whether there was time for game in the school curriculum?
- 10. In summary could you explain what you think the potential of games like Spore™ is for helping students with their studies?

7. Appendix B: GBL and other technology-enabled practices and their potential as suggested by students, with reference to specific programs

Technology-enabled practices	Perceived potential
GBL in general	Mnemonics
	Transfer of knowledge
	Rule-oriented
	Transfer of knowledge
	Visualization tool
	Flexibility in combination
	Remedial learning material
	Virtual reality
GBL for biology	Challenge and competitiveness
	Virtual reality
Spore™	Mnemonics
	Transfer of knowledge
Bio Shock™	Rule-oriented
	Transfer of knowledge
BBC Bitesize for GCSE	Flexibility in combination
	Interactivity
	Transfer of knowledge
	Challenge and competitiveness
	Caters for the needs of non-game players
Wii Fit™	Transfer of knowledge
Halo: Gears of War™	Transfer of knowledge
The Bus Stop	Flexibility in combination
Active Expression [Voting System]	Challenge and competitiveness
The Sims™	Transfer of knowledge
Theme Hospital™	Transfer of knowledge
Portal™	Transfer of knowledge
Tetris	Transfer of learning skills
Pool	Transfer of knowledge
Half Life 2™	Transfer of knowledge
XBox Live™	Communication tool.

8. Appendix C: matching learning outcomes and knowledge and skills demonstrated by the students in the focus group discussion

Level of cognitive domain	Learning outcomes associated to deep learning	Example included
Application	To apply knowledge gain in Year 9 into the playing of Spore™	…I can use my biology knowledge to work that out so I might want to be the biggest.
Analysis	To differentiate the degree of learning in biology between Year 9 and A-Level.	Spore™ is a lot like that but it's not as detailed
		it's not learning at A-Level standard… for us, it's just a fun game to play… We already know enough about evolution to understand it… students Year 9 may actually gonna be learning from what they are doing
	To criticize the usefulness of Spore™ in the learning of A-Level biology.	I would say it makes things more interesting rather than real because at the end of the day, it's still a game. the second part of the game probably uses more history and politics
		I don't think it's that beneficial to A-Level, but as a Year 9 student, as I go home and then I can give feedback in the lesson
Synthesis	To construct understanding of game mechanics and relate it with knowledge gained in real life.	…you also found once it reached certain level or centaur…you no longer have a need to evolve, because you're above of the other being and also that show how some developments can useless when centaur has it all yourself.
	To propose games and other learning activities that could be used in the learning of biology	Don't you ever remember things more easily when you can attach your emotion to it?
		It could be incorporated into the classroom
		…it's application of logic and knowledge at the same time.
Evaluation	To appraise the quality of games used in facilitating GBL	It reinforces what you already learnt, to make sure you understanding it
		We were actually able to discuss more biological properties within here.

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Arguing for Multilingual Motivation in Web 2.0: a Tool for Facilitating Plurilingualism

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Abstract: There are several purposes that Alternate Reality Games (ARGs) can be used for and facilitating plurilingualism is definitely one of them. In the age of ICT-based communication, Alternate Reality Games (ARGs), interactive narratives, often involving multiple media and game elements used to tell a story that may be affected by participants' ideas or actions (Connolly *et al*, 2008), are known in non-educational settings but can serve as a teaching and learning tool that can contribute to activating the use of modern foreign languages in authentic situations, something that classroom teaching lacks. This paper aims to examine various educational and social aspects of games-based learning with a special focus on multi-channel communication between speakers and learners of different European languages. In this paper, we explore further the use of web-based foreign language learning and the questions that it poses. What has to be done so that ARGs can achieve their educational objectives? How can we best use their potential as a powerful motivator for acquiring more than one foreign language? With the context of the Tower of Babel ARG developed as part of the EU Comenius project, ARGuing for multilingual motivation in Web 2.0, this paper presents an analysis of the opportunities that an ARG provides, but it also discusses the issues that educators and game developers should be aware of and cater for.

Keywords: ARGs, plurilingualism, motivation, communication, social networks, modern foreign languages

1. Introduction

In the age of ICT-based communication, teaching and learning have started moving slowly but steadily towards the Internet in response to the changing patterns and channels of communicating and learning of secondary school students both in Europe and other parts of the world. Elements and approaches from spheres different from the orthodox school education are now being integrated into teaching and learning thus providing greater motivation for students. One of these elements is Alternate Reality Games (ARGs), interactive narratives, often involving multiple media and game elements used to tell a story that may be affected by participants' ideas or actions (Connolly *et al*, 2008). ARGs can serve as a teaching and learning tool that can contribute to activating the use of modern foreign languages in authentic situations, something that classroom teaching lacks. This paper will examine various educational and social aspects of games-based e-learning with a special focus on multi-channel communication between speakers and learners of different European languages leading to the development of plurilingual competence for secondary school students. We will explore the use of web-based foreign language learning and the questions that it poses. What has to be done so that the ARGs can achieve their educational objectives? How can we best use their potential as a powerful motivator for acquiring more than one foreign language? With the context of the Tower of Babel ARG developed as part of the EU Comenius project, ARGuing for multilingual motivation in Web 2.0, this paper presents an analysis of the opportunities that an ARG provides, but it also discusses the issues that educators and game developers should be aware of and cater for.

2. Background

The advent of Information Technologies has brought about a change in educational policies that has influenced both teaching approaches as well as learning tools. The question to be answered is why**.** There is no need to say that this perhaps is the most important question of all. It started about 15 years ago when the majority of European schools and universities became equipped with computers that caused the change of learning habits and communication channels of European learners. What was originally done by a teacher using verbal communication (often called *chalk* and *talk*) was taken over by a computer screen.

It is worth mentioning here one particular effect of this phenomenon. Many teachers, including some policy makers, either refused to accept the new reality or were very slow in adopting it. What they said and believed in was that there could be no substitute to the teacher in the classroom. In his interview conducted by e-mail with ELT News editor Mark McBennett in July 2005 Dr Ken Beatty (PhD, MFA, Ling Dip, Ed Dip, BA) expressed the opinion that, "Computers and the WWW are great for communication, but spelling can deteriorate as students start adopting phrases such as How R U? I m gr8. Computers are good for research, but they usually fail to help students think critically about what they read. Computers can test simple written input efficiently, but they cannot deal well with ambiguity in speech or writing. Computers can present interesting graphics and video to enliven learning, but they cannot easily adapt their presentations to different audiences. In short, a state-of-the-art computer system generally cannot do many of the things that any reasonably qualified teacher can do …"

Vivienne Collinson, a professor at Michigan State University and the author of *Reaching Students: Teachers' Ways of Knowing* expresses a similar opinion by summarising that, " Computers can be effective tools for helping students learn academic subjects, but young people will always need human teachers to provide moral guidance and foster intellectual growth and social development. Computers provide students with information, but only teachers can teach children to think critically, discriminate among sources of information, and be creative.
It is still true, but that does not mean that a channel of communication, so powerful and as versatile as the one based on ICT should be rejected. Using ICT in Foreign Language Teaching (FLT) is just another very useful tool in the FL teaching inventory that should be made proper use of.

Dwelling further on the effect of the expansion of the use of computers on the main participants in the process of learning, it should be said that students embraced the new ICT technologies and made them their preferred learning and communication channel. The findings of the UK survey on Internet literacy among children and young people from the UK 'Children Go Online project' (published 9 February 2005) show that online young people aged 9-19 do the following (figures are for regular online users)

- send/receive emails (72%)
- play games online (70%)
- send/receive instant messages (55%)
- download music (45%)
- watch/download video clips* (30%)
- use chat rooms (21%)
- use internet to do work for school/college (90%)
- use it to get information for other things (94%)
- try to set up a webpage (34%)

A closer look at the figures shows that the highest percentages are connected with using the Internet to do work for school/college and getting information for other things. The second group of high percentages includes sending/receiving e-mails and playing games online. All other activities display far lower percentages in comparison to the previously mentioned ones.

Returning to the effects of the expansion of ICT in society we must admit that teachers often lagged behind this process refusing to recognize the fact that students should be taught using channels and tools that they accept and recognize as familiar but also attractive. It would be unfair to say that educators did not respond to the newly-identified needs of the students, however, the materials that were created often replicated traditional teaching approaches but in electronic (digital) format, which could not serve as a motivator powerful enough to replace the teacher and his input into the education of students. Another important detail is the time students spend on their computers, time which often exceeds the time they spend at school or devote to other extra-curricular activities. It is evident that something very important has been happening in society that calls for reaction from educationalists and other stakeholders in the educational sector. A further observation worth mentioning is that computer games became an important development in popular culture and that more recently there has been an appreciation that computer games can play a significant role in education (eg. Connolly, Stansfield and Hainey, 2007; Garcia-Carbonell, Rising, Montero, and Watts, 2001). The statistical data shown in Table 1 collected from students at the start of the large scale pilot that we ran in April 2009 of the Tower of Babel ARG developed as part of the ARGuing EU Comenius project serve as evidence of the above statements.

Table 1: Question 6. Do you think it is a good idea to use **computer games** in studying different subjects at school?

Response	Average	Total (number of students)
Yes	93 %	231
No	7%	18
Total		249/249

Yet another phenomenon that is worth investigating is the emergence of online social networks such as Facebook, MySpace, Hi5 and many others, which have usurped several functions from family and school life. One element that makes them so very attractive is the freedom to be creative and show your skills to the rest of the world or to a community you recognize as closest to your interests, values or beliefs. The lack of proper communication within the family, one of the evils of modern times, has led to the transfer of these functions to an environment that amply compensates for the deficiencies in communication of present-day families. Communication on the Web includes elements from spheres that were previously the monopoly of schools and the closest family environment of people. What happens today is that instead of asking or talking to their parents or teachers students converse with people they do not even know. They share experiences, make comments, ask for advice and consult the online community about anything, including learning. Web 2.0 now incorporates another element of education, namely learning resources. The Web has become a major source of knowledge for the ICT generation and sites such as Wikipedia serve as main reference points. If we sum up the new developments in the hi-tech society of 21st century we will see that several vital societal functions have been transferred into a new environment, the Web 2.0, a fact that has to be recognized but also catered for.

3. The advantages of ARGs for teaching languages

The comparison of traditional classroom language teaching cultures with the culture of ARGs as a new teaching and learning tool shows that ARGs provide the following opportunities that are lacking in the traditional language classroom:

- The opportunity to practise the target language, or any other non-native language, in a near authentic situation, which the traditional classroom does not provide. The importance of this factor has often been underestimated, which explains why students can read and write in a foreign language without any problems but spoken intercourse is a challenge they rarely overcome.
- The freedom to express themselves without worrying about the mistakes they may make because the focus of teaching has been re-positioned towards communicating in the language, not the production of flawless chunks in the target language.
- The opportunity to learn from peers, who can also be friends, a process that is far less intimidating for students than the usual classroom correction method. This includes the opportunity of getting support and encouragement from fellow players.
- The opportunity to learn through tasks that challenge the students’ creativity.
- The opportunity to initiate conversations on topics related to the quests and occupy a leading position (e.g. when setting up guilds or starting forums and blogs), a fact that boosts the student’s self-confidence and his/ her determination to master his/ her knowledge of the target language.

The analysis of the pre- and post-game questionnaires for students from the April 2009 ARGuing pilot provide convincing evidence that students are aware of the potential of ARGs for language teaching and that they would prefer adding such an educational tool to the classical language classroom teaching approaches and using it on a larger scale (see Table 2).

Table 2: Question 9. Do you think that it is a good idea to use computer games in studying languages at school?

Response	Average	Total (number of students)
Yes	96 %	239
No	4%	10
Total		249/249

As seen from the above statistic students are nearly unanimous about the necessity of an ICT-based tool in foreign language teaching at school. As shown in Table 3, the responses to the next question explain why they hold this opinion.

Table 3: Question 10. If your answer to Question 9 is YES, why do you think so? (Use as many options as applicable)

Response	Average	Total (number of students)
Because they are fun.	41 %	101
Because they help me understand the grammar and vocabulary more easily.	45 %	111
Because they make the lesson more exciting.	50 %	125
Because while I am playing I can use the language I am studying.	42 %	104
Because I can use my ICT skills	16 %	41

A more detailed analysis of the above responses shows that what students miss in class is the fun/game element in the process of teaching and learning, which is still very important for students of ages 13-16.

The *Tower of Babel* ARG created by the project team has made full use of the advantages of ARGs in the best interests of the students. But since we are looking into the potential of ARGs to facilitate plurilingualism, we specify those elements in the Tower of Babel ARG that were used to promote the learning of several languages. As we have mentioned before an ARG includes various components such as a narrative, videos, quests, blogs, e-mails, as well as text and skype messages used between the student players. One of the tasks that was used to promote plurilingualism was the inclusion of several parts of the narrative in a language different from the foreign language studied by the learners. The final piloting of the game (the third of three) was done over a period of 15 days. On 9 out of the 15 days the continuation of the story included information provided in Spanish and French, not English. This information was in the form of long messages or blogs from 2 of the characters in the story (the Spanish-speaking Seb and the French-speaking Lor).The following sequence illustrates the use of this approach:

Day 1

Mensaje de Seb: ¡Hola! Soy Seb (Spanish)

Message de Lor: Je m’appelle Lor (French)

Day 3

Blog de Lor: Comment tout a commencé ... (French)

Day 4

Mensaje de Seb: El interior (Spanish)

Video message from Sera (in English only as well as additional versions in English with subtitles in Spanish and French)

Day 6

Mensaje de Seb: ¡Buen trabajo! (Spanish)

Day 7

Message de Lor: Allez-y!(French)

Day 8

Blog de Seb: La única oportunidad de Lor (Spanish)

Day 9

Blog de Lor: Trahie? (French)

Day 12

Message de Lor: Dernier message (French)

Mensaje de Seb: ¡Rodeados! (Spanish)

This approach meant that the students had to contact their Spanish or French co-players to be able to understand the development of the story and proceed with the game which resulted in active communication between the native and non-native speakers of the language in question. One of the effects was the challenge to the students who, coming across a language they did not know, could decide to learn the respective language. Another effect that was aimed at (and that was the intention of the game scenario writers) was to encourage the players to try to understand the meaning of the respective story section by using their knowledge of a language belonging to the same language group (for example, using English to grasp the story development in the French extract or using French to work out the meaning in the Spanish extract); in other words, to apply intercomprehension. A similar approach was used in some of the game quests where the players were expected to provide the answers in one of the national languages of the countries participating in the game (e.g. one in Bulgarian, one in Italian, one in French, one in Spanish). The elements that were provided in a different language than English included also instructions given by the puppetmasters of the game, as for example instructions in French. An interesting observation made within the course of the game was that Greek students showed initiative and contributed to the plurilingual approach used in the game by providing words in Greek and giving their translation for their fellow gamers.

4. ARGs and plurilingualism

Alongside the discussion of the opportunities that ARGs provide for the development of plurilingual competence for secondary school students we would like to define plurilingualism and explain the economic and social background to it. Like all other skills linguistic competences in a foreign language are acquired for economic and social reasons that serve as the most powerful motivators for any individual learning a foreign language. In the case of a united Europe, the perspectives of studying, working or living in another member-country of the EU explain the necessity of doing it.

Several EC documents clearly state the imperative need to acquire competences in several languages as, for example, in the Commission's White Paper on Teaching and Learning of 1995 which points out that:

> *"… it is becoming necessary for everyone, irrespective of training and education routes chosen, to be able to acquire and keep up their ability to communicate in at least two Community languages in addition to their mother tongue.";*
>
> *"…Upon completing initial training everyone should be proficient in two Community foreign languages.";*

“Policies for language education should therefore promote the learning of several languages for all individuals in the course of their lives, so that Europeans actually become plurilingual and intercultural citizens, able to interact with other Europeans in all aspects of their lives.”(Council of Europe, 2003: 7)

As to the definition of plurilingualism, the Common European Framework of Reference for Languages states that it is “The ability to use languages for the purposes of communication and to take part in intercultural interaction, where a person, viewed as a social agent, has proficiency of varying degrees, in several languages, and experience of several cultures. (Council of Europe, Common European Framework of Reference for Languages. 2001, p.168). It is appropriate to mention the distinction between plurilingualism and multilingualism, a term that has been in existence for some time. As specified in Michael Byram’s speech on *Plurilingualism in Europe and its implications*, (Byram, 2007) “Plurilingualism refers to persons whereas multilingualism refers to geographic (sometimes political) areas – where there are plurilingual and/or monolingual persons.” He also argues that plurilingualism has to be complemented by intercultural competence, not pluriculturalism, a competence which refers to the ability of the speaker of a foreign language to negotiate intercultural norms when communicating with speakers of other languages.

According to the action plan 2004-2006 for Promoting language learning and linguistic diversity stated in Communication (2003) 449 of the European Commission, plurilingualism is based on:

- opening towards other languages and cultures;
- integrated didactics of teaching foreign languages;
- integrated teaching of languages and subjects;
- acquisition of partial competences in many languages;
- inter-comprehension of languages belonging to one and the same linguistic group.

Analyzing the potential of ARGs to integrate the above – listed pillars of plurilingualism we must say that ARGs provide ample opportunities for all of the above. What we are particularly interested in though is the possibility to motivate students (through the use of ARGs) to acquire partial of full competences in many languages and to experience intercomprehension as a result of their participation in language-targeted ARGs such as the Tower of Babel ARG created by the ARGuing project.

Plurilingualism, which represents a global intercultural educational approach to forming citizens of Europe and the world, should lead to:

- linguistic diversity;
- tolerance;
- social inclusion;
- social peace and cohesion;
- a better and richer method of teaching and learning.

Reading through the visionary words of the Greek student Sofia Velentza posted in the Europe Forum on 24th April 2009, one can trace most of the aims above, aims that all teachers should strive to achieve:

“The Europe Forum Virtual Wormhole is a very intresting idea...of course we are in the beginning but till the end will be very close to each other....and we will save the world at last..... unity is a great achievement and we'll succeed it through tough work and commitment to our goals....... that is why this project is one of it's kind.....communicating with people from other countries.....helping them....being helped by them.....trying to learn things about them.... and hopefully through this task we'll find new friends! and all we'll have a vision for us....for our descendants.......!!!!!!!”

This particular opinion, alongside many others expressing similar views and impressions from the ARG, lead us to believe that the Tower of Babel ARG has attained its goal. On a more prosaic note we would add that language policies and linguistic ideologies (according to Beacco and Byram, 2003) will therefore be examined in relation to how they approach plurilingualism with respect to education for plurilingualism, which involves enhancing and developing speakers’ individual linguistic repertoires from the earliest schooldays and throughout life (something which the Tower of Babel ARG aimed to do.) *Education for plurilingualism* will from now on refer to language education (national, “foreign”, regional languages) in which the purpose will be to develop plurilingualism as a competence.

There have been several European programmes dealing with the integration of ICT and the learning of languages such as the Lifelong Learning programme and two of its four horizontal activities, namely language learning and ICT; the Information Society Technologies (IST) sub-programme within the 6th Framework Programme; the Technology-enhanced Learning (TeLearn); the eContent*plus* Programme (2005-2008), which supported the production, use and distribution of European digital content and promoted linguistic and cultural diversity on global networks, as well as the ICT Policy Support Programme which is part of the Competitiveness and Innovation Framework Programme (CIP). There have been few attempts though to use ARG-like teaching activities for studying languages and the ones that we have been able to trace, deal with only one language at a time (e.g. Chinese).

4.1 ARGs and the opportunities they provide for acquiring plurilingual competences

An ARG in itself presupposes the establishing of a social network of players who have to collaborate so that they can solve the quests. A WebQuest is an activity whose aim is to provoke learners to find information some or all of which comes from resources on the Internet. There are several things that are inherent in online social networks. One of them is communication between speakers of different languages whether or not united by a common competence in English as a ‘mediating language’ (Castelotti and Moore, 2002) and the other is a common purpose or goal in using the social network. In addition to that, teachers as educational designers and “managers of learning” (Gagne, 1975 cited in Doyé, 2005) are in a position to arrange the conditions of learning in such a way as to make the intended learning possible (Council of Europe, 2005). An ARG can be designed in such a way to encourage the acquisition of both plurilingual and intercomprehensive competences.

Some of the educational objectives, in this case encouraging plurilingualism, may be achieved in quite a natural way, merely through the circumstance that an ARG can be played by students from numerous European countries, in our case 17. Friendships established while playing the game can serve as powerful motivators for learning a new language as well as interest aroused through reading a text or viewing a picture within the course of the game. These are useful spin-off results originating from the nature of the game but what really matters is the ability of the educational scenario designers to devise, structure and guide the game in such a way so as to unobtrusively lead students to the decision or conclusion that it is important or at least useful for them to learn a couple of other languages.

4.2 Methods that can be used to activate plurilingualism in ARGs

If we go back to the definition of ARGs, we will notice that the main component of ARGs is a narrative that inevitably involves one or several characters. Depending on the educational purposes of the game, which in our case is motivating students to learn foreign languages, these characters can represent speakers of different European languages and accordingly, different cultures. Furthermore, some of the components of the game such as parts of the story, messages, e-mails, blogs and any other component you can think of can be in different languages which forces the students to attempt intercomprehension especially if they are unwilling or unable, for whatever reasons, to contact native speakers and ask for translation or explanation. Apart from this, the integration of quests that demand that the answer be provided in a national language leaves the students no choice but talk to players who are speakers of the respective national language. The *Tower of Babel* ARG developed under the ARGuing project applied all of the above. To be more specific, the three main characters of the narrative - Lor, Seb and Zak represented speakers of French, Spanish and English. The game included quests that invited students to try and find the answers in other languages, languages that the students did not know or learn. One of the quests used more closely related languages such as Italian and English (Roma/Rome) and was based on intercomprehension whereas the other quest (Sofia, written in the national language, which was Bulgarian in this case) made use of a language totally distant from the students native languages English, Spanish, Italian, Greek, etc. (which excludes the Bulgarian students since it was their native language). The main pilot of the game, despite some weaknesses and minor inconsistencies in the game itself, provided convincing evidence that an ARG can be used for promoting plurilingualism in a very natural but also attractive way, as reflected in the post-game data shown in Tables 4-7.

Table 4: Question 1. Did you enjoy playing the Game and using foreign languages at the same time? (Choose one option.)

Average rank

Didn't enjoy it at all	Can't decide	Wasn't that bad	I liked it	Absolutely loved it

The average rank of 4.1 (82 %) shows that the level of satisfaction was very high.

Table 5: Question 4. What did you like about the Game? (Choose as many as applicable)

Response	Average	Total (number of students)
I liked the story of the Game	47 %	49
I liked the characters	27 %	28
I liked the fact that I could play with my classmates and students from other schools.	63 %	66
I liked using my computer for the purpose of studying languages.	59 %	61
I could feel some support	21 %	22
I like solving the quests.	54 %	56

Table 6: Question 6. Did the Game motivate you to use foreign languages? (Choose one option.)

Average rank

It didn't motivate me at all	It could motivate me but it didn't	There were things I liked	It got me intrigued	It motivated me strongly

The average rank of 3.8 (76 %) testifies that the Game has achieved its task to motivate the students.

Table 7: Question 7. Would you like to experience more of this integration between ICT (information and Communication Technologies – computers) and language learning?

Response	Average	Total (number of students)
Yes	92%	96
No	8%	8
Total		104/104

A further question (Question 8 in the post-game questionnaire), which asked students to explain why they would like to experience more of the integration between ICT and language learning, provoked comments of the type:

- I would like to experience more of this integration between ICT and language learning because I want to know more about the history and life in the other countries and more about people and their languages.
- It is a good experience because we learn many languages and communicate with other people of different countries.
- It's nice the idea of combining ICT and language learning with the traditional way of teaching
- This play was great :) There I learned language.
- Using computers and other technologies is very useful in learning languages, and also it's very interesting.
- Yes because this experience made language learning more vivid and interactive
- Yes, because this experience is utility for the apprehension of language learning and interactivity with the people all over Europe.

The opinion of the student Ignas Gailiunas posted on the Europe Forum on 30th April 2009 is another testimony to this:

> *"I believe that EU forum is a good thing, i believe that the most effective way of learning foreign languages is using them, so if we talk with each other, for example in English, our English language knowledge will increase. That's the way to learn foreign languages!! Lets keep up the good work and socialize with each other!!"*

A final thought is that it is the responsibility of game developers and educational content designers to fine-tune the Tower of Babel ARG in such a way that it meets the needs of language education in a format which corresponds to both educational objectives and the preferences of 21st century learners for a games-based e-learning environment.

5. Conclusion

As we have discussed in this paper, much more can be done to facilitate the acquisition of plurilingual competences for secondary school students but the main pilot of the Tower of Babel ARG has clearly demonstrated that ARGs targeted at language learning do have the potential to be used as a powerful tool for encouraging the acquisition of a second, third, or even fourth foreign language at secondary schools in Europe. They can be used to develop awareness of the significance of other European languages in a way which differs from the traditional foreign language teaching and is much closer to the way present day students obtain information, acquire knowledge and skills, and, most importantly, to the way they communicate since ARGs represent a very accurate reflection of the way of life of the 21st century school generation. They also employ the whole spectrum of communicative tools of the information society, in particular the Web 2.0 generation services and products which enable learning anywhere, at any time and at any pace. The social networking component of ARGs has two important functions: first, to connect people and enable them to communicate in real time and second, establish connections between the users of the Web which can later develop into information-gathering, teaching or learning tools as was the case with the Tower of Babel ARG. The feelings of empathy and the synergy derived from the collaborative work while solving the quests create the desire to get closer to the other members of the gaming community by learning their languages despite the presence of a mediating language such as English. It must be noted that as a first attempt the Tower of Babel has features which can be improved but on the whole it has shown that it can be used to serve the purposes of plurilingual education by providing appropriate media and educational components to achieve this.

Acknowledgements

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Arguing for Multilingual Motivation in Web 2.0: the Teacher Training Perspective

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Abstract: Not only is it necessary these days to bring *technology* into classrooms, to suit teaching to the actual needs and the skills learners bring from the 'real world', but it is of paramount importance to equip their teachers with the tools to mediate successfully in the process of acquiring knowledge and developing competences in a changing educational environment. Drawing on the experience gathered while designing and running a teacher training course for teachers of modern foreign languages in their preparation to run the Tower of Babel Alternate Reality Game (ARG) (a specially developed game to suit the contemporary needs of motivating students to learn and use more than one foreign language) the authors shall concentrate on the why's and how's of helping teachers cross the boundary between the classrooms they are familiar and comfortable with and an e-learning environment. They will reflect on the different stages that teachers undergo in this process using their observations as well the gathered quantitative data paying particular attention to teachers' reactions and recommendations. They will also focus on drawing some conclusions about the possibilities and requirements that on-line teaching and learning pose.

Keywords: ARGs, motivation, collaboration, social networks, modern foreign languages, plurilingualism, teacher training

1. The changed roles in education

However drastic it might sound, more and more people today are inclined to agree with Marc Prensky's view on the changed students' and teachers' roles and student-teacher relationships in and out of today's classrooms (Prensky 2001). Within a digital world, one that is technologically developing at a fast pace, learners and teachers are no longer what they used to be, the processes of acquiring knowledge have been altered, and different teaching approaches, decisions and styles are urgently required. Students' digital competencies and ICT experiences outside the classroom pose a very important requirement to their teachers who must begin to change the way they plan their lessons, organise the learning activities and consider the use of materials and resources so that the students are interested, active, positive to learning and, above all, motivated to develop in the particular subject area. Prensky states that in learning situations students react in the same ways they react when they are using their computers or the Internet. The "digital natives", as he calls students, are no longer satisfied with how they are being taught by the "digital immigrants", as he refers to the teachers. He also speaks about the necessity for a new type of content to go with what he calls "legacy" content: reading, writing, arithmetic, logical thinking, understanding the writings and ideas of the past, etc. This new type of content Prensky terms "future" content: software, hardware, robotics, nanotechnology, genomics, etc. (It is interesting to note that among such innovative strands of teaching content he includes the learning of languages.)

The main focus of this paper is on examining the assumptions, the needs, as well as the reality of helping language teachers overcome this supposed lack of digital skills and experience to help them prepare for their students' involvement in an Alternative Reality Game aimed at stimulating communication in more than one modern foreign language.

2. Innovative learning content and context

2.1 Alternate reality games

It is, perhaps, not necessary to go too far to look for such "future" content since today's computer games are wide-spread and can be adapted to various educational purposes. What is more, it seems that there is one type of game that can easily be altered to meet the requirements of modern foreign language teaching. According to researchers Alternate Reality Games (ARGs) provide "a blend of online narrative and puzzle solving" (Connolly et. al., 2008). This "alternate reality" is staged by a puppetmaster who steers the players towards taking one or other direction as the story of the game unfolds. Collaboration among players and networking can be viewed as central to an ARG as they help the participants to become immersed in the game plot.

Not used initially in educational contexts, ARGs, however, have a huge educational potential – research has shown they are compatible with at least several theories of teaching and learning: Constructivism, Situated learning, Cognitive apprenticeship, and Problem-based learning are definitely suitable for use in foreign language education (Connolly et. al., 2008). ARGs make use of different technology channels to search for information and communicate, work and learn collaboratively, solve problems and decode images and messages in order to fulfill different game-specific tasks. ARGs tell a story whose development may be affected by participants' ideas or actions and often involves multiple media and game elements. They give players opportunities for multi-channel communication – through emails, instant messages, blogs, etc. One of the most prominent features of ARGs, which makes them extremely useful in foreign language education, is the need for collaboration in order to cope with the tasks and, finally, with the game itself (Moseley (2008)). Thus, learners are highly motivated from the start to the end of the game; they have a real need to seek communication with various game participants and solve different problems.

From an educational point of view and especially one that is focused on teaching and learning languages, this means that, without overtly concentrating on language form, through performing what they perceive as game-specific tasks, students are working towards achieving the aims of modern foreign language education. They can use their language competence in real, authentic situations and solve problems which they take as "real" in the course of the game. This, in turn, gives learners confidence in their acquired knowledge and skills in the foreign language or languages they are studying (as outlined in the Common European Framework of Reference (2001). What is more, the plot development and the requirements of the ARG provide learners with opportunities to use not only one foreign language but every foreign language ever learnt to come to a bilingual and even trilingual acquisition (Esch, 2003). This potential for stimulating plurilinguism (an individual's ability to use several languages) is clearly visible and results in valorising every student's experience of learning and intercultural "échanges" (Little, 2003).

2.2 The Tower of Babel ARG

It is because of these aspects of playing an ARG that an international team of experts in ICT and educational applications, in ARGs, in language learning and teacher training from five European countries have collaborated to develop an ARG, suitable for acquiring modern foreign languages and for stimulating curiosity towards communicating in these languages. It was clear from previous experience that such projects and initiatives favour greatly the opportunity to learn more than one modern foreign languages, as shown by Bailly and Ciekanski (2003) or to develop intercomprehension skills (Bonvino et. al., 2008).

The ARG in question, which its creators have called *The Tower of Babel* because of its plot which refers to notions and values well-established in European civilization, have used the Game as their starting point in developing an appropriate methodology for incorporating social Internet (Web 2.0) tools within language education as well as a teacher training course to help teachers learn and understand how they can use the Internet, in similar ways to how their students are already using technology on a daily basis. Through a 'virtual wormhole', the Game takes students into a future ruled by the greedy SOLO Systems and their owner – Mr Nimdor who, disguised as Don Mir, lures students into taking part in a Pan-European contest while his true aim is to take hold of their minds and of all people's minds by use of his evil invention the 'MI Casque'. However, there is hope – the future of the Earth can be saved if students collaborate with each other and with the Game characters – the French-speaking Lor, the Spanish-speaking Seb and the English-speaking Zak - to solve different 'quests' whose aim is to bring people from different parts of Europe together by learning more about each other's personalities, the history and traditions of the different countries and people's daily lives. All these educational aims are in line with the ideas of plurilingualism and intercultural communicative competence (CEFR, 2000; Byram, 1997). Some of the quests, which resemble Bernie Dodge's WebQuests (1999), require a correct answer – one of a choice of three; or an open-ended answer such as uploading a suitable photo, an audio file or a short text in a particular language. Thus students' ICT skills are also used and/or further developed. The majority of the Quests would send the players to search for the information they need before they submit what they see as the correct answer or seek cooperation with other students – speakers of different languages. Thus, for instance, Bulgarian learners of English would have to identify Spanish learners of English or Polish learners of Spanish in order to find about the mystery personality from one of the Quests (Olentzero, a Basque character similar to Santa Claus), for example.

3. The ARG teacher training course – assumptions

There is hardly any end-product for classroom use which requires no preparation on the part of those who are to implement it in practice. That is why, to make sure that this and perhaps similar ARGs developed in the future will be embraced by teachers and applied in language classrooms, it is necessary to prepare them for this task through a relevant training course. Thinking of the particular context the *Tower of Babel* ARG has been developed in - by an international team of experts for teachers and students across Europe - it is logical that such a course will be a web-based one.

Such a course has to aim to:

- convince teachers that using ARGs is effective, worth-while and manageable;
- equip them with the necessary ICT skills to function in Web 2.0;
- allow them to experience different game roles in order to help them be efficient Puppet Masters;
- raise teachers' awareness of plurilingualism and intercomprehension and help them develop their own intercomprehension skills;
- equip them with teaching techniques for helping students develop intercomprehension skills;
- prepare them to incorporate this particular ARG in their language teaching practice (Tsvetkova and Stoimenova, 2008).

The underlying language learning and language instruction theory has to be covertly incorporated in the course materials and must be oriented to classroom practice; besides, it must involve the teachers in trying these out for themselves. Teachers' experience in using ICT in their everyday lives and in their teaching practice have to be valued and respected, reflected on and further developed while 'experiencing' and carefully thinking over all ARG roles teachers and their students can assume throughout an ARG.

4. *The Tower of Babel* teacher training course – format, duration, content and activities

In keeping with the above outlined assumptions, the developers of the *Tower of Babel* ARG have made sure that the course is organised along all these basic principles and approaches in modern education. They have tried to provide opportunities for teachers to actually be exposed to and experience for themselves certain game features as well as relevant up-to-date language learning theory. That is why the course is an online, distance one. The teacher training activities are incorporated within the same platform where the actual Game takes place so that teachers can get used to the interface and the different links they can follow before the Game itself starts. Training is meant to take place over two days. However, access to the platform is not restricted after these two days are over and teachers can go back to any element of the training they find they find need more practice in. They are encouraged to use forums, messages, emails, etc. while communicating with each other as well as with their tutors. The aim is for all teachers who will participate in the ARG to have got acquainted with and to have practised using the channels of communication both they and their students will have at their disposal during the actual run of the Game.

The course is divided in two major parts – the *Getting to Know You* and the *Teachers Info* sections. The activities included in them focus on the *before*, *during* and *after* the Game phases, similar to the organisaton of a language learning activity (Harmer, 2007). Figure 1 provides a screenshot of the "before" stage of the teacher training course.

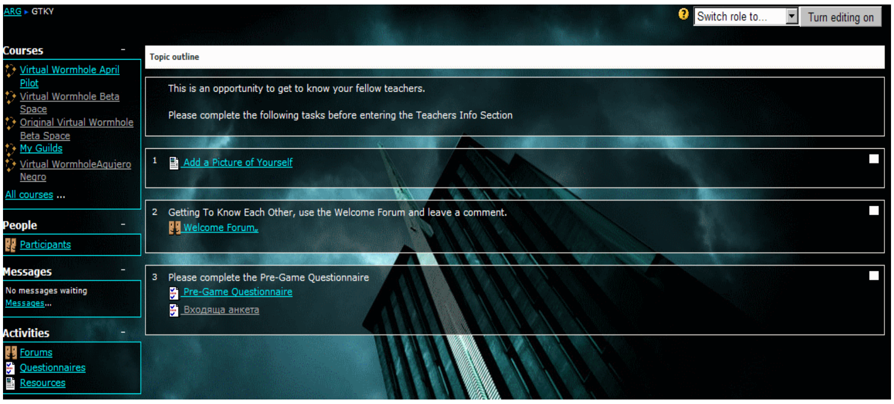

Figure 1: A screenshot from the *Getting to Know You* section of the Tower of Babel training course

As evident from the screenshot, the Getting to Know You section encourages teachers to introduce themselves to the other participants and, at the same time, to learn more about each other by uploading a picture of themselves, adding a new topic to a forum and contributing to a forum discussion. In addition, the Pre-Game questionnaire for Teachers has two main aims – to serve as a data-collection tool in the team's research into the ICT and Web 2.0 educational applications in language classrooms across Europe and to have the teachers reflect on their competences, experiences, expectations and needs related ICT and Web 2.0 educational applications.

As evident in Table 1, there are two types of tasks on the teacher training course – ARG-specific and FLT-specific tasks (where FLT is foreign language teaching). Most of them have objectives related to the development of language skills such as reading and summarising, reading and understanding main ideas and specific information, formulating one's opinion in writing, etc. These skills are the object of development in language classrooms. On the other hand, these training tasks pursued objectives related to the development of Web 2.0 skills – watching a YouTube video, contributing to a forum discussion, looking up information in an online resource, etc.

Table 1: Distribution of course tasks in the *during* phase of the course

		Task-related aspects	
		ICT task	*FLT-task*
Content-related aspects	*ARG–specific*	Online glossary of terms	Game space – a reading comprehension exercise
		Introduction to the plot and characters – a drag and drop exercise	Introduction to the Game quests – an integrated reading and writing task
	Modern FLT-specific content		Multilingualism versus plurilingualism – a reading task
			Introduction to intercomprehension – plurilingual reading task
		Les Visiteurs or Just visiting? – watching a You Tube video	
		Les Visiteurs or Just visiting? – a plurilingual interpretation exercise	

As revealed in the above table, the team aimed at striking a balance between material, related to recent Europe-wide developments in language-learning and material, related to the development of certain ICT skills. However, there is one more balance that is consciously sought after – that between the theoretical input on ARGs, social Internet, plurilingualism, intercomprehension, etc. and the practical hands-on process of trial and error while coming to grips with the 'theory'.

Figure 2 illustrates the variety of teacher training tasks and presents some of them in their linear sequence. Teachers are led from what is general and refers to ARGs, Web 2.0 tools and contemporary approaches to foreign language teaching and learning to concrete details concerning the *Tower of Babel* ARG, its plot, characters and the specific tools through which learning and communication between players take place during the game itself.

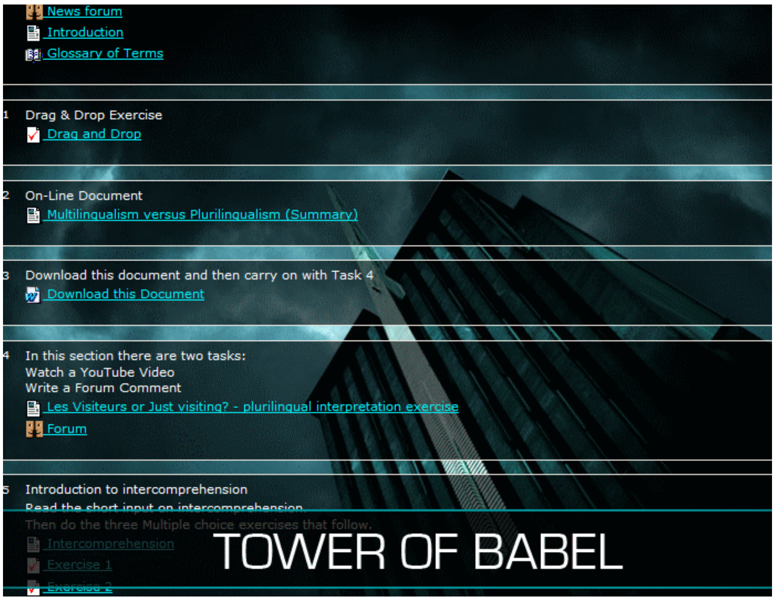

Figure 2: A screenshot of part of the *Teachers Info Section*

Figures 3 and 4 present how the participating teachers are made to experience in practice one of the novel theoretical aspects in modern FLT - intercomprehension. The example chosen is a reading comprehension task which is in Spanish based on a text in English on a popular topic (the Harry Potter series). Teachers of either of the languages will easily access one or other part of the task but will have to employ their knowledge of international vocabulary, of their skills to cope with unfamiliar texts, of their general knowledge in order to deal with the task successfully. Besides, the topic itself is close to the learners who are the target group for this game, so the same task can be used in class when teachers are preparing their students to play it.

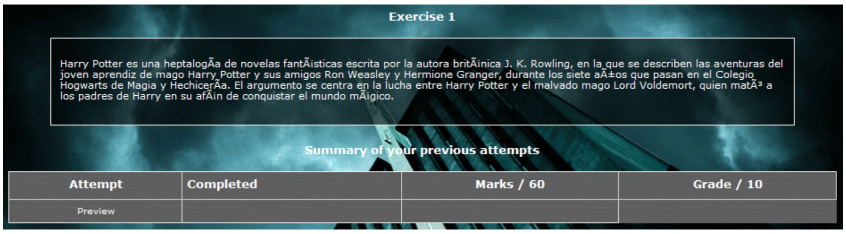

Figure 3: A screenshot of an exercise on intercomprehension – a text about Harry Potter

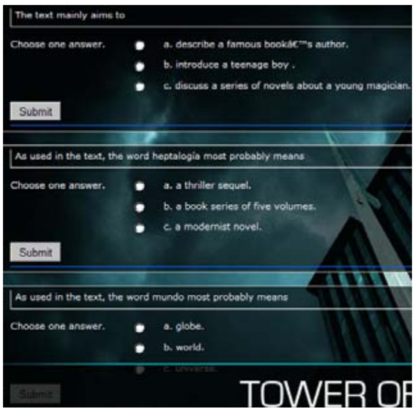

Figure 4: A screenshot of an exercise on intercomprehension – the reading comprehension tasks based on the text about Harry Potter

To summarise, there is a prominent element of reflection incorporated in the training experience – teachers are encouraged to think about the activities they have done from the perspective of both a teacher and a learner and then share their reflections with the whole group. On the other hand, some of the tasks that they are taken through may be applied in their own classrooms when introducing students to the Game and its educational potential. Finally, the Post-Game Questionnaire for teachers invites them to reflect on the experience after they have played the Game with their students.

5. Teachers' views before and after the game

The total number of countries taking part in the actual massive pilot run of the game in April 2009 was 13 (Bulgaria, Belgium, Greece, Hungary, Italy, Lithuania, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, UK). Out of the 95 piloting teachers, 42 completed the Pre-Game Questionnaire. It is especially worth noting that no teacher has given a negative reply to the question "Do you believe that computers can be useful in teaching in general?" They explain their agreement by choosing arguments such as:

> *"Using them adds variety to the lesson" (98%);*
>
> *"Using them motivates students to learn better" (86%);*
>
> *"Using them brings the teaching / learning process closer to the students" (83%).*

The teachers added other explanations to the question such as:

> *"it deals with multi level learners";*
>
> *"it improves the teacher - students relation because it is a way of sharing experiences";*
>
> *"provides many tools for teaching in a constructive way";*
>
> *"they resemble our students' way of life".*

Of all the teachers who took the questionnaire, 81% had previous experience in playing computer games against 19% who had no such experience. However, all of them express a firm belief that web-based games are useful in foreign language education because:

> *"using them adds fun to the language lesson" (86%);*
>
> *"using them motivates students to learn better" (90%);*
>
> *"using them adds variety to the language lesson" (79%);*
>
> *"using them brings the teaching/learning process closer to the students" (79%); "using them allows students to learn at their own pace" (45%).*

Only one teacher has chosen to add a comment that they expect that such a game used in foreign language teaching would pose a difficulty in requiring "too much extra preparation on part of a language teacher".

The Post-Game Questionnaire was taken by only 19 teachers. The question "Was the game better than you expected?" received mostly positive answers such as:

> *"It was a very valuable professional experience" (42%);*
>
> *"I felt intrigued to follow the game development" (37%);*
>
> *"I took part in the Tower of Babel ARG with great pleasure" (26%).*

However, there were some negative answers like "*It was too difficult to monitor students' actions throughout the game*" (5%), "*It was more difficult in terms of language proficiency than my students could cope with*" (5%). These answers, combined with the team's observation of the Game prove that the majority of teachers are open-minded, ready to take risks with what they are not completely comfortable. However, some of them had to cope with feeling frustrated or disappointed when the platform did not react as quickly as they had expected it to or in the case of a passing technical problem.

In this train of thoughts, it is easy to see that these teachers' participation in the pilot run of the game has turned a valuable experience in the course of both their regular work and their professional development since it has enhanced their confidence in using ICT to teach foreign languages. And, as some researchers have already pointed out, the 'language' of the Internet (Web 2.0) becomes a door to learning another language (Pradal, 2008). This is exactly the case with the participants in the pilot run of the *Tower of Babel* ARG.

On the whole, the piloting teachers were very appreciative of the possibilities for learning Web 2.0 (as revealed in this particular Game) has for stimulating language learning and multiple-language communication: the students "*enjoyed working collaboratively*" (58%); "*enjoyed solving the Quests*" (58%); "*found the fact that they were working with digital technology very appealing*" (53%); "*they had the possibility to be in touch with peers in real communicative situations*" (5%).

These answers show that the teacher training methodology has been approved by more than half of the teachers who took the questionnaires. They have seized the opportunity to face up to the challenge to use Web 2.0 together with their students and have managed to deal with obstacles and drawbacks in the course of actually playing the game with them.

6. Summary and conclusions

Educational environments across Europe are changing, including foreign language classrooms. However, it is not enough to equip schools with cutting-edge technology but spare time and effort to help teachers cope with what is perceived as a serious gap in the digital competences of the students' and teachers' generations. The study taken by the *ARG*uing team has established that there are several aspects of such preparation:

- the technological aspect – teachers must be not simply acquainted with Web 2.0 tools such as blogs, wikis and forums but must also be exposed to a genuine need to use them and trained to do so
- the theoretical aspect – teachers need to get acquainted with the relevant methodology underlying the use of educational web-based games in foreign language education, they need access to relevant information, opportunities for hands-on experiences as well as room for reflecting on respective classroom application
- the time aspect – it is important to bear in mind that just like an ordinary classroom, a group of trainee teachers would be a mixed-ability one. Participants would react at a different pace, they would need a different length of thinking and reflection time.

These aspects are equally important and need equal attention while planning the training activity. Proper training must take all three into account by providing a training course that is flexible in format so its constituent parts can be redone as many times as teachers need to become comfortable with both the practical and theoretical aspects of applying web-based games in their regular teaching. However, the first steps towards meeting the above-outlined considerations have already been taken and the positive results have encouraged the team to look for further development of relevant teacher training methodologies which will support non-ICT teachers in their struggle to keep abreast of the latest technological advancements and their educational applications.

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Welcome to my World: Induction to Games for Learning

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Abstract: Game-informed, or game-based, approaches to learning are often characterised as being fundamentally student-centred in nature. While this may be so with respect to the conduct of the game-informed activity, engaging learners in the first place with a playful activity in the context of what they see as the serious business of study may present some challenges. That is, if students are to benefit maximally from playful learning, there is a matter of induction and orientation that the teacher or mentor will have to consider. Although many academics may remain sceptical about the potential value of game-informed approaches in education, it is widely believed that students will be universally accepting of such approaches, but this may not always be the case. Some, particularly mature learners, may import negative perceptions of the domain of digital games gathered from the media. Some, while essentially being neutral with respect to the cultural role of digital games, perceive no association (or may even assume a negative relationship) between play and study. Neither does enthusiastic engagement with the digital game culture for recreational purposes prepare people to accept their role in education. This paper seeks to explore the nature of reticence, unpreparedness and contrapreparedness of learners and teachers to engage with digital games, game environments, and virtual worlds, in the context of their academic lives. It then describes ongoing work to develop practices of induction that teachers may utilise to help and support them. Two examples in particular will be used. First we draw upon experiences of introducing a range of different groups of learners and teachers to the virtual world *Second Life*. Secondly we consider insights gained in the process of developing an integrated "taster" experience of the game environment *World of Warcraft* designed for those wishing to explore the game's educational relevance. These experiences have emphasised the fact that there can be no "best practice" approach to induction, but rather that the induction experience must be sensitive to the needs, aspirations and previous experiences of the learners, as it seeks to scaffold their explorations.

Keywords: Games; virtual worlds; induction; World of Warcraft; Second Life

1. Introduction

Educators became interested in computer games as soon as the arrival of the personal computer in the mid to late 1970s allowed the games to escape from the confines of the video arcade. Malone's seminal work (1980) was directed towards understanding quite what it was about the design of games that contributed towards their powerful motivational effect on players; part of what Turkle (1984) referred to as the "holding power" of the software. Malone identified the three themes of fantasy, challenge and curiosity as being key to our understanding of the player's engagement with the game. More recently Gee (2003) has developed a more nuanced analysis, describing 36 "learning principles" which he sees manifest in successful video games. In his essentially Darwinian analysis, Gee argues that in order to survive in the market, games must be both sufficiently accessible to be appropriated successfully by the player, and yet sufficiently challenging that the player feels that they have been given a run for their money. The interest from education has clearly been to understand the engaging properties of games, and to deploy these in the service of formal teaching and learning practice. There can be identified broadly two strands in this work. One has been the explicit embedding of "content" to be learned within a game-like structure with the intention of engendering persistence with that material through the motivating elements of the game (Prensky 2001). The other, manifest in the title of Gee's book, has been to use the example of successful games to better understand what constitutes intellectual engagement, and from that understanding to orchestrate learning experiences (Caine and Caine, 1994) that will be more engaging. The former approach might be characterised as "game-based" learning, and the latter as "game-informed" learning (Begg et al 2007).

There is a further important dimension to the rhetoric that links games to education and that is the place of playfulness in the educational endeavour. Study, seen as a form of labour, is often placed in contradistinction to play (Kane 2005). The break given to children in the course of the school day is sometimes know as "play-time", thus indicating that what is going on during the rest of the time is certainly not play. There is thus a tension inevitably present for some when game-based, or game-informed, approaches are introduced in to formal education. This is often responded to by manipulation of the language we use; either the word "game" is avoided, with notions such as "simulation" being discussed instead, or the qualifier "serious" is introduced to emphasise that the games being discussed are not directed towards goals such as enjoyment or fun.

Conceived of thus, game-informed approaches to learning can be seen as special cases of experiential learning which can trace its roots to Dewey (1938), but can also be seen in more recent traditions (such as Alexander and Boud 2001 and Boud et al 1993). In this understanding, the game is a tool or catalyst, deployed by the teacher in order to bring the learner in to contact with a certain experience, or set of experiences, about which they are then encouraged to reflect. A game is seen as a particularly useful tool in this respect, as learners (perhaps particularly young learners) are expected to engage very readily with it, as games are a common and integral part of their everyday culture. Games are thus used to "sugar the pill" of learning, and to bring about "learning by stealth" (Falstein 2005). Considering the confused relationship between work and play described above however, there is reason to expect that learners will experience some psychological conflict when they encounter games being used in the service of their learning. People may be very familiar with the idea, or the detail, of games and play, but will have appropriated them in to their lives in such a way as to render them somewhat inaccessible to the agenda of learning. Domestication theory (for example, Silverstone and Hirsch 1992) argues that technologies are not merely neutral elements to be deployed in to our lives according to the designs and intentions of their creators, but are adapted by the actions of their users as they are integrated in to the lives of those users, and come to change them by their presence. The process is an active one, like the cognitive assimilation and accommodation described by Piaget (1952). This appropriation by the user is not simply a practical and technical matter, but also has important symbolic significance, and the symbolism may not be so easily linked with learning and study – even for those positively oriented to games and gaming. That is, educationally directed game-based activities may be less successful not because they lack the affordances for rich, experiential learning, or because the learners are intrinsically disinclined to engage with games *per se*, but rather because games carry the wrong associations for the participants. Even those who play games regularly, and participate in game culture, may nevertheless not be predisposed to regard games as an appropriate vehicle for learning.

This attitudinal position is not assisted by the concerns often expressed about the alleged negative social and cultural consequences of playing video games (as reported, for example, in studies such as Wastiau et al 2009).

The reluctance may arise on the part of the teachers (Baek, 2008) or students (Bragg, 2007). The reasons behind the use of a particular game, or technologically mediated role-play approach may not be made clear (Sanchez 2007), or perhaps the learners feel that their use is more gimmick than innovation, as the following extract from a recent study commissioned by the UK's Joint information Systems Committee (JISC) suggests.

> *"When discussing Second Life, students felt that games and virtual worlds as part of learning could easily become "tragic" – technology being used for its own sake, and used rather childishly. They would need to understand the educational benefits of virtual worlds or games, it is not enough that they are simply 'new'."*
>
> *(JISC Student Expectations Study 2007)*

Thus it should not be assumed that just because video and computer games are in widespread use for recreational purposes that the enthusiasm for the playing of such games will transfer in to the acceptance of their role in supporting learning and study. Orientation and induction are likely to be necessary, not just to introduce users to the technical dimensions of using a game, or game-like system, but also to set forth how their particular educational agenda is going to be addressed through the medium.

2. The MSc in e-learning programme, Second Life and World of Warcraft

The MSc in E-learning at the University of Edinburgh is an online collaborative distance-learning programme, with a current international cohort of 130 students. The MSc was one of the first UK higher education institutions to set up an in-world presence in *Second Life* (SL).

Second Life (http://www.secondlife.com) is the most prevalent of the immersive worlds with just over 15 million users currently registered (as of January 2009). Other technologies, such as *ActiveWorlds*, *There* and *Sony Home* offer similar immersive environments but *Second Life* was selected, as it is available for Mac as well as Windows, and thus can be used by a wider array of our potential participants. SL was launched by Linden Labs in early 2003 and is free to use. SL is the third most popular social networking site, after Facebook and YouTube, in the United Kingdom, in terms of minutes spent using it (Keegan 2008). Keegan highlights that in January 2008 SL residents spent over 28 million hours in world (*ibid*).

Figure 1: MSc in e-learning tutorial, Second Life

The in-world teaching space used by the MSc programme has evolved from a small-borrowed acre on Campus Island in 2005, to a 16 acre parkland on Vue (Virtual University of Edinburgh), which consists of 10 island spaces in total. The MSc space in SL is called Holyrood Park after the royal park (of the same name) in central Edinburgh, which contains Arthur's Seat, the highest point in Edinburgh and Salisbury Crags, both of which overlook the University of Edinburgh campus. Holyrood Park in SL consists of five distinct tutorials spaces; the grove, the garden, the beach, the cloud, and the cafe; in which groups of students meet with their tutors for scheduled synchronous text discussions.

Figure 2: Aerial view of Holyrood Park, Second Life

One of the authors, Fiona Littleton, has had extensive experience running orientation sessions in to *Second Life* and other virtual worlds. In her role as Educational Development Adviser for virtual worlds in the University of Edinburgh and with various other UK universities, she endeavours to highlight the affordances of SL, and other virtual worlds, for use in all levels of education. This is achieved by hosting SL lab sessions within which the participants (both teachers and students) create their avatars, log in to SL for the first time and complete a basic orientation. During this induction the participants learn the specific SL movements, edit their appearance, use the text communication, navigate through SL and make friends with other avatars. These labs normally last an hour and a half and have been hosted for almost four years. The attendees of these labs have varied in age, work experience, and technological experience. They have ranged from, for example, teaching colleagues attending the Postgraduate Certificate in University Teaching (PGCert) Learning and Teaching online course; postgraduate students attending the Masters in Management of Training and Development (MTD) who were assisting in a pilot SL project on virtual appraisal; medical undergraduate first year students who were encouraged to use SL for simulating the UK wide "cleanliness champions programme" as part of an assessed module, and learning technologists from the College of Science and Engineering who were interested to hear more about the potential of SL. Key observations from these labs will be discussed in detail later in the paper, but we must first introduce *World of Warcraft*.

World of Warcraft (WoW) is the largest, and currently most successful Massively Multiplayer Online Role Play Game (MMORPG) with a monthly subscriber base of 11.5 million, indicating that they currently occupy 62.2% of the MMOG market share (http://www.mmogchart.com/). In the game, players can choose from a selection of races (elf, human, troll, tauren etc.), and also classes such as warrior, priest or warlock, which offer a range of different talents and skill bases. The principal of the game is that characters explore the different regions of the fictional world, Azeroth, completing a sequence of quests that allow them to progress from level 1, through each subsequent higher level (currently capped at 80). Through the process of “levelling”, characters develop their class skill set and can use improved resources, such as armour and weapons. Although questing is only one of the ways through which the game is structured (Walker-Rettberg 2008), it is through this process in the initial stages of the game that the new user experience is scaffolded, so that “a player shouldn't be thrown in to the world and expected to figure out what to do” (Kaplan 2009). Part of the attraction and success of MMORPGS is the social nature of the game (Carr et al 2008). By creating ‘affinity groups’ (Gee 2003) known as Guilds, players can tackle the more challenging quests in the game in groups, drawing on the distributed knowledge of the guild members.

Figure 3: MSc in e-learning tutorial, World of Warcraft

Recently, the educational potential of WoW has also become a research focus amongst colleagues within the MSc programme, as it is considered to be well aligned with many of the learning principles proposed by Gee (2003), and further that its commercial success is due, in part, to the strength of the scaffolding during the early stages of the game, which guide, inform and engage the user. Certainly, from the perspective of the games developers at Blizzard, the makers of WoW, this stage is of paramount importance as its success results in conversions from free trial accounts to monthly subscribers. Gee challenges the notion that knowledge gained outside of the formal educational domain is “meaningless play”. He observes that the commercial success of the video games industry relies upon utilizing effective approaches through which players are intrinsically motivated, immersed and engaged in learning new and often quite challenging skills over a sustained period of time. Furthermore, if the optimal conditions such as these are met, they can create a state of ‘flow’ (Csikszentmihalyi 1997), whereby deep learning can occur. It was decided that as part of this research, an induction package or series of ‘taster’ sessions should be developed for educators, that not only introduces them to the environment, the game concepts and its educational potential, but that also offers an insight for educators who want to understand something of the culture that their students are participating in, or for those who have an interest in Gee’s analysis of games and learning, yet have no personal experience of games in which to locate an understanding of it.

It should be noted that this is not a matter of advocacy, and it is not the intention that these inductions should be a promotional exercise whereby participants are ‘converted’ or recruited to either SL or WoW. What they seek to achieve is the proffering of balanced, and informative perspectives in to the use of game-based learning in education, which in turn may prompt discussion and reflection of existing pedagogies and spaces for teaching and learning.

3. Induction issues

At this juncture the question should be posed as to why, when there are existent in-world introductory processes in place for both platforms, we decided to create our own inductions for these environments?

In relation to SL, until 2008 all new residents were constrained to complete the SL orientation session when they first logged in. There was no way to circumvent this in world orientation. Subsequent to 2008, a new resident can opt to log in to a specific area of SL that they choose, without having to work through the various stages of Orientation Island. In the authors' experience the Linden Labs' Orientation Island has been found to be a negative experience and creates difficulties for our students, some of which are examined later in this paper. When a new user logs in to SL for the first time using the conventional methods they land at a certain point on Orientation Island. All new users signing on to SL land at this point, and the number of users signing up to SL is judged to be in the thousands every week. Therefore, using the conventional methods of signing up, the first experience of many of our students in SL is of avatars, belonging to complete strangers, landing on the head of their avatar at Orientation Island landing point. And always their first instinct is to move out of the way and yet they have not yet learned *how* to move in this new and strange environment nor do they know *how* to ask for help in this new environment. For those who have chosen spontaneously to engage with the environment, these indignities may be no more than minor irritations, but for our attendees, entering the environment with an initially more sceptical perspective in the first place, the experience of such intense loss of control can be extremely disturbing. Therefore an early dilemma faced by any educator introducing SL to colleagues and students is whether or not to have the users progress through the stages in the Linden Lab created self-paced orientation or to bypass the Linden Labs orientation in preference for an induction process created specifically for an educational user.

Conversely, in WoW an induction session is necessary because the game introduction is *too* effective. By delivering information and guidance to the player 'just in time' (Gee, 2003), the player progresses at a manageable and comprehensible pace, developing their knowledge and understanding on a need-to-know basis, as observed by the developers, "players should never have to try and discover the core game experience" (Kaplan 2009). However, from this perspective it is very hard to gain sufficient overview of the game as a whole and how it might be used for education. Therefore it is necessary to construct a series of induction events, which maximize the possible game experiences on a trial account, thus giving the participants the overview that they would not normally gain at that stage in the game play.

4. Preconceptions and motivations

Primarily, the motivations to use SL for the participants at the aforementioned lab sessions are extrinsic and thus are very different to motivations of those users for whom Linden Labs have designed their orientation session. Those that choose to begin to use SL for leisure are intrinsically motivated, as they are interested in using the world itself (Malone 1980). In SL lab sessions the motivations and expectations amongst groups has differed considerably. For example, the groups of university academic colleagues are interested in university teaching, the students on a programme of Management of Training and Development are interested in appraisal and maybe even the possibility of role-play, the medical students are interested in passing their assessment, whereas the learning technologists are interested in technology and its implementation in education but not specifically SL. Whilst participants may have prior knowledge of virtual worlds or an interest in the educational potential of these environments, the lack of intrinsic motivation has ramifications for the role of the teacher, and it is something of which they need to be acutely aware. Difficulties in platform use, navigation and avatar control, for example, are less likely to be tolerated and the period of persistence in mastering these issues far shorter than in those who are intrinsically motivated by the world itself.

As a game, WoW has long courted controversy, particularly in the media. Anxieties about the game tend to focus on gaming addiction, online safety, violence and a concern that long hours of game play will be detrimental to the social wellbeing of users (as reported, for example, in studies such as Cellan-Jones 2008 and Govender 2009). It is therefore anticipated that the preconceptions of those educators participating in the induction will be widely spread, ranging from those with a strongly negative perception of videogames, through to those who feel that game-based learning is using technology for technology's sake in an attempt making learning look 'trendy', through to those who wish to explore the educational possibilities of new teaching spaces such as virtual worlds and gaming environments.

For all of these varied groups, the following induction outcomes are proposed as being necessary:

- Confidently control their avatar, communicate with other players and navigate around the starter zone.

- Have a rudimentary understanding of the User Interface (UI).
- Have an awareness of the affordances of the game.
- Have an informed view about the social concerns surrounding the game.
- Have an awareness of how the game design of WoW adheres to Gee's learning principles.
- Have some example ideas of how WoW can be used as part of a teaching curriculum.
- (In cases where WoW is not likely to be used as part of a curriculum) – To consider the learning principles in the game and how they might be applied to rethink classroom curriculum design (Jenkins and Squire 2004).

There should, however, be a caveat about making such suppositions and assumptions as to the preconceptions of participants, as one of the authors recently experienced whilst introducing two new users to SL. The first, Sue, is a retired University lecturer whose online competence extends as far as email and using a web browser. The second user, Matt is a graphic-designer who refers to himself as a 'serious gamer' often playing in excess of 25 hours a week in MMORPGS. Sue struggled with the user interface (UI) and progressed slowly through the orientation. Despite this, she was very positive about the experience and reflected that she could see considerable and exciting potential for educational progress in SL. In contrast, it had been expected that Matt would embrace the SL experience, but after having rapidly progressed through the orientation and having adapted rapidly to the UI and communication, his primary response was "I really do not see the point of any of this – why would people want to be here?"

5. Observations and Issues

This section of the paper reflects upon some of the observations that we have made, and issues that have arisen whilst we have been running induction sessions in both SL and WoW, and further issues pertaining to the role of the teacher in these environments.

There is a predisposition amongst users of computing technology to assume that if the system doesn't work, then they as the user must be at fault, resulting in a negative experience (Schriver 1997). This is a particular issue in SL and WoW, both of which have high technical specifications and can therefore be prone to poor system performance. Thus teachers need to anticipate and forewarn participants about potential technological barriers that may be encountered, promoting a sense of confidence and "self-efficacy" (Potosky 2002).

An overwhelming feeling for first time users or "newbies" in SL is that "everyone knows better", knows where to go, how to control and make their avatar look good and how to fly properly (Boostrom, 2008). One student reflecting on using SL for the first time in a tutorial summarized this viewpoint during a conversation on Skype with one of the authors:

> *"I feel more inhibited in SL…Here [on Skype] I feel I am me, there [in SL] I feel that I am bad at it because of needing to control the character / dexterity, and my PC is slow and I get a time lag. I still feel a bit out of the gang…it feels different because you can see the people and you feel that they know one another…but you don't really know who the avatar is, so it is like sitting on Santa's knee and it gets a bit scary."*
>
> *(Personal Communication February 2009)*

Consequently, the teacher's role during induction is to give the student time to move around in SL, exploring the new environment, testing boundaries, making friends, and becoming aware of the dangers and pitfalls, much in the way of real life student/teacher relationships. New users in our education inductions arrive on a remote University owned beach where the only avatars in close proximity are avatars representing those participants that are in the real lab session with them. Thus, there is an immediate familiarity and sense of shared experience that serves to reduce the feeling of anxiety and unfamiliarity.

The difficulties surrounding movement and communication often lead to frustration and embarrassment for the new user. Bayne (2008) quoted an MSc student who was reflecting in her Weblog on her induction session in to SL:

> *"Sometimes trees block my view and I can't see where I am. It almost felt like a blind person moving around in an unknown territory without the white stick. Since our meeting place was so close to the sea I was really worried of drowning because of this time delay.*

> *That is another experience that I could not even begin to describe. It truly gives you an out of the body experience with unshakable feelings of getting lost, drowning and even dying."*
>
> *(Bayne 2008 pp 199)*

Thus, far from creating the liberating experience of a psychosocial moratorium (Gee 2003), where users can take risks without "real world consequences", many new users are initially hindered by the experiences of using this fantasy environment as a learning space.

There is also a prevailing confusion about what to do and where to go in SL, which often exists even *after* the orientation session has been completed. It is one of the most common difficulties that arise in regards to educational use of SL. When this question arises, the teacher's role is to guide the student to the next step in their exploration, giving them a sufficient amount of information to keep them interested and engaged, but not to the extent that they become overwhelmed as Gee (2003) reflects in his 'on demand and just-in-time' principle. In the past we have used treasure hunts as a potential solution to these difficulties. After completing the induction sessions our students are given an opportunity to compete in various treasure hunts throughout SL. By following a given clue, the students decipher the chosen (educational) location within SL and then submit a screenshot of the location in question. The best snapshot (as voted by the whole student group) wins Linden Dollars, the in-world currency. These treasure hunts have been designed to give students the opportunity to become familiar with the environment, experience meeting other users, visit other spaces, and uncover the educational potential of an environment such as SL. This type of activity is also designed to assist the student in answering the inevitable question "what do I do here?"

In contrast to SL, WoW is a intensely structured and sign-posted gaming environment and therefore many of the difficulties that need to be anticipated in SL inductions have not presented the same set of issues during the pilot induction sessions where educator colleagues have been introduced to WoW.

We wanted to construct an induction experience that did not compel participants to incur any costs. We therefore worked to create a coherent experience that could be completed within the period of the company's 10-day free trial offer. This inevitably raised several issues, firstly that there are functionality limitations on a trial account of which participants needed to be aware, and secondly that there was a temporal constraint of completing the induction sessions within a 10 day period. Finally, this also raised issues about global inclusivity as WoW is run by hundreds of servers worldwide, divided in to regions e.g. EU, Asia, and USA. Participants needed to be on the same server and to have agreed to create a character of the same race and faction as the others in the group so that they can start in the same location in the game.

There needs to be adequate planning and time in advance of the induction sessions to ensure that all participants have downloaded the correct region-specific trial software, which is a considerable file size, that they have successfully created a trial account and that they have been able to create a character on the correct server. The issue of timing also arose during the sessions themselves as it became clear that it had been underestimated as to how much time the participants would require to observe, absorb and assimilate the sheer graphic and audio richness of the environment.

We also observed a considerable disparity in the group's abilities. Some had previous gaming experience and therefore to a certain extent were able to move, navigate and interpret the user interface (UI) with relative ease, whereas others needed assistance with the most basic aspects of the environment and the control of their avatars. This posed the potential issue of demotivation in participants either because the level of the induction was pitched at too difficult a level, or an issue of demotivation due to the induction pace not being fast enough.

Unlike the University Island in SL where the environment can be controlled in terms of access, WoW is an open real-time environment over which there is no control. This results in a level of unpredictability in terms of the behaviours of other players, and therefore a risk of "griefing" or "ganking", for example, where high-level players challenge new players to duels, or harass them to join new guilds. If participants are unprepared for these possible eventualities and how to react to them, then there is a risk that this will reinforce negative views of the game.

In order to scaffold the initial experiences of a new player, the first few activities have been tightly structured and limited by the game developers to ensure that players have gained all the skills and understanding that they need to progress. However this leaves players little choice of activities, and, as was observed in the pilot inductions, there is therefore a risk that should some of the participants choose to access and try the game outside of the induction sessions, they are then no longer at the same level as the other participants, having completed the quests and activities, and subsequently, the group becomes mismatched.

6. Summary

As we have demonstrated in this paper, using technologies such as SL or WoW for game-based learning raises issues for educators, as these technologies are not being used as they were intended by the developers, nor are they necessarily being used in this context by the developers' intended target audience. Whilst they provide scaffolded new user experiences, inevitably those inductions do not address the needs, motivations, attitudes and questions that may arise from users in an educational context. Educators need to anticipate and customise induction experiences that are sympathetic to and take in to consideration the needs of the users.

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A Design Proposal of a Game-Based Professional Training System for Highly Dangerous Professions

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Abstract: Recently, modern society frequently faces local wars, terrorism, earthquakes, fire accidents, epidemics and coal mining accidents. Members of highly dangerous professions must obtain rigorous training so that they could bear the great historical mission. Generally speaking, these professions include armed forces, special police force, fire department, astronauts and mine disaster rescue troop. The game-based professional training systems for highly dangerous professions have their own distinct requirements. The aim of game-based learning systems is not only the study of declarative knowledge, but also entraining procedural knowledge through repeated practice until it becomes an automatic skill. The result of highly dangerous professional training is extremely important, since if a trainee dose not master the basic knowledge and skill, they could be in grave danger; the trainee's mental qualities should be continuously prompted by the training system so that they could be act intuitively under the most execrable circumstance. Based on requirements analysis and taking the case of mining rescue into account, we divide the whole training system into three parts: machine learning subsystem, brain information subsystem and credit-assignment subsystem. The machine learning subsystem (as know as serious game subsystem), contains the audio-visual coherency analysis, semantic annotation of a scene based on association memory, cooperating management of audio-visual cross-modal signals, personalization rendering of a scene. The brain information subsystem includes functions for receiving, storing and analyzing trainee's trial data based on visual and auditory signals from EEG, sEMG and psychological tests. The credit-assignment subsystem involves trainee's profiles and effect evaluation which are sent from brain information subsystem to machine learning subsystem, while the plan of knowledge learning, the result of skills training and consequence of the desensitization trial are sent as the feedback to brain information subsystem. Therefore , the whole framework works as a reinforcement learning system. The kernel of this system is the cooperating learning schema of audio-visual cross-modal signals. Furthermore, in this system the main visual signals contain scene textures, 3D character animation, 3D scene animation, while the main auditory signals contain the realistic sound, the on-the-spot orders, the on-the-spot yells and background music. In the light of cognitive principles, the following factors should be considered when a game-based leaning system is designed: （1）The working memory including phonological loop and visuo-spatial sketchpad act as two slave systems, play the role of dual sensory channels so that semantic coherency of the visual and the auditory data could be combined with the prior knowledge to be formed as long-term memory; （2 ） A goal of cooperative learning for audio-visual cross-modal signals is to create an approach which can process verbal information(like the realistic sound and the on-the-spot orders) and non-verbal information(such as 3D character animation as well as 3D scene animation) from the two separate subsystems; （3） Schema acquisition (based on Theory of Cognitive Load -TCL) should be a primary means of learning, and the automation of cognitive process (including declarative knowledge procedural knowledge) will be used to reduce working memory load.

Keywords: Game-based professional training, highly dangerous professions, audio-visual coherency, working memory, theory of cognitive load

1. Introduction

Modern society frequently faces various conjunctures including local wars, terrorism, strong motion earthquakes, fires, epidemics (SARS, Disease by A/H1N1 virus) , extreme climate, and men-made disasters. Sometimes these accidents and crisis can not be avoided, therefore, professional emergency teams for each field are indispensable to fight against these emergent events, and reduce overall losses. Members of highly dangerous professions must obtain rigorous training to support their missions. Generally speaking, these professions include armed forces, special police forces, fire departments, astronauts, mine disaster rescue troops and so on.

Game-based professional training systems for highly dangerous professions have their own distinct requirements. The aim of game-based learning system is to focus not only on the studying of declarative knowledge but also on the training of procedural knowledge through iterative practice to become an automatic skill (details in section 4). Declarative knowledge is "factual knowledge" that can be reported or described. The basic unit of this knowledge is a chunk, which can also be grouped hierarchically (chunks within increasingly complicated chunks) (Stephen 2005). The chunk is organized using a schema into packets of knowledge, which can be represented as a semantic network, or a propositional network. Procedural knowledge should be acquired through three stages: cognitive stage (understanding declarative knowledge), associative stage (combining declarative knowledge with procedural knowledge) and autonomous stage (mastering procedural knowledge); Highly dangerous professional training extremely important since if a trainee dose not master the basic knowledge and skill, they could be in grave danger. Without this knowledge the applicant may end up with a lower salary job, not be able to participate in more dangerous scenarios and could result in suffering from serious physical or psychological trauma.

The trainee's mental qualities should be continuously prompted by the training system, so that they are able to act intuitively under the execrable circumstances and accomplish their historical missions. Such training acts as a form of psychotherapy to re-enforce these principles and systematically desensitize the trainee from negative automatic responses that could put them in danger.

The core topics of this proposal for game-base professional training system focus on the following three aspects: the construction and retrieval of game scene library, the formation of training knowledge and skills, as well as the application of cognitive theory. Accordingly, the remainder of this article is divided into the following: section 2: the related work, section 3: the framework of game-based learning system, section 4: declarative knowledge vs. procedural knowledge, section 5: the application of cognitive theory, section 6: future work.

2. The related work

In 1996 John P Eakins wrote an article "Automatic Image Content Retrieval—are we getting anywhere?" summarizing the progress of content – based image retrieval (CBIR), and enumerating some of experimental and commercial-strength systems such as QBIC and Virage. His most important contribution puts forward a retrieval model for three levels of content.

> *"level 1, the lowest level, comprises retrieval by what Gudivada & Raghavan describe as primitive features such as color, texture and shape, or the spatial location of image element";*
>
> *"Level 2 comprises retrieval by derived attributes (Gudivada & Raghavan describe these as logical features), involving some degree of logical inference about the identity of objects depicted in the image. It is also sometimes referred to as retrieval by semantic content";*
>
> *"Level 3 comprises retrieval by abstract attributes, involving a high degree of abstract -and possibly subjective- reasoning about the meaning and purpose of the objects or scenes depicted." It can retrieve a "picture with emotional or symbolic significance" (J. P Eakins 1996).*

Passing through two decades with the research, studies on semantic attributes have resulted in enabling the machine to understand the meaning of an image, which is the aim of AI (Artificial Intelligence). The father of Machine Learning, Tom M. Mitchell has given an AAAI Presidential Address called "AI and impending revolution in brain sciences" at 2002. He predicted that "The synergy between AI and Brain sciences will yield profound advances in our understanding of intelligence over the coming decade, fundamentally changing the nature of our field" (Mitchell 2002). In this address, he mentioned the AI and Brain sciences impact on each other, which has resulted in the introduction of Brain Image fMRI, PET, ERP and some others. After six years the research results in this field have been published by Tom M. Mitchell in the Journal of Science in "Predicting Human Brain Activity Associated with the Meanings of Nouns". This illustrates that the combining of AI and Brain Sciences is a promising approach.

Stephan D. Sorden published in his paper "A Cognitive Approach to Instructional Design for Multimedia Learning"(Stephen 2005), his opinion of "Baddeley's model of working memory (Baddeley 1986) and Paivio's dual coding theory(Paivio,1986) suggest that humans process information through dual channels, one auditory and the other visual. This combined with Sweller's Theory of Cognitive Load (Sweller 1998) and Anderson's ACT-R cognitive architecture (Anderson 1983) provides a convincing argument for how humans learn, which then leads to the question of how multimedia instruction can be designed to maximize learning."(Stephen 2005) We attempt to make use of these principles to design our game-based training system.

3. The Framework of the proposal

According to requirement analysis and along with the case of mining rescue, we divide the whole system into three subsystems: machine learning, brain information and credit-assignment as illustrated in Figure 1.
The machine learning subsystem (as know as serious game subsystem) contains the audio-visual coherency analysis, semantic annotation of scenes based on associative memory, cooperative management of audio-visual cross-modal signals, and personalization scene rendering. Audio-visual coherency refers to the audio and visual materials in the game which are mutually stimulatory but not inhibitory (as know as registration for audio-visual signals). Usually, the aim of registration is to prevent a geometric deformation and to make alignment of the medical heterogeneous image in the image process, to resolve the aligning problem for virtual object and actual object in enhancement reality, and to resolve the synchronization or fusion problem in multi-modal information system respectively. For example, when the scene of gas explosion is presented, the visual stimulus of the raging fire accompanied with the auditory stimulus of the sharp snapping sound will give players an unforgettable impression. This is a kind of synchronization or registration problem for audio-visual signals.

In the human brain, information is storied and accessed as associative memory. "Associative memory refers to a memory organization in which the memory is accessed by its content (as opposed to an explicit address). Thus, reference clues are "associated" with actual memory contents until a desirable match (or set of matches) is found". (The URL is: http://ai.eecs.umich.edu/cogarch0/common/prop/assoc.html). Thus, scenes for five kinds of mine accidents could be storied in a scene library, and after emotional semantic annotation these scenes could be retrieved by the trainees mind quickly. Within the library, mine accident scenes could be divided up and categorized by severity. When a player (or trainee) enters the game, a group of corresponding scenes (referred to as a personalization scene rendering) will be presented to them by the system according to their personal profile and tolerance.

The brain information subsystem includes three parts: psychological test, ERP (Event-Related Potential) and sEMG (surface ElectroMyoGraphy), This subsystem mainly gathers the data regarding public (such as demographic information) and private (like the preference) information, and produces each trainee's profile. At the same time, subsystem collects the trainee's psychological and physiological responses as the feedback signals, and sends them to the credit assignment subsystem. The psychological test refers to an approach to test the psychological differences of individuals with the use of a simple and convenient psychometric questionnaire, which can measure and evaluate people's behavior. In a general way, psychological response and physiological responses are closely related, but physiological responses are better representations of a trainee's personal state. Comparatively, in order to get a personality model, collecting the trainee's physiological response is more effective than collecting psychological response. Therefore, data relating to psychological as well as physiological approaches mutually complement each other, and it is up to the brain information subsystem to accomplish the tasks of perceiving, storing and analyzing audio-visual cognitive information together.

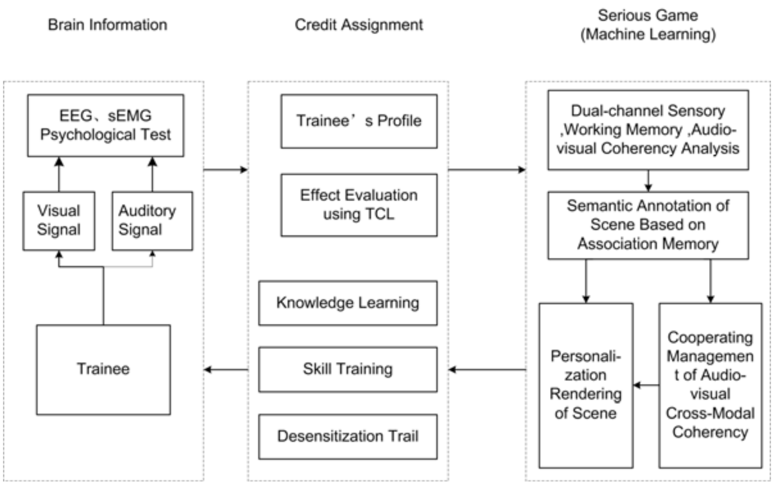

Figure 1: The framework of game-based professional training system

The function of the credit assignment subsystem is to produce trainee's profile, to evaluate the performance of the whole system, and to form a reinforcement system. A reinforcement learning system consists of environment, learning system, action signal (from learning system to environment), and signals of reward as well as state (from environment to learning system). In our proposal, the environment contains the results of psychological and physiological tests for actual trainees' audio-visual cognitive information; The learning system is the machine learning subsystem; The action signals provide guidance to the knowledge learning, to the skill training and to the desensitization trail; The signals of reward and state are not only the status of system running but also the reward to learning system. Finally these four parts make up a reinforcement system which connects the learning system and environment closely by using feedback signals.

It is necessary to stress that the core of the proposal is a cooperative learning schema, which should handle the audio-visual cross-modal coherency, the declarative knowledge, and procedural knowledge as well as the transferring process from working memory to long-term memory.

4. Declarative knowledge vs. procedural knowledge

As we mentioned in section 1, declarative and procedural knowledge are two different kinds of knowledge. From the point of view of cognitive psychology, sensory information stays at short-term memory (or working memory) for only several seconds, but declarative knowledge and procedural knowledge could be stored in permanent memory (or long-term memory). John B. Best (Best 1998) described permanent memory as the declarative knowledge which consists of concepts, memories, and linguistic knowledge. The memories include general knowledge about the world, episodic memory as well as the semantic memory. At the same time, the procedural knowledge is composed of the skill, inference and problem solving, along with pattern recognition. Well then, how can the declarative knowledge and procedural knowledge be produced in good time through necessary training steps of the game-based multimedia training system?

4.1 Declarative knowledge

The main components of declarative knowledge can be derived as following:

General knowledge

General knowledge about the world includes the background knowledge, the domain knowledge and common sense. We have gathered lots of materials about mining rescue including "A hundred competing questions of the business theoretic knowledge for coal mining rescue technique in China". This material has been aggregated in a PowerPoint document, with some data stored in parts of files employing flash technique.

For instance, the material contains a question and its answer about the concentration of harmful gas (see Figure.2).

18. Ask: What kind of demand should the air components of mining be accord with?
Answer: The air components of mining should be accord with flowing demands:

(1) In the flow of intake air of the mining face, according to volume computing the oxygen is not lower than 20%, and carbon dioxide is not higher than0.5%;
(2) The most maximum allowable concentration of harmful gas should be accord with following table

Name	Carbon monoxide	Silicon dioxide	Sulfur dioxide	sulfureted hydrogen	ammonia
Chemical Formulas	CO	NO_2	SO_2	H_2S	NH_3
Maximum allowable concentration	0.0024	0.00025	0.0005	0.00066	0.004

The allowable concentration of gas, carbon dioxide and hydric should be executed following the "Safety regulations in coal mine".

Figure 2: A question and its answer about the concentration of harmful gas

The background knowledge is a kind of declared knowledge, and the question and answer is a good training and examination method.

Episodic memory

There are five serious types of coal mining accidents, namely from roof pressure, methane gas, smut, flood and conflagration. Any of these types of accidents could result in a disaster and in the heavy casualties, so even for to training rescue members (namely the players in a game, or the trainees in a cognitive psychological system). After an in-depth analysis of the typical cases of the five grave coal mining accidents and “a hundred competing questions of the business theoretic knowledge for coal mining rescue technique”, a portion of the accident scenes for explosion of methane gas and conflagration has been accomplished. These scenes could give players strong stimuli and urge them to better remember relative rescue knowledge. These scenes involve visual signals and auditory signals, such as scene textures, 3D scene animation, 3D character animation, realistic sound, the on-the-spot orders, the on-the-spot yells, groans, and background music, all of these scenes are connected closely with rescue episode, and are consistent with script and continuities script of the game.

Semantic Memory

The generalization viewpoint of behavioral psychology deems that a conditional response formed by a conditional stimulus can be arisen by a similar stimulus. Thus after the cross-modal memory is formed, as long as a single modal stimulus is appearing, the whole memory could be recalled again. The idiom “a man once bitten by a snake will for ten years shy at a rope” is a representative example about generalization and convergence; the strong sense of pain (snake bites) has grown on the memory of coherent visual sense (snake), and has formed long-term memory, or reflective memory; while the visual stimulus (the rope) similar to the visual memory (snake) appears, it could recall memory of pain quickly. How can the different modal information (like the audio and video information) mutually register each other to enhance and prompt? And how could be a profound memory be formed at the trainee’s brain by convergent multi-modal information?

The registration algorithms of audio-visual materials comprise three steps: the synchronization of audio-visual materials, the alternation of audio-visual materials and the interval adjustment for reappearance of scenes.

4.2 Procedural knowledge

“Declarative knowledge can be acquired quickly from direct encoding of the environment, while procedural knowledge takes longer and must be compiled from declarative knowledge through practice. After a certain amount of practice, the path or production becomes stable and procedural learning has occurred”. (Stephen 2005) How “a certain amount of practice” can be produced? We apply the TOTE principle to handle the procedural knowledge. ”TOTE standing for ‘Test-Operate-Test-Exit’, and is an iterative problem solving strategy based on feedback loops. It was described by George A. Miller et al in their 1960 book, “Plans and the Structure of Behavior” which outlined their conception of the cognitive psychology.” (http://www.viswiki.com/en/T.O.T.E) The working principle of every unit of TOTE is shown in Figure 3, Coy Foy (Coy Foy 2006) summarized the steps of TOTE like this:

a. Test-Compare present state with ideal state

b. Operate-Act on environment to realize ideal state

c. Test-Compare present state with ideal state. If congruous go to d, the else go to b

d. Test-Present state in congruity with ideal state

(Coy Foy 2006)

We will give an example to explain the working procedure of TOTE in a coal mining rescue.

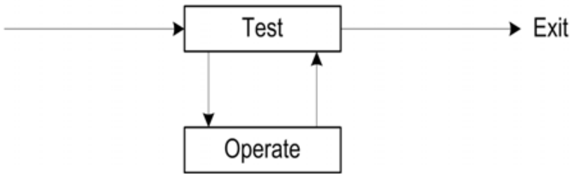

Figure 3: TOTE (test-operate-test-exit) concept

The resuscitator is one of the essential lifesaving appliances currently deployed, and the use of it is an important skill training subject in coal mining rescue. The resuscitator can forcibly give patients an oxygen therapy, and can resuscitate the heart function, which is not yet quite cardio necrosis. The resuscitator consists of gas tank, external air-blast connection pipe, regulator, respirator, automatic lung, oxygen inhalant valve, gas storage bag, tongue-spatula, sputum suctioning, and admission valve enclosure. The use of it contains nine steps:

- 1.Putting the wounded person on his back on rigidity ground, blocking up his shoulder
- 2.Connecting the respirator with the automatic lung, then joining with canal of admission valve
- 3.Opening the switch of the gas tank
- 4.Covering the mouth and nose of wounded person (strictness)
- 5.Adjusting the regulator so that automatic lung beats at 12—16 times/minute
- 6.Adjusting regulator so that the heartbeat of automatic lung debases when its heartbeat is irregular
- 7.When the working frequency of automatic lung reduces to 8 times/minute the heartbeat is still regular, it proves that wounded person could breathe by himself
- 8.Alternating with oxygen inhalant valve quickly
- 9.The wounded maybe sent to hospital for further therapy

With the nine steps, 9 units of TOTE will be designed to train for the use of the resuscitator. At the same time the TOTE units are permitted to embed TOTE subunits. For example, step2 could be divided into four sub-steps:

- Putting resuscitator to the one side of head of wounded person's head
- Opening the resuscitator and bringing the needed tools
- Connecting air path of the sputum suctioning, automatic lung and oxygen inhalant valve of the resuscitator, checking action status
- Join with external oxygen tank

The four sub-steps will be designed as 4 new TOTE subunits, all of these TOTE units and TOTE subunits are following to the main principle of TOTE, and forming an iteration of skill practice.

5. The application of cognitive theory for multimedia learning

The game-based professional training system is a typical multimedia application system; it should follow the essential principle of cognitive theory so as to maximize learning. There are three main problems that should be considered: the action of working memory, the application of dual channels and the strategy selecting to avoid overload working memory.

5.1 The action of working memory

"Working memory is a structure for temporarily storing information before it passed to long-term memory" (Stephen 2005) and it consists of a central executive system, two slave systems (phonological loop and visuo-spatial sketchpad), it permits to temporarily maintain task-relevant information during performance of complex cognitive tasks. In designing the procedure of the game system, the amount of information stimuli, from auditory or visual materials, should not exceed the capacity of working memory, and this capacity is a number of chunks (it equals to seven plus or minus 2) according to cognitive psychology principle.

5.2 The application of dual channel

Though the time that information stored in working memory could be very short, the two slave systems belong to two different sensory channels (phonological loop pertains to auditory channel, while visuo-spatial sketchpad pertains to visual channel). We can adequately take advantage of the dual channels to shares the cognitive load, as well as to check and select those audio and visual materials which possess audio-visual coherency as personality scenes to present to players at a moment.

5.3 The strategy selecting to avoid overload working memory

These strategies that reduce cognitive load should be considered from two sides: the working memory and long-term memory.

In working memory, according to Sweller et al. (Sweller 1988), “there are three types of cognitive load: intrinsic, extraneous, and germane.” “Intrinsic cognitive load cannot be manipulated, but extraneous and germane cognitive load can.” (Stephen 2005) “Mousavi, Low, et al. argued that “cognitive load is reduced by the use of dual-mode (visual-auditory) instructional techniques and that the limited capacity of working memory is increased if information is processed using both the visual and auditory channels”, Baddeley’s theory asserts that “effective working memory capacity can be increased by using auditory and visual working memory together rather than using one or the other alone” (Baddeley 2000). Therefore, the first strategy is to handle the dual-mode information.

The second strategy is to eliminate redundant text so that to reduce extraneous cognitive load, “when information that can be fully understood in isolation, as either visual or auditory information, is presented to both channels as essentially the same information. Integrating redundant information in both working memories can actually increase cognitive load” (Stephen 2005)

In the long-term memory, the main problem considered is how to organize the content knowledge into schemas. Schemas not only contain the declarative knowledge but also contain the procedural knowledge, not only are based on the controlled process but also on the automation process, “Automation frees capacity in working memory for other functions” (Stephen 2005).

6. The future work

In this paper, the distinct requirement and main functional framework for game-based professional training system of highly dangerous professions are described, the characteristics, mutual relations and the establishment of declarative knowledge and procedural knowledge are analyzed and instantiated. Finally the assumption of applying cognitive load theory is given to guide the forward research work. The future work should focus on the system evaluation and the concrete algorithm of designing and implementation for game scenes.

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Research in Progress Papers

Experiences of Promoting Engagement in Game-Based Learning

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Abstract: There is a growing belief that techniques from digital games can improve student engagement in learning, resulting in improved success rates and a more rewarding experience for everyone involved. In practice, of course, success is never guaranteed because of the difficulty of addressing the many factors affecting the outcome. The main purpose of this paper is to clarify those factors as a basis for developing guidelines to help improve the chances of success. The ideas presented are based on the positive experience of using an engagement game in the teaching of first year programming and a more problematic experience of extending the approach to encourage students to seek one-year work placements. The paper starts with a summary of the first year engagement game, outlining its approach, results, and the lessons learned from the exercise. This is followed by the description of a substantially different game for second-year students, who undertake a full-year work placement in their third year of a four-year Computing degree. Again lessons learned from the experience are reported, with suggestions for further experimental work outlined.

Keywords: Games-based learning, student engagement, success factors

1. Introduction

Engagement is central to the success of student learning. According to Skinner and Belmont (1993) students who are engaged "...*show sustained behavioural involvement in learning activities accompanied by a positive emotional tone. They select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration in the implementation of learning tasks; they show generally positive emotions during ongoing action, including enthusiasm, optimism, curiosity, and interest*". Such engagement is commonplace among those playing digital games so it is not surprising that there is a growing interest in how games techniques might be used within education (Gee. J. 2007; Prensky 2006; Cordova & Lepper 1996; Jonassen et al. 1995; Ricci et al. 1996; Squire & Jenkins 2004). One approach is to create what is effectively an educational game. That is, the student is presented with a game which when played has an educational benefit. This means tailoring educational material to be used within whatever game framework has been selected (McFarlane et al 2002). Another approach, however, is to wrap a game framework around existing material. This has the significant advantage of being usable for any content, in any context. In effect, it means making a game of the teaching process rather than the teaching materials.

Earlier work (Charles *et al*. 2008) started with the vision of making education as enjoyable as playing electronic games. In this work, 'engagement' was identified as the central issue, leading to a study of the elements relevant to engagement that were commonly found in computer games. Six main factors emerged, which in summary are:

- *Fun*: *engagement is easier if the experience is enjoyable*. Koster (2004) argues that "*fun is just another word for learning*", implying that effective learning is inherently enjoyable. Certainly 'fun' improves engagement but surprisingly isn't given as much attention in the educational literature as might be expected, perhaps because it can be difficult to align with the basic outcome-driven demands of a typical learning process.
- *Social*: *engagement is reinforced by the social support of others going through the same experience.* When players *interact* within a game environment there is social interaction though competition or when the players share their experiences (Salen & Zimmerman 2003). Educationally, it is recognised that such social interaction is important in any learning process and so ideally should be facilitated explicitly.
- *Identity*: *engagement can be encouraged if everyone has a visible role in the learning environment.* In games, a player usually has a visual representation of themselves within a game system. Gee (2003) suggests that this identity deepens personal investment in the game and encourages players to interact and engage to a greater extent through the projected character.

Usually, there is no equivalent explicit mechanism in education, but identities do develop, particularly if group work is involved (e.g., group identity and team leader).

- *Challenge: engagement can build on human competitive drive, enhanced by social pressure.* In practice, 'challenge' means rising to meet demanding but achievable goals. Challenge (or conflict) is an intrinsic element in game systems but isn't always emphasised in education, perhaps because it can be seen as demotivating for students with low expectations.
- *Structure*: *engagement is more likely if objectives and constraints are clear and acceptable.* The rule-bound, goal-oriented structure of games contributes to an engaging experience (Bjork & Holopainen 2005). So, in education, objectives, required levels of achievement, and rules of acceptable behaviour need to be explicit and appropriate.
- *Feedback*: *engagement is reinforced by making achievement explicit.* Feedback in games is important in providing players with timely and relevant information on their progress towards goals and identifying their level of achievement so far. Progress within the game will often be summarised in a map, and achievement indicated though ongoing game statistics, measuring attributes such as player skill, strength and health. Equivalent information is provided in education but tends to be less detailed at university level.

These six game engagement elements can be used in both the design of learning materials and in the way that the learning process itself is organised. This paper focuses on the latter case, and in particular, on isolating the factors that affect success; for although games techniques seem to have the potential to improve engagement, the goal of achieving significant improvement in learning can be as elusive as success in any endeavour. The basic idea was to make students compete for points awarded for desirable behaviour in a way that had a positive educational benefit, without any negative side-effects. It was unclear initially, however, where points should be awarded and what complexity or simplicity was needed to ensure engagement. The work therefore relied on action research (Lewin 1946) in an evolutionary prototyping framework (Crinnion 1991). The strategy was to first do whatever was necessary to create a game that the students would play with reasonable enthusiasm, analyse the educational impact of the game and then tune it as necessary. The belief was that once a basic framework had been identified more rigorous studies could be made of individual engagement factors to better understand their contribution, interdependence, and reliance on context. Such studies would only be worthwhile, however, if it could be demonstrated that significant improvement could be achieved with this approach.

The paper draws lessons from the experience of the authors in using digital games techniques in the teaching of programming to first year undergraduates and in encouraging second year students to obtain a one-year work placement. Section 2 of the paper explains how the first year engagement game was designed and implemented, followed by a discussion of the results achieved. Section 3 then describes how a second year engagement game, to encourage placement activity, was developed for the students advancing from the first year game. Again lessons learned from the experience are discussed and plans for further development of the approach outlined in the conclusions.

2. First year engagement game

The experimental introduction of digital game ideas into teaching started in the first year of an undergraduate course in Computing at the University of Ulster in 2007. The experiment covered two first year Java programming modules, delivered in successive semesters: *Software Development* 1 (COM158C1) and *Software Development* 2 (COM164C2). The modules ran from September to December 2007 and January to May 2008, respectively. These were presented in the previous academic year, 2006-07, by the same person (third named author on this paper), and with the same technical content, so the overall consequences of adding game ideas to improve engagement were expected to be relatively straightforward to identify. This section describes the design of the first year games and the results of running them.

2.1 Game design

Building on the six game engagement elements presented in the introduction, the first year game was designed as follows:

- *Fun*: the authors recognised at the outset that it would be unrealistic to attempt to develop an educational game that was guaranteed to be 'fun'. So, initially, the objective was simply to have reasonable student participation in the game, with the hope that some would also find it enjoyable. Participation was encouraged by making it clear that this was an experiment, which was necessary anyway for ethical approval of the work. The students were also required formally to agree to be involved in the experiment, which further increased their commitment.

- *Social*: to encourage social interaction, the experiment in the first semester was a group competition. The first module already had a strong tradition of groupwork as a way of also helping to induct students into the university. This framework could be built on directly. Groups were selected carefully and typically took account of the home location of the students involved. Experience also suggested that peer pressure in groups would further encourage engagement. A similar game, based on individual performance was run in the second semester.
- *Identity*: to promote a sense of identity, the groups could choose their own names; also, in the first semester, this sense of identity was reinforced by displaying the relative performance of each group on a plasma screen at the entrance to the computing department. In the second semester, students were shown their individual scores, indicating their position in the class, and the top and bottom scores.
- *Challenge*: The first semester was divided into two halves, with a simple introductory game run in the first half to help introduce the game and give a chance for it to be refined. Table 1 identifies the final elements of the game created. This shows rewards for ‘good behaviour’, such as attending regularly and scoring well in required practical work. Additional points could also be obtained by taking on a range of optional, more demanding tasks, such as completing an individual online quiz or the group analysis a technical topic and explaining it to the rest of the class. Similar individual challenges were set in the second semester. Note that, for the group game, the points awarded were normalised to take account of different group sizes.

Table 1: Rules for first year, first semester, engagement game

Element	Score	Possible Points
Attendance	10 Points for each of the lectures, lab class and tutorial	200
Contribution to Tutorial	10 Points for every question answered correctly (Maximum of 10 points per student per tutorial)	50
Outstanding Achievements	10 Points awarded at lecturer’s discretion	50
Online Revision Quizzes	10 Points awarded for each quiz a student completes successfully; further attempts not rewarded with points but the student who obtains the highest score on their first attempt awarded a further 20 points	210
Group Assignment	25 Points group mark 15 Points individual mark	40
Exam Revision Questions	10 Points awarded to each question completed by group, max of 2 questions per group	20
Group Presentations	20 Points awarded for a presentation, max of 2 presentations per group	20
Total		590

- *Structure*: the basic rules of the game, as summarised in Table 1, evolved over the first half of the semester. The aim was to keep the game simple but it also needed enough structure to be interesting. The rules had to be acceptable to the students for them to engage but it was also important to avoid behaviour that was counterproductive by setting limits on certain activities.
- *Feedback*: group performance was presented weekly, showing the breakdown of points for each element. This information was accessible through each student’s virtual learning environment (WebCT) and was also displayed publicly, as indicated above in the discussion of ‘identity’.

This description shows that the six game factors are inter-connected, but looking at them individually helped ensure that each contribution was addressed adequately.

2.2 Game results

The underlying motivation for this work was to help students achieve their potential. The main measure of success, therefore, was the extent to which overall pass rates improved. In practice, the results for the 2007-08 class exceeded all expectations. In the first semester, every student taking the exam passed at the first attempt, though some had left the course earlier in the year. This had never been achieved before and indeed with a programming module, initial failure rates of about 25% were more common. In the second semester, the results were less spectacular, but the failure rate was still less than 10%. More importantly, the results now followed a normal distribution rather than the bipolar pattern that had often occurred before, which suggested that there was no longer a group at the bottom end expecting to fail. The bipolar pattern can be seen in Figure 1 for the 2006-07 cohort, shown against results for the 2007-08 group.

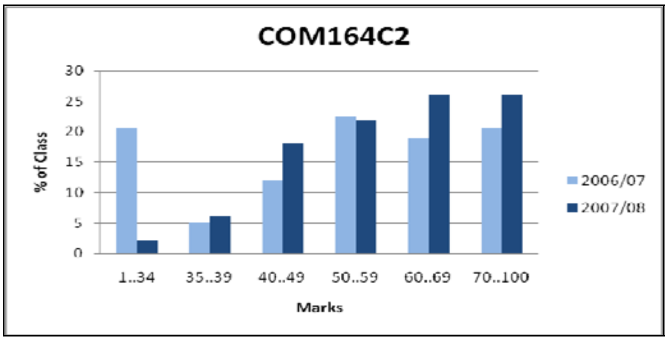

Figure 1: Cohort comparison showing the effect of the engagement experiment

Another consequence of the game was that class and laboratory attendance increased by about 5%, which undoubtedly contributed to engagement and success overall. A third, unexpected benefit was that the performance of the students improved in all first year modules they studied, suggesting that there had been a beneficial change in their approach and study skills. Unfortunately, as these modules changed in other ways it is too early to be certain that this was a general effect. On entry to second year, the students who took part in the first year experiment were asked to complete a questionnaire. 25 statements were presented, inviting agreement or disagreement on a 5-point scale from *strongly disagree* (1) to *strongly agree* (5). Suggestions for improvement were also invited and there was space for other comments. 49 questionnaires were completed. In terms of the six game engagement elements, the questionnaire revealed the following:

- *Fun*: In the context where 90% of the class said they enjoyed playing games, 70% of the students *agreed* or *strongly agreed* that playing this engagement game made studying the module more enjoyable, with most of the remainder having no opinion either way. Further evidence of enjoyment is that over 60% felt encouraged to spend more time on the module and over 70% felt the game could be run successfully in second year, which they were just starting. 70% also believed that the game helped them obtain better results overall.
- *Social*: 75% *agreed* or *strongly agreed* that the game helped them work better in a group, with over 85% believing that the game helped others improve their performance. Disappointingly only 45% felt that the game encouraged them to help weaker students in the group. When asked about their preference for a group over an individual game the class was divided equally, though over 50% expressed a clear preference for gathering points for the group rather than themselves.
- *Identity*: 70% agreed that the public display of results using the plasma screen encouraged them to try and gain more points as they knew other people could see their progress in the game. About 45% believed that presenting the results publicly embarrassed some groups, but pressure from discomfort is part of the game and the benefits seem to justify this aspect of the game.
- *Challenge*: 65% of the students agreed that the feedback received from the games-enhanced modules encouraged them to take on challenges that they would normally avoid. Three in the class (6%) felt that they had less time to spend on other modules but as indicated earlier, the other modules showed improved performance in relation to earlier years. Over 90% agreed that the level of challenge in the game was ‘about right’.
- *Structure*: There was general agreement that the rules of the game were clear (85%) and that the allocation of points was largely fair (85%), though one person wanted the number of points more directly matched to the effort involved.
- *Feedback*: Nearly 90% agreed that the visual representation of their performance helped them to better understand their achievements within the module. As might be hoped, students were keen to see the effect of any points they earned reflected immediately in the public display rather than having it updated weekly. Ways of speeding up feedback are discussed in a later section.

From the results obtained so far it can be concluded with confidence that introducing game engagement elements into teaching:

- provides a more enjoyable learning experience;
- increases student participation in the learning process;
- improves basic desirable behaviour, such as students attending lectures regularly and completing coursework effectively;
- encourages personal development through students taking on additional challenging tasks; and
- promotes effective group work.

Also, the visual display of feedback has a positive impact on how students interpret their progress and the public display of that information leads to enhanced performance. Having established that, with suitable care, game engagement techniques can be beneficial to learning, the next stage was to see how well the approach could be transferred to a different situation. To help interpret the results it was decided to use the same cohort of students in their second year of study. An area that seemed particularly suitable was the process that students go through in seeking a work experience placement. This is discussed in the next section.

3. Second year engagement game

Students on a Computing degree at the University of Ulster are expected to spend the third year of a four-year programme in a full-year work placement, which they obtain during their second year of study. Traditionally, this has been a difficult area for engagement, with students often slow to apply for work, resulting in delay or failure to secure a placement. The basic process is that each student prepares a CV (résumé), completes a mock interview and then applies for placement opportunities accessible electronically through a locally developed web-based placement management system, *Opus*. Employers can offer job descriptions for inclusion in Opus, and once visible, further communication is exchanged directly between the students and the organisations involved. Thus, through Opus, students receive and submit application forms, are informed about interviews and receive notification of interview results.

3.1 Game design

In designing a game around placement employment, the following assumptions were made:

- Following on from their experience of the engagement games in first year, students would welcome another game as the questionnaire results suggested that over 70% believed that a similar game could be run successfully in second year. The greatest benefit had been gained when the students were in groups so this approach would be adopted again.
- The game should improve the existing process as it would raise the profile of placement activity, including public display of information, and add urgency to each stage. Previously, students had sought placements individually. A group structure should provide additional encouragement and support. The main measure of success would be the percentage of students placed by the end of the academic year.
- Having had the first year experience, and finding it both enjoyable and beneficial, the students would be largely self-organising and begin the game immediately, driving its progress.
- An early start was likely as the first stage was CV approval and the students had already developed a CV in their first year.
- In first year there were small prizes awarded as an incentive to take part in the game (e.g. most improved group). For the placement game it was assumed that being offered interviews and jobs would be sufficient encouragement.
- It was recognised that game strategies, such as trying to obtain job interviews and offers with no intention of taking them up, would be a problem for the University. It was believed, however, that the students would not engage in such behaviour because of the effort involved. Nevertheless, the rules of the game were devised to minimise such risks.
- On paper, the game didn't sound as much 'fun' as the first year experiment but it was believed that the students would welcome the increased support available and participate to a reasonable extent.

As in first year, the class was split into teams and a member of academic staff was assign as a 'coach' to each team. The coaches had the responsibility of approving achievements and awarding points through a web-based support system. The system also gave coaches and students a visual summary on their performance individually and within their team. Again, like the previous year, results were also displayed publically on a plasma screen at the entrance to the Department. The aim of the game was to encourage the members of each team to work together to secure placement positions. The game was intended to run throughout second year, with the overall objective being to have all students placed before the end of Semester 2; the first team to secure positions for all its members would be the 'winner'. The game rules and sub-goals were structured around the main tasks that are required to obtain a placement, as indicated in Table 2. The points were set to encourage students to obtain a placement as quickly as possible.

Table 2: Rules for second year engagement game

Element	Score
CV	50 points for each CV (approved by the coach)
Mock Interview	Up to 100 points according to performance (Week 6, marked by interviewers)
Placement Applications	100 points for each job application (confirmed by coach), with a 200 bonus (per person) for any application submitted by Week 9 of Semester 1
Interviews	200 points for each interview offered and attended (confirmed by coach)
Placement Appointments	2000 points for a job secured by 1 Dec 2008 (confirmed by coach), reduced by 200 in each successive month

3.2 Game results

At the time of writing, the game is still in progress, but some preliminary results can be reported. Again these are presented in terms of the six game engagement elements:

- *Fun*: As indicated in the previous section, the placement game was not expected to be as enjoyable as the first year game and so it turned out. One issue was that many students were anxious about putting themselves through an interview process and failing. This meant they delayed involvement which simply increased their anxiety. Also, the progress of the game was much slower than in first year so it didn't develop the same level of enthusiasm. A more serious oversight was failing to see that the academic coaches were also stakeholders who needed to find the experience enjoyable and be fully engaged. Much more time should have been spent discussing the game with them and indeed involving them in the design of the game itself.
- *Social*: Because of inadequate preparation of the coaches, they largely left the students to organise themselves. In practice, some groups, with strong leaders were successful but many drifted along and, more importantly, weaker members of groups were given little encouragement. It was also disappointing to see that those who succeeded in finding placements tended to withdraw from the game rather than stay and help others. Regular team meetings to review progress are essential and need to be built into the structure of the game in future.
- *Identity*: The groups by default adopted the identity of their coach, which was a problem as the coaches were insufficiently engaged. When the team results were first presented publicly, the coaches with low performance points were unhappy with the resulting pressure but it was difficult for them to make a difference at that point as they had not built a sufficiently strong relationship with their team. As performance across a team was variable, it was decided to show the individual breakdown of points halfway through the year. This seemed to have little effect on the effort of weaker students and also tended to take pressure off the coaches.
- *Challenge*: Finding a placement is difficult because many employers see the process as a way of recruiting permanent staff in the longer term and so put the students through a full recruitment evaluation. Also, in the current economic climate, there were fewer placement opportunities available than usual, with some employers withdrawing during the year, even after job offers had been made. This meant that some students had to make more applications than necessary in previous years and also deterred those at the weaker end of the class from applying for any jobs.
- *Structure*: The basic structure of the game seemed reasonable overall, but its rules and organisation need a significant overhaul to better encourage desired behaviour among students and coaches. A full detailed review of the game will be undertaken before it is repeated next year.

- *Feedback*: The frequency of positive feedback promoting competition was missing, with teams rarely being aware of those in opposing teams who were securing jobs. The undoubted success of each student obtaining a job should have been celebrated publicly.

Despite these issues, however, the students did show signs of improved engagement with twice as many job applications submitted up to May 2009 as in the same period in the previous year. As a result, the students secured a similar number of jobs in a very difficult job market. On that basis, the game can be considered a 'success' though, clearly, there are many opportunities for improvement. These suggest that level of engagement in the game and its overall effectiveness can be increased significantly, though suitable refinements.

4. Conclusions

The experiences described in this paper have convinced the authors of the benefits of using game engagement techniques in third level education. These techniques seem particularly effective in first year teaching but also have a role in second year, and may even be beneficial for final year students.
The initial success in introducing the techniques in first year programming, however, was perhaps misleading, as it gave the impression that the existence of the game itself was sufficient to improve student performance. In contrast, the second year placement game was a reminder that the elements of such games need to be designed carefully to create the required experience and so ensure full engagement. The second year game also drew attention to the importance of the interests and experience of the academics involved in the process. In the first year experiment, the lecturer was a champion of game engagement techniques and had a strong interest in the personal development of students. The game therefore built directly on the already effective way that she organised and delivered the modules. In the second-year game the six academics involved had widely varying backgrounds, and significantly different levels of interest in the experiment. Also, there was little existing support practice on which to build the game. It is very encouraging, therefore, that it showed signs of improvement in such unpromising circumstances and in the context of difficult economic conditions. Overall, the results of these experiments have confirmed the value of trying to improve engagement in education through the recognition and adoption of techniques used in the design of digital games. They also have begun to clarify where and how these techniques should be used and the necessary conditions for their successful introduction. It is expected that many more lessons will emerge from planned further attempts to apply these techniques, both in new areas and in refining the existing experiments. Many have shown interest in this work and so an immediate priority is to package the technology support for the process game into a learning object that others can use experimentally. The goal of this work is to produce a flexible generic tool that can be used in virtually any educational context.

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Game-Based Assessment: can Games Themselves act as Assessment Mechanisms? A Case Study

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Abstract: Effective assessment of practical skills is a challenge for large-size classes. To reduce the time-consuming burden of staff members without compromising the quality of the assessment, a case study was set up to investigate whether games can be considered as suitable and valid tools for summative assessment. Using a traditional exam as bench-mark, a boardgame format was experimentally trialed to assess students' knowledge, skills and attitudes at the end of a first aid course in a pre-service teacher training programme. Twenty-eight master students were randomly assigned into two groups. Two assessments, a game-based assessment and a traditional test, were applied on both groups in opposite order. One group started with the game, the other group was assessed by the traditional test. This latter consisted of a paper-and-pencil test in combination with a skills assessment. Both parts were assessed by an expert evaluator. The written test was marked using a scoring key, the skills assessment was scored using an observation matrix. In the game-based assessment, the focal point was peer assessment. Students were placed in the role of judge over other students' efforts. Similarities between both assessment types included individual testing, content, type of questions (true/false, short answer and essay questions) and demonstrations, and the use of checklists for skills assessment. The assessment methods differed in type of assessor (peers or expert), assessment format (written or oral test, both in combination with skills assessment) and feedback availability. A survey investigating students' preferences on playing games was taken just before the first assessment and analysis indicated that most students preferred to play games in general. Both groups performed equally in the game-based assessment as well as in the traditional test, in spite of opposite order of the assessments. Overall, students performed significantly better on the game-based assessment than on the traditional test, presuming beneficial effects of gameplay, peer assessment, peer feedback and oral defence.

Keywords: Assessment, game-based, summative evaluation, health education

1. Background

In the pre-service teacher training at XXXX, a complementary course "First aid for teachers" has been developed and organized once a year since September 2007. Given the focus on practical training, a suitable assessment type is needed. To assess students' acquisition of course content, multiple choice, essay and short-answer exams are widely used (Berrenberg and Proser, 1991). Mostly traditional paper-and-pencil tests are used, because they are easy to administer and score, allow variability in the content addressed and the type of cognitive behaviors measured, and can be a precise and reliable measure (Palomba and Banta, 1999). Testing technical skills on the other hand require methods and assessment instruments that are somewhat different than those used for cognitive skills. In medical education, new methods of assessment have been developed and implemented in order to assess clinical skills (taking a history from a patient and performing a physical examination), communication skills, procedural skills, and professionalism (Norcini and McKinley, 2007). Regarding the assessment of technical skills, simulations - standardized patient simulations (e.g., Reznick *et al.,* 1996; Whelan, 1999) and computer-based simulations (Kneebone, 2003) - are increasingly being used in medical education to ensure that examinees can demonstrate integration of prerequisite knowledge, skills, and attitude in a realistic setting (Tekian, 1999). However, simulations in skills assessment also have their limitations. For instance, a major drawback of computer-based simulations is that they are aimed at teaching clinical problem solving skills. In most cases they do not provide the opportunity to conduct a physical examination or demonstrate medical care, such as first aid (Garrett and Callear, 2001, Bergin *et al.,* 2003). In other, however limited cases, complex mannequins are used to realistically simulate clinical cases, but are also restricted in their ability to allow the user to conduct physical examinations other than those to what the mannequins are designed for (Gordon *et al.,* 2001). Using specially trained actors -referred to as "Standardized Patient" (SP)- to portray patients with particular health conditions or concerns may provide an elegant alternative. SPs are able to give a consistent and pre-defined account of their condition and to answer the full spectrum of questions about themselves (Eagles *et al.,* 2001). Related to this study, most first aid manipulations can be trained or simulated on SPs. However, because of the high costs for training, delivery and management on one hand and the big classroom sizes on the other hand, students are not exposed to a large number of cases and the encounters are often only used for the summative assessment of students' performance and not as formative learning activities (Hubal *et al.,* 2000). This is in contradiction with didactic principles which emphasize the importance of organizing assessment in accordance with learning and teaching, i.e. if training of technical skills occurs without simulations on SPs, it is not recommended to introduce SPs in a summative assessment. As a consequence, alternative assessment methods that are economic and logistically feasible, need to be explored.

Peer assessment and feedback

Peer assessment, also called peer evaluation or peer review, might be an elegant alternative to overcome costly and time-consuming assessment methods. Peer assessment is a process wherein peers evaluate each other's work, usually along with, or in place of, an expert marker (e.g. Topping, 1998). Peer assessment can serve several goals: e.g. peer assessment as a tool for social control, for assessment, for learning, for active participation, and as learning aid for how to assess (Gielen, 2007). By introducing peer assessment as an assessment tool, students are considered to be 'surrogate' or 'assistant' teachers. As a result, the observation or reading burden can be shared among multiple assessors (e.g. Forbes and Spence, 1991). Concerns however exist on the validity and reliability of peer-generated grades. Over 70% of the studies find the reliability and the validity of the peer assessment adequate, i.e. grades that are similar in level and rank order as those provided by expert graders (Sadler and Good, 2006; Pare and Joordens, 2008); a minority find them variable (Falchikov and Goldfinch, 2000; Topping, 1998). Nevertheless, several studies conclude that instructor concerns about peer evaluation reliability and validity should not be a barrier to implementing peer evaluations, provided that appropriate scaffolds are applied, e.g. providing guidelines, checklists, or other tangible scaffolding to students, introducing decision making by teams instead of individual peers, etc (Cho *et al.,* 2006; Desrochers *et al.*, 2007; Falchikov and Goldfinch, 2000; Topping, 2009). Peer assessment can also prove to be helpful in terms of providing feedback. Peer feedback can confirm existing information, add new information, identify errors, correct errors, improve conditional application of information, and aid the wider restructuring of theoretical schemata (Butler and Winne, 1995). Although peers are not experts in the domain, their feedback can be a trade-off against expertise in terms of being understandable, timely, frequent, extended, individualised and reassuring (Cole, 1991).

Games-based assessment

In general, summative assessment induces a high degree of stress/anxiety, which may have debilitating health, emotional and educational effects. The stress of examinations can produce poor performance and is unlikely to provide a positive motivation for many students. To overcome these issues game approaches may be used. Games are interactive, motivating and challenging (Desrochers *et al.*, 2007; Patel, 2008). They provide an opportunity to integrate and demonstrate knowledge and skills, and they give direct feedback. To date, researchers tend to concentrate on the use of games to enhance student learning and to enhance delivery of courses (e.g. Ackil, 1986; Gibson, 1991; Keutzer, 1993; Klassen and Willoughby, 2003; McDonald and Hannafin, 2003; Patel, 2008). Studies have been focused on using games as formative assessment instruments (e.g. Wang, 2008). However, little research exists on the use of games as an assessment tool for summative evaluation. Berrenberg and Prosser (1991) used the concept of games-based assessment by instructing students to design games incorporating course material for their final exam. In this study games are present in the summative evaluation, but represent assessment products instead of assessment instruments. Desrochers and colleagues (2007) empirically evaluated the effectiveness of a game format as an assessment of students' knowledge of research methods. Using the game format of a quiz, the concept of cooperative group testing compared to individual testing has been investigated. Both formats, evaluating knowledge, were assessed by the same expert evaluator. Students performed better in the cooperative (game) assessment than in the individual test. Their performance was consistent with their assessment preference and perception of accuracy.

In this case-study, we investigate the validity of an alternative tool for the assessment of knowledge, skills and attitudes at the end of a technical course by comparing it to students' score on a traditional exam. Given the positive effects of peer assessment and peer feedback, we opted to apply these principles in the new assessment tool, i.e. a board game. Due to the absence of a first aid board game, we developed our own game. The focus in this study is on end point summative assessment.

For the study, two research questions were formulated:

- 1. Can the boardgame used in this study serve as a valid alternative tool for the assessment of first aid competence ?
- 2. What relationships are found between students' gaming preferences and their performance in a games-based assessment ?

2. Method

2.1 Participants

The sample consisted of university students studying the preservice teacher training programme (Master level). Twenty-eight students (26 women and 2 men) without specific prior knowledge on the content of the course participated in the study. The course, a first aid and basic life support training module for future teachers, is part of a compulsory, one-semester (13 weeks) course (4 ECTS). The module is organized in four sessions of 4h during four following weeks. Summative assessment took place during the last session.

2.2 Procedure

In this study, the validity of a game as alternative assessment tool has been investigated. Therefore, a traditional test consisting of a written test and a demonstration of two first aid skills was used as a bench-mark. As a consequence all participants were assessed twice, i.e. by a traditional test and a game-based assessment. Both assessments were held during the final session of the course. Since both scores were included in the final marks, a possible impact of one assessment on the outcome of the other assessment needed to be taken into account. Therefore, we randomly assigned participants into two groups, receiving the two assessments in opposite order. One group started playing the game, while the other group was assessed by the traditional test. To obtain game groups of three players, two groups of 12 and 16 students were created. In the latter subgroup, one game group consisted of four players. At the beginning of the evaluation session, the lecturer (evaluator) explained its structure. Subsequently, the total group was divided and accommodated in a separate medium-sized classroom. Prior to the game-based assessment, the rules of the game were explained by the evaluator. Subsequently, the evaluator left the classroom to assess the technical part of the traditional test. Supervision of each group was performed by an independent assistant, i.e. he was not involved in the course itself. Both assistants were familiar with the game and had expert knowledge on the content of the course, but were instructed only to supervise and mark irregular observations. At the start of the game-based assessment, participants were randomly assigned to three- or four-member groups, sitting in different areas of the same room. Since the first aid game was new to all players, a test round of 15 minutes was played in order to master the rules and the course of the game. Subsequently, groups were given 90 minutes to play the game. Players were instructed to finish the last round to assure an equal number of answered questions or demonstrations by each player within his own group.

2.3 The game

The game board is a landscape of a developing country built by the players as the game progresses. The game starts with a single terrain triangular tile face up and 69 others shuffled face down for the players to draw from. On each turn a player draws a new terrain tile and places it adjacent to tiles that are already face up. The new tile must be placed in a way that extends features on the tiles it abuts: swamps must connect to swamps, fields to fields, seas to seas and bushes to bushes (Figure 1). After placing the new tile, the placing player chooses a blue, red, green or brown card with a true/false, short answer, performance and open essay question respectively which is read aloud by a competitive peer player. The question answer or performance of the player is reviewed by the two peer players. If the answer or performance is correct, the player receives the question card. If not, the card is placed aside. As soon as a player has collected a blue, a red and a green card, he is allowed to station a first aid post. Building is only allowed on a specific feature on the tile marked by a white square. If this feature is present on the newly placed tile, the player may opt to station a first aid post of his color on the white square in exchange for the three collected cards. In a next round the player can transform the first aid post by a hospital in turn of a brown question card. Players are able to sabotage one another by natural disaster. Six of the 70 tiles display a malaria epidemic, a bush fire or a tsunami. They and can be used to distroy a first aid post of a competitive player. Hospitals cannot be distroyed by disasters.

At the end of the game, all first aid posts (1 point) and hospitals (3 points) placed by each player are counted. The player collecting the most points wins the game.

Figure 1: Top view example of the game showing five tiles with the following features: swamps (pale brown), fields (dark brown), seas (blue), bushes (green) and a building lot (white square). Another white square is covered by a first aid post of one of the players (yellow). On the top right corner some question cards are shown

2.4 Research instruments

2.4.1 Game-based assessment

The outcome of the game (number of first aid posts and hospitals) was not used as assessment score, due to a factor of luck (i.e. the chance of drawing a tile with a white square) and sabotage (by natural disaster). Instead a summative individual score was generated by comparing the amount of question cards collected by each player to the number of play rounds. The amount of collected question cards represented the amount of correct given answers and demonstrations through peer assessment, and thus indicating the level of acquired knowledge, skills and attitudes. To overcome concerns about peer evaluation reliability and validity, checklists indicating the order and description of each individual step of the (complex) manipulation were used in the peer assessment of first aid skills. These checklists have extensively been used during the training sessions in order to familiarize students with these instruments.

2.4.2 Traditional test

In this study a traditional test was used as a bench-mark for the evaluation of the validity of a game-based assessment. In the traditional test, participants had maximum 60 minutes to complete a paper-and-pencil test and demonstrate two first aid skills. The written test consisted of five true/false, four short answer and three essay questions, assessing their knowledge and attitudes on first aid. During the test, each student was individually and in private assessed by the lecturer (evaluator) on his/her first aid skills. To assure reliability and validity the question items and demonstrations covered all course material delivered during the training sessions. Similar, but no identical questions were used in the traditional test and game-based assessment. A scoring key for all items of the written test was designed in advance. The scoring of each item, being 0 or 1, was informed to the students and was consistent with the scoring of the items in the game (being correct or not). Each demonstration was scored using observation matrices.

2.4.3 Questionnaire

To investigate students' opinions on playing games and a possible impact on the assessment results, a short survey consisting of 6 items was conducted at the beginning of the session: "To what extent do you like to play games ? To what extent do you like to play strategic games, solitary games, team games, quizzes in particular ? To what extent do you play board- and/or computergames frequently (> once a week) ?" Each item is rated on a 5 point Likert-scale (from 1 = strongly dislike to 5 = strongly like).

2.5 Data analysis

All quantitative data were listed using the SPSS 16.0 software for statistical analysis. Descriptive statistics (minimum, maximum, means, and standard deviations) were calculated for the two groups and the two assessments to be compared. Students' scores on the two assessments were compared using a paired samples t-test. An independent samples t-test was performed to evaluate the mean scores of both groups on each assessment method seperately.

In addition, students' scores on both assessments were transformed into grades using the grading rules of our university. The difference in grades on the two assessments was calculated for each student.

The reliability (Cronbach alpha factor) of the six items of the survey was determined and the correlation between the survey outcomes and the assessment results was analysed (Pearson correlation).

3. Results

We scored participants' objective answers on the traditional test (14 items) and used these outcomes as bench-mark. Students played an average of 16 rounds, answering or demonstrating an equal amount of questions and demonstrations. In both groups, the mean game-based assessment score (M(group A) = 96.94, SD = 4.16; M(group B) = 95.46, SD = 5.25) was significantly greater than that of the traditional test (M(group A) = 85.11, SD = 12.36; M(group B) = 87.94, SD = 11.58) (group A: $t(12) = -3.09$, $p < .05$; group B: $t(16) = -2.50$, $p < .05$) (Table 1).

Table 1: Assessment score percentages of both groups on the traditional test and the game-based assessment

	Score traditional test	Score game
Group A (N = 12) game - traditional test	M = 85.11 SD = 12.36 Min = 57.15; Max = 100.00	M = 96.94 SD = 4.16 Min = 87.50; Max = 100.00
Group B (N= 16) traditional test - game	M = 87.94 SD = 11.58 Min = 64.30; Max = 100.00	M = 95.46 SD = 5.25 Min = 82.40; Max = 100.00

Fourteen students (50%) obtained the highest score in the game-based assessment compared to 8 students (28.57%) in the traditional test. No significant difference was observed between the mean scores of group A, taking the game-based assessment before the traditional test, on both assessments and those of Group B, taking the assessments in opposite order (traditional test: $t(28) = -.62$, p = n.s.; game: $t(28) = .83$, p = n.s.).

Regarding the analysis of an academic grade shift, our findings indicate that using the game as an alternative assessment tool results in an increase in grades for more than half of the students (53.8%). Three students even gain four grades compared to the traditional test. Eleven students are awarded the same grade and two students obtain a lower grade in the game-based assessment compared to the traditional test.

The reliability of the six items of the survey was good (Cronbach alpha = .85). As a result individual scale scores for each student were calculated, reflecting the overall students' preference of playing games. Descriptive statistics analysis indicated that most students (85.7%) preferred to play games (mean = 3.73; SD = .86). Four students indicated not preferring to play games, however no correlation was found between preference and game-based assessment outcome (Pearson correlation = .02, p = n.s.).

4. Discussion

Mean scores in the game-based assessment significantly surpassed those in the traditional test. Different factors may contribute to these results. First, the effects of a game itself may produce a better performance. While traditional tests are most likely to induce a high degree of stress/anxiety resulting in a poor performance, games can be fun, motivating, challenging and therefore dispel someone's fear of examination. Related to this, students who are used to play and/or like gaming, feel comfortable in playing games and therefore might benefit from a game-based assessment. We investigated the students' preferences of playing games in general. In case a correlation between students' gaming preferences and their performance in a games-based assessment exists, we expect to find higher scores for students who like to play games compared to those who dislike gaming. Most students indicated that they like to play games. Only four students did not prefer gaming. Our findings however demonstrate that these students did not score significant lower compared to students who like gaming. We may thus conclude that in this study students' gaming preferences have no impact on performance in the game-based assessment. In this study, winning the game is not necessarily equivalent to obtaining the highest score on the assessment. Players who don't like the game and have no insight in strategic moves, can perform poorly in building their first aid posts and hospitals, resulting in a low game result. This does not imply that these players are not able to collect a high or maximum amount of question cards, indicating their level of competency.

Secondly, the availability of feedback might contribute to the higher game-based assessment scores. Feedback has proven to induce a positive effect on learning (Butler and Winne, 1995). If we hypothesize in this study that the higher scores on the game-based assessment are solely or mostly attributed to the availability of feedback, we would expect an increase in student scores in a following assessment. More in particular, students of group A would benefit from playing the game first and thus receiving feedback on their performances and obtain higher scores in the traditional test compared to students of group B. However, no significant difference on the traditional test was observed between the mean scores of both groups. Even more, group A performed worse (however only 3%) on the traditional test than group B, indicating no positive immediate effect of feedback. These observations however need to be interpreted with care. First, the quality of peer feedback has not been measured. The results could be attributed to poor (in quantity and quality) feedback. Simply telling a student that his answer is wrong does not help him perform very much better on a second attempt (Lee *et al.*, 2008). Related to this, questions in the traditional test, although covering the same content, did not reappear in the game-based assessment. As a result, a learning effect might have been present although not observed, due to the absence of second attempts.

Finally, since a different assessor type was chosen for each assessment, this factor might influence students' assessment performances. While assessment in the traditional test was carried out by an expert evaluator, assessment in the game format was performed by two (or three) peers. To overcome concerns of reliability, observation matrices, extensively used during training, served as skills assessment instruments. Also a final decision was made by two (or three) peers to increase accuracy, as was suggested in the literature (Desrochers *et al.*, 2007). Still, a significant increase in scores on the game-based assessment was observed. While some studies have demonstrated that peer assessors can be more demanding than faculty assessors (Calhoun *et al.,* 1984), other studies observed that peer assessors tend to be more lenient than faculty assessors (Rudy *et al.*, 2001). In this course, students worked extensively together during the training sessions and therefore may be willing to please their peers in case of an incomplete answer. Oral defense, being available in the game-based assessment, not only enables a student to nuance his performance, but might also reinforce the fear of peer assessors by making strict decisions. Related to the concept of peer assessment, performance may have been enhanced due to the presence of peers. The potential embarrassment of performing poorly increases the time of reflection and the effort spent by students on producing answers and demonstrating their skills (Cole, 1991).

There are some potential limitations to this study. First, the number of participants in this study is low, due to its implementation in an existing course. This study was designed to investigate whether a game would be valid as an alternative instrument for the assessment of practical skills in a first aid course. Although this course is compulsory in the teacher training programme, the number of students taking the course has been doubled in the second year. To anticipate on this evolution causing concerns of time-consuming burden of staff members, an ecological valid case study was set up to investigate an alternative assessment method without compromising the quality of the assessment. Secondly, the results of this study are produced using a particular boardgame. Therefore, prudence is in order extrapolating these results to other game-based assessments.

5. Conclusion

Students performed significantly better on the game-based assessment than on the traditional test, presuming beneficial effects of gameplay, peer assessment, peer feedback and oral defence. No impact of gaming preferences on assessment outcomes was found. These data suggest that use of a game approach for assessment purposes may provide an effective means of assessing student competence at the end of a practical course.

Further research is needed on the use of games as summative assessment instruments. While many studies are available on the quality assessment of games, the use of games as learning and teaching tools and the use of games in formative assessment, there is a lack of literature on hands-on experience and lessons learned from research implementing games as summative assessment tools.

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Harmonising Culture in Co-Operative Business Ventures: Using a Simulation in a Metaverse

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Abstract: In recent years, there has been and continues be an increasing numbers of company mergers and takeovers. However, many of them such as the AOL – Time Warner, merger destroy shareholder value instead of increasing it. Mirivis (1992) and Vansina (1992) observe that approximately half of all company mergers fail at some stage of the integration process with the blame generally going towards the inability to reconcile two different organizational cultures. Dealing with the human elements of a merger there is often a lack of understanding on how to integrate organizational cultures of the existing firms. Not only is the concept of organizational culture one that is hard to tackle due to its vague and subtle meaning, but also an issue which is hard to manage due to the large amount of resources often required when dealing with human issues. While attempts have been made in the past to manage culture, they have been notoriously difficult to execute. However, innovations in information technology have provided new opportunities for employee training and education which go beyond the traditional seminar and discussion such as employing low-cost simulations using virtual worlds as a platform for communication and interaction. Using a qualitative approach based on the interpretation of previous research, elements from a variety of subject areas will be investigated in order to suggest an outline for the creation of a prototype application. Looking first at the composition of organizational culture and its manageability, an attempt was made to analyze culture to the extent that key dimensions can be identified. Due the difficulty of tackling the culture problem as a whole, it has been tackled by targeting cultural dimensions by drawing upon experiences and learning objectives from existing serious games, commercial and educational, in order to identify the necessary specifications for establishing a simulation aimed at changing organizational culture. Consequently, an attempt will be made to enhance elements borrowed from traditional games into one simulation using key elements in behavior modification and drawing upon theories in education and learning, to achieve an ultimate goal of providing the outline for an innovative prototype scenario for SME and large organizations, capable of dealing with the culture problem in mergers and acquisitions. At current stage, virtual worlds and metaverses not only provide the ideal learning environments for tackling a group problems such as culture, but also they potentially do allow for the creation of complex extensive games. If one takes some of the key components of organizational culture and compares them to the learning objectives of some traditional games, it can be established that the ideal simulation needed to tackle the problem of culture within organizations, consists of a mixture of processes, random events, role-play and adaptable reward structures, conditioning and ultimately a complex emulation of reality.

Keywords: Organizational culture, serious game, virtual world, metaverse

1. Introduction

Culture as a human phenomenon is something explains ‘why we do and what we do’, which has fascinated countless sociologists and anthropologists. At a national level, culture often acts as the glue which holds society together creating an unspoken relation between individuals whom may have never met before. In the past, organizations have experienced some of the negative consequences that a strong national cultures can provide for working dynamic within multinational corporations, a strong organizational culture is nevertheless something most firms will greatly desire. While definitions, scope and significance of organizational culture is something few authors can agrees on, there is a general consensus that organizational culture is some sort of collective programming of employee minds, meaning a strong cultures can subconsciously guide employees to do the ‘right thing’ regardless of feelings and emotions. Culture as a control mechanism for employees is therefore something executives value as it said to have the ability to help firms through times of problems. Considering then, cultures are unique and present within most firms who consciously spend much money and time to ensure unity amongst employees; it is only natural for problems to arise when this unity is broken. Just as we often find ourselves feeling uncomfortable when faced with a culture we are not familiar with or understand. So can organizations face ‘culture shock’ when employees are faced with a new way of thinking and behaving within the office they are not familiar with? ‘Culture shock’ may arise due to a variety of reasons; one stands out particularly above the rest: Mergers and Acquisitions.

Much of the recent literature on mergers and acquisitions has established that physically merging firms are often failed by the problems merging culture provides. Therefore, the problem becomes how firms can successfully change organizational culture, running under the assumption that providing framework for guiding organizational culture change will allow for a successful merger of cultures. However, since the possible approaches to the organizational culture problem are so numerous, the scope of this investigation lies in assessing the opportunities and recent developments in ‘virtual worlds’ and ‘social gaming’ provide for tackling organizational culture change. Virtual worlds and Mass Multiplayer Online Games have attracted great attention in recent years, their popularity sky-rocketing as technological innovations have allowed for the creation of truly immersive environment. With many firms having already get into the trend currently exploring some of the business opportunities ‘virtual worlds’ may provide, and much of the recent literate recommending multiplayer environments as an ideal learning environment, using virtual worlds for a simulation to aim at changing an organizational culture seems not only solution, but an ideal opportunity for a low cost solution to a large and expensive problem.

Looking first at the composition of organizational culture and its manageability, an attempt made to dissect to the extent that key dimensions can be identified. Due to the difficulty of tackling the culture problems as a whole, an attempt made to tackle its dimensions through drawing upon experiences and learning objectives from existing ‘games’, commercial and educatory, in order to identify the necessary specifications for establishing a simulation aimed at changing organizational culture. Consequently, an attempt made to combine elements borrowed from traditional games into one simulation using key elements in behavior modification and drawing upon theories in education and learning, to achieve an ultimate goal of providing the outline for an innovative prototype application for SME and large organizations, capable of dealing with the culture problem in mergers and acquisitions.

2. Organizational culture, mergers and acquisitions

The idea that organizations, in a somewhat similar way to countries, contain distinct cultures and have intangible aspects that allow for deep analysis beyond a firm’s structural elements is a concept fairly new to the management literature, yet has gained great popularity since the early 1980’s (Alversson, 1990). As western economic stagnation and productivity declines where contrasted to the rapid rise of the Japanese economy, dissatisfaction with the explanatory value of quantitative techniques within organizational theory became more apparent and social forces changed the ideas of organizational culture received extensive attention as the possible illuminating factor (Frost et al. 1985). Yet while the concept of organizational culture received much academic attention over the last two decades it remains an elusive concept authors rarely agreeing beyond the definition of it being a general relationship between the employees and the organization. Yet if we are to establish how computer aided interaction between employees can have transformational effects on organizational culture, a more complete investigation of its origins and mechanism must be done. Looking at organizational change and how to achieve it, a framework for analysis needs to be built in order to allow an assessment of the current state of culture within an organization and how it needs to change. Building on Peter and Waterman’s work of identifying strong cultures as those who are cohesive, share attitudes, communicate and work interdependently as opposed to weak cultures who exhibit none or few of those traits we can add a further distinction between positive and negative cultures. If we see the difference between how management and the workforce view their organization as a source of conflict, (Mead, 2005) positive cultures are those where these views are aligned and the workforce trusts, supports and shares the commitment with management while negative cultures are the opposite. The goal of any program of culture change, would therefore aim to place its workforce in a positive, strong cultural environment (A) while a strong negative environment would be a manager’s worst nightmare (B). Such a framework for analysis is showed in figure 1.

	Strong	Weak
Positive	A=Good	B
Negative	C=Bad	D

Figure 1: Culture matrix

Successful organizational innovation, however, specifically one that targets culture is not a straightforward process as has been indicated by the numerous mergers and acquisitions over the last few decades. Approximately half of all mergers fail at some stage of the integration process with the blame generally going towards the inability to merge two different organizational cultures (Mead, 2005). As the organizational change literature generally attributes these failures to a general lack of understanding, on part of management, of the existing organizational cultures and sub-cultures, changes become a two stage process requiring some sort of 'culture audit' before changes are implemented (Rosenfeld & Wilson, 1999). Gancel stresses the need for a diagnostic model for cultural change as the predominance of sub-subcultures, not necessarily hierarchical in nature; make a generic attempt to change culture very ineffective (Gancel, 2002; Hofstede, 1980; Graves, 1986).

Dimensions of organizational culture

Building a game to help corporations with organizational culture, it is necessary to understand and categorize some of the dimensions of organizational culture. While much work has been done in the literature to establish some broad groupings authors still differ in how they define organizational culture's dimensions largely due to different assumptions they assume to be true. Even so, there do seem to be some elements of agreement between authors to the extent that uncertainty and risk, individualism vs. collectivism, distribution of power and processes or tasks all can be used to make some classification on organizational culture. Looking at the dimensions now, these will act as the focal points for defining the specifications and requirements of the culture game later on.

Uncertainty and risk avoidance are amongst the most mentioned elements of organizational culture due to their fundamental impact on employee behaviour (Hofstede 1980, Deal& Kennedy 2001). It reflects the extent employees are willing to make decisions of which the consequences are less know and exposing themselves to different levels of risk. Individualism vs. collectivism as an element of organizational culture (Handy 1985, Hofstede 1980) is the extent employees behave as individuals or as part of the group. Organizations can be made up of individuals who contribute to the organization through exhibiting individualistic characteristics or expertise to the organization or can be built around the idea that the organization needs a group of similar like-minded people.

Distribution of power within an organization is the third dimension stressed by again by both Handy and Hofstede (Handy 1985, Hofstede 1980), which looks at the extent to which power is divided amongst an organization. While some organizations choose to distribute power amongst a small elite group of employees avoiding bureaucracy and advocating fast decision-making process, other organizations will stress equality and a more distributed decision-making network.

The last element of organizational culture, which as with risk and uncertainty have widespread reference in the culture literature is the extent of emphasis placed on processes. As some of organizations wish to foster a process oriented culture of employee whom ' work by the book' in order to guarantee consistent, reliable and dependable employee behaviors such as organizations in public sector, other organizations will value employees contributing their own creative ideas to alter processes and tasks.

Changing organizational culture has always been a difficult issue due to the variety of differing views it has attracted and its often very subtle nature. The literature does however point towards a set of dimensions, whose definition is a pre-requisite is one is to take a direct hand-on approach to managing culture. Using a digital game based approach, it are these dimensions that need to be targeted by promoting those behaviors, through game-play, which are in line with the type culture organizations choose. However, it is imperative to note that some have pointed out there are different levels at which culture works on an organization (Schein, 2004). While much of the discussion has centered around the deepest level culture demonstrates itself, sometimes termed *tacit assumptions*, Schein amongst others point out there is a more physical element to organizational culture which is reflected in slogans, mission statements, history, rites, rituals, myths, and facilities (Google's office Googleplex is a good example of this). While emphasis of this paper rests on the tacit assumption level of culture, and its more physical manifestations have to be taken into account.

3. Can organizational culture be altered and managed?

Now, the problem becomes whether organizational culture can be altered and managed to build strong cultures and performance to claim positive relationships. In order to design a culture change program based on computer based interaction one must be certain, organizational culture as it has been defined can be genuinely altered to have a lasting effect on the behavior of employees. Additionally, manageability of this change is a necessity and essential, while no authors will argue against the possibility that culture will change there are those who believe that direction and impact of such change cannot be consciously controlled by senior management and is subject to its own random pattern of evolution (Ackroyd & Crowdy, 1990). However, this view has been challenged by numerous authors who through case study work on organizations who have attempted programs of cultural change, have observed changes in organizational culture as a result of management initiatives (Ogbonna & Harris, 1998) (Grugulis, 2000).

One of the earliest and model case studies addressing the issue of culture management within organizations, is Hopfl's study of British Airways (BA) transformation in the 1980's from a autocratic and bureaucratic organization to a more horizontal and flexible one which puts great emphasis on customer service (Legge, 1993). Carol Lavin Bernick's firsthand account of the 'culture makeover' program at Alberto-Culver is one more case of many has attributed company success to the active management of culture (Bernick, 2001). The most compelling evidence, however, there is truth to the functionalist argument that culture is an organizational property subject to control comes from the work of Ogbonna and Harris (1998), who used a mixture of case study work with empirical results to evaluate the culture change at a UK retailer under the pseudonym of 'Westco' (Ogbonna & Harris, 1998). While the approaches taken to change organizational culture are different in each case. There are certain elements of communality in all approaches that might shed some insight into culture change. The case studies suggest having employees experience change rather having it preached to them is what makes a culture change initiative successful. Such an interpretation of the case studies is not only supported by Hofstede's view that organizational culture is merely our subconscious perception of what we do within an organization on a day to day basis, but also makes sense as an organization's culture is so abstract it can only be understood through firsthand experience. Therefore, showing and allowing employee s to experience a desired target culture is the most efficient means of getting employees to genuinely adopt it.

Scenario Planning

An interesting approach to the culture management issue that takes into account, by definition, unique characteristic that all organizational cultures entail is the use of scenario planning in the culture adaption process (Korte & Chermack, 2007). Pioneered in the 1970's as a means of assessing strategic options, Scenario planning is a disciplined method for imagining possible futures based on trends research and key concerns which are converted into narrative stories. Korte and Chermack argues that scenario planning can be used to uncover the implicit process of behavior decisions and discuss these to create and alter the 'shared mental models' employees' hold of the firm. Though assessing the future needs of the firm and giving employees an active role in determining these, new beliefs and assumptions that govern organizational reasoning may be fostered. As the case studies, but specifically the Alberto-Culver one, seem to suggest, change initiatives which value high levels of employee contribution and acceptance seem to stain the best results. Shell in the 1980s under the leadership of Pierre Wack Claimed to have successfully used scenario planning to predict the fall of oil prices following the Iranian revolution and OPEC's disarray offering the world a new paradigm that oil was about to become a commodity product which at the time seemed bizarre to many. While by no means evidence of a culture change, conceptually scenario planning seems to be a broadly applicable means of altering unique cultures.

Behavior modification: Theories of Learning

If as the evidence suggests, organization can undergo programs of managed culture change the question that remains is, exactly how this can be achieved and adapted into a computer based exercise. To therefore establish with what means a computer based exercise can alter participants' behavior, it will become helpful to explore the literate enhancing the science of behavior modification and its clinical uses. If we accept culture to be a mere aggregate of individual behavior, looking at the theories of learning behind behavior modification can give us an insight into how behavior is formed.

This potentially allows us to artificially recreate the circumstances upon which desired behaviors are formed, which is often what behavior therapy sets out to do, except that in our case we can draw upon the power of computer based virtual environments (Sundel & Sundel, 2005). So by looking at how individuals build, what is known as, their behavioral repertoire we can establish certain parameters and requirements needed in the simulation as to encourage users to adopt the right behavior, which then aggregates into the right culture.

Brian Sheldon identifies four generic types of learning; classical conditioning, operant conditioning, vicarious learning and cognitive learning, which all have all undergone rigorous scientific study to assess the extent of their influence (Sheldon, 1982).

The principles of behavior modification are not very new as they are 'woven into the fabric of major social institutions' as is seen in education, government, law and religion in what is often described as a process of socialization (Kazdin, 1978). If we accept then that we can learn almost as much from other's mistakes or achievements then from our own it adds further weight to the argument of using a computer simulated environment which allows social interaction, such as second life, as the basis for organizational culture change exercises. Research into software design for incorporating learning and educational characteristics into video games has established that 'social environments in which motivation is generated through peer collaboration, peer pressure, group meritocracy and the very short feedback cycles,' or behavioral consequences that re-enforce behavior, are best suited for e-learning initiatives (Moreno-Ger, 2008). Furthermore, vicarious learning theory provides some insight into how virtual environments can have influence on behavior without the possibility of directly being able to condition the subject, as experiments have shown learning can be achieved through merely observing and modeling certain behavior and not only though directly experiencing it.

Classical conditioning, operant conditioning and vicarious learning provide a powerful toolset and provide insight into how behavior modification can be successfully utilized, they by no means provide an all-encompassing theory of learning, as more recent work has given more credit to 'cognitive structures' in the process of learning and acquiring behavior. What is essentially meant through cognitive structures, are our abilities of understanding, imagination, prior knowledge, memory facts and creative intelligence, to influence our decision making and hence influence how we decide to act (Sheldon, 1982). It is for this reason that it may be useful to combine the implicit and more covert methods of behavior modification with more explicit means such as a discussion and analysis, to not only determine the goals a computer simulation for culture change but also as to the reasons behind them and how they will an effect on the larger picture of the organization as a whole.

4. Games, simulations and virtual worlds

After examining the nature of organizational culture and looking at the behavioral and cognitive processes that enhance the manageability of organizational cultures, it is possible to assess in what form a culture change exercise should occur based on some of the requirements gathered in reviewing the literature on culture, organizational change and the psychology of learning. Game and simulations allow for quick and almost immediate re-enforcement and at times when employing multiples players can even exhibit elements of social re-enforcement. Within gaming, such re-enforcement also comes in the form of feedback-cycles, where after each day/turn/round 'players' are evaluated for their performance.

The start of games within management arrived on the scene in the 1950's. It was developed in other fields such as war, operations research and education which have had much longer traditions of gaming and simulation. Simulation and war games are a fundamental component to the training of any military personnel due to its critical ability for games to provide a safe environment for learning to take place (Elgood, 1997). Drawing on these experiences, the rise of experiential learning theory was another force that contributed to the introduction of gaming in management. It also shows learning is the best accompanies by emotional arousal, safe environment and time for cognitive processing. The first management game was developed by American Management Association in 1957, which was a sequential-decision making exercise. The traditional structure of such game is the whole process divided into three separate elements, briefing, game play and debriefing in order to extract maximum educational value from the exercises. Regarding to creating a game to modify organizational culture, this research choosing free format game for game play element (Kritz, 2003), as we are not interested in prescribing how employees should behave and defining their social system, but want to control stimuli and re-enforcement within a simulated environment in order to lead employee towards adopting behavior which coincided with a company's desired organizational culture.

Serious game

Video and computer games have taken culture by storm in the last two decades and generate more revenue than the motion picture industry by many estimates (Gee, 2004). While many are quick to attribute societal problems and towards the growth in realism and violence of many of the video games, only few are willing to accept the often hidden merits of video gaming and encourage their use in education. Serious gaming has seen a steady growth in application across a variety of different subject areas, for use in both professional education and training as well as secondary and tertiary education. There is an example called Immune attack, which is a biology game designed to teach student about the complex functioning of the human immune system (Kelly et al., 2007). More evidence that serious games offers a highly effective means of offering insight into complex issues, such as a proposed simulation of organizational culture comes from the application of serious games in knowledge management and software engineering. From the eariler study of culture change, culture is something must be taught through allowing the individual to experience it directly, and using a serious game to teach something as complex as organizational culture then holds just as it does for knowledge management process such as software engineering.

Game and simulation can provide a learning experience that is immersive, motivating, experience based, capable of quick feedback the behavioral literature prescribes, and suitable for simulating highly complex dynamics, it will now be useful to address the general design principals a proposed culture game may take. According to the earlier conclusions, Moreno-Ger (2008) states careful thought at the design stage is critical to the success of any serious game. In this research, the simulation not only has to be a free format game play where participants are free to determine their own course of action, but provide multiplayer support to the extent that participant have the freedom to act in ways which allows for the creation of a unique culture. Furthermore, there are the requirements of quick and various forms of feedback as well as being able to overcome the most important arguable and limited financial resources. Therefore, using a Mass Multiplayer Online Role Play (MMORP) based on an adaptation of Second Life technology is the best approach to satisfying our serious game requirements.

Second Life (www. secondlife.com) is a 3-D virtual world created by Linden Lab in 2003, which is unlike most multi-user platforms. It is a completely free of a publisher-imposed narrative meaning, and has the potential to be used in almost any way the user aspires, simulating the real world principle of self-determination (Livingstone & Kemp, 2007). In terms of research purpose, Second Life is not only the most ideal, but arguably one of the only virtual environments allows for enough freedom to create and develop a virtual simulation game within its environment. Also considering financial constraints, building a culture game in the Second Life is one of the far more cost efficient approaches which probably can see much of the risk involved in firms taking on new technologies and approaches reduced to a minimum as the Second Life platform has somewhat of a proven track record when it comes to corporate involvement in the virtual world. Furthermore, the Second life allows its programmers (mostly virtual world's residents) to simulate reality rather than fictional story lines through a reasonably easy process.

5. A proto-type business simulation for managing corporate cultures

This section describes both the structure and content for the proposed prototype simulation, which aims to manage culture change with specific emphasis on dealing with the human element of mergers and acquisitions.

Defining Game Specifications:

In order to add an element of credibility to the proposed organizational culture simulation, this paper draws on the experiences and methods in both computer and management gaming, using the previously defined dimensions of culture as criteria. Having earlier established that an organization's levels of; uncertainty and risk, individualism vs. collectivism, power distribution and process culture are all core parts that help to define organizational culture, the ultimate aim is to provide the specifications for a prototype application which manages to aggregate elements of existing games which have shown to target these areas. Four types of games, which have been academically reviewed, have been selected due to their learning objectives which seem to be more or less analogous to our defined culture elements. Their learning objectives and more importantly their method of achieving these objectives are summarized in table 1.

Table 1: summary of learning objects and method of achieving these objectives

Game	Author	Achieved Learning Objectives	Methods used
Real Game	Lainema & Nurmi (2006)	Uncertainty/ processes	Learning as social experience/ complex process configuration
KM Quest	Leemkil et al. (2003)	Process/ decision making	Process+random events/ complex emulation of reality
World of Warcraft	Nardi & Harris (2006)	Social interaction/ Collectivism	Role-play/ game reward structures
Medical behavior games	D.H Goh et al. (2008)	Behavior modification	Conditioning/ re-inforcement

The Simulation Structure

It is useful to look and discuss some of the more structural elements before indulging into the more complex matters of defining the content of the simulation. The structure of the proposed simulation can be described in the following diagram:

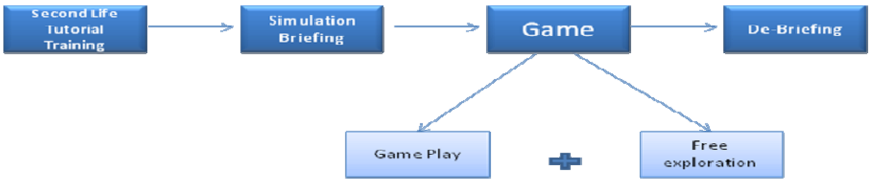

Figure 2: Game structure diagram

Figure2 shows that the simulation breakdowns the game element into game play followed by a free exploration mode while also involving some tutorial training participants have to take prior to commencing the simulation. The game-play element of the prototype simulation is an adaptation of traditional process oriented management simulations, used as a basis on which more advanced culture oriented events and interaction can take place. It is important to note however that the game-play elements will however only act as a component of the whole, and will be complemented by additional activities and events such as briefings and debriefings or a socialization and free-roam component. Therefore, for the sake of clarity, the all-encompassing prototype application is referred to as the 'simulation', while the game-play element of the simulation will be referred to as the 'game'.

SL Tutorial Training:

The SL tutorial training session consists of a series of online written tutorials aimed at familiarizing the participants with the mechanics, interface and workings of Second Life. While these tutorials can easily be purchased for minimal fees, there is a wide range of free content available including sites dedicated to teaching users about some the basic function of Second Life (www.sltutorials.net). In order to maximize the usefulness of the proposed simulation and guarantee its success, it is important that all participants are on the same playing field in regards to familiarity with Second Life prior to commencing the simulation. As discussed earlier, unlike more traditional learning methods, using serious gaming as a teaching method requires some elements of computer literacy, which some participants have and some won't prior to the simulation. Letting each participant accustom themselves with the second life software on their own time, not only cater to the participants different learning curves but also ensure participants are ready to benefit form the simulation and feel comfortable through its duration. One real danger of not familiarizing users with the software is prior to starting the simulation, is that it may hinder the creation of an in-game culture, as this may require complex forms of communication and complex behaviours.

Briefing + Debriefing:

The briefing portion of the online simulation aims to mirror the briefings of the traditional management games in its aim being to explain the game's mechanics and administrative elements. As the game consists of rounds participants are taken through one sample round and given the opportunity to ask questions, the aim once again being to make participants as comfortable as possible throughout the game. The goals of the game are explained as well as how to achieve such goals. However, while participants are made aware that the simulation is aimed at merging the human elements of two firms and, there is no explicitly state what kind of behaviours are being looked for in the simulation and accurately define what the garget organizational culture is. Based on the experiences looking into cases studies on organizational change, was that there is a need for experiential learning of required culture behaviour is participant are to 'genuinely comply' with new target culture. The approach took in this simulation is to allow participants to explore different behaviours, along the lines of the free rule simulation tradition, and use the scoring and feedback elements of the game to re-enforce those behaviours deemed to be in-line with the target culture. This avoids participants exhibiting desired behaviours merely for sake of doing what they are told.

The debriefing on the other hand is slightly different from those traditionally preformed in management and simulation exercises due to some of the features the second life platform has to offer. While simulation leaders may review more in-depth the desired behaviour changes the simulation was aiming to uncover and show the link between these behaviours and being successful in achieving the simulation goals (ie. Gathering most points), a key feature of the debriefing is the ability to capture and replay in real-time portions of the simulation to aid the post-game discussion. Such elements of the debriefing can be quite important in ensuring the simulation entails some elements of vicarious (from observing others) and cognitive (through interpreting) learning. Furthermore, since all elements of the simulation take place in the digital realm, the opportunities for data-harvesting and gathering statistics required supporting the discussions is immense.

6. Conclusion

Addressing the human side and more specifically the organizational culture side of M&A will therefore remain as big of an issue in the future as it is today. Culture as a highly evasive concept must nevertheless be tackled with advances in information technology providing some ideal opportunities. Culture, as an organizational property, is open to change and not only natural change, but change that can be managed. Being an aggregated measure of how employees are programmed to behave, organizational culture can essentially be targeted through inflicting lasting changes on to the aggregate behavior of employees. While behavior modification and different theories of learning provide a valuable insight into how the programming of the human mind take place, implementing behavioral techniques to a population as large as a whole organization (or two) has most likely been hindered by conventional constraints such as money, space, time and environments.

What recent developments in information and technology have however allowed us to do, is extending a part of ourselves as avatars in to virtual world or metaverses where real world constraints do not apply. The aim of this paper has been to define structure and technical specification for a culture simulation, being more or less platform independent, rather than concentrating on the physical construction of the simulation. The fundamental conclusions of this paper is that organizational culture can be altered through identifying key dimensions of an organization's culture and then applying conditioning techniques through the means of simulation exercise set in a virtual world.

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Aspects of Social Games in 3D Spaces Considering Usability and Accessibility

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Abstract: Many established usability patterns from 2D applications do not apply in 3D; users familiar with completing dialogues in 2D applications, using links on Web-pages and alike find it difficult to recognize similar interaction options in 3D and trigger offered events and vice versa. Re-using widely known social games or TV quiz-shows can partly help resolving the challenge but participants from a different cultural background might not be familiar with the specific game or show. In language learning this issue emerges quite often because the trainer and students usually are coming from different cultural backgrounds. A careful game-design which reuses a lot of existing "common sense" has proven to be beneficial to keep participants motivated and engaged. Moreover, fostering motivation seems to be one of the crucial success factors in game design. Simplifying access to and usage of a 3D platform is a significant hurdle preventing potential participants from joining in. In this paper we focus on participants' motivation, individual ownership, gains in reputation and personal network, flexibility and applicability of the learning content to the "today's" situation of the participant.

Keywords: Social games, 3D spaces, usability, accessibility

1. Introduction

We have been using Second Life as a 3D environment for language education since 2007 and observed that many established usability patterns from 2D applications do not apply in 3D. On the other hand usability patterns established in 3D games, such as highlighting objects which can be manipulated, moving characters using the arrow-keys, etc. are not familiar to most users interested in learning how to use a 3D space. A careful game-design which reuses existing game principles has proven to be beneficial to keep participants motivated and engaged. Simplifying access to and usage of the used 3D platform is a significant hurdle preventing potential participants from joining in; communicating the value of participating in the 3D learning experience is a specific challenge upfront, because using games for education is still a novel idea for most people with classical education. Reusing "common sense" elements may help overcoming these obstacles by building a motivating expectation for the potential participant.

We focus on the participants' motivation, individual ownership, gains in reputation and personal network, flexibility and applicability of the learning content to the "today's" situation of the participant. As we support students active in their day-job the question "how can this game help me getting my job done today" is the key question to our game design in the first place.

The application of Multi User Virtual Environments (MUVEs) for learning purposes is becoming increasingly popular as a new media delivering education (NMC 2007). Especially in the field of language education the potential to create a "virtual" version of the foreign country benefits a lot from the immersive nature of the 3D space a MUVE offers. In our case of talkademy.org, Second Life (SL) is used as an implementation of MUVE, but we focus on general aspects of usability and accessibility relevant to all kinds of different MUVE implementations.

Language learners want to learn a language, not how to handle new applications. They will look for a learning experience with the promise of success, addressing their individual needs, helping them to stay engaged and motivated during the process and enabling them to integrate it into their daily life. However many potential students don't have experience in using MUVEs, 3D spaces or even 3D computer games. Previous studies present (Ousland 2002) students with little or no prior knowledge can survive in the intended environments. An important condition for that is best use of the usability practices while designing 3D applications.

The motivation behind our work is focused on the intention to provide research solutions that entice, motivate and engage the intended participants by providing best usability and accessibility practices in a 3D space. This effort may help uncovering some of the facts that require consideration to better design 3D multiuser virtual environments.

Although there are some disadvantages related to corporate politics, Second Life (SL) was chosen as a Multi-User Virtual Environment (MUVE) for the application in language learning, for which it provides all relevant media (including voice chat) as well as the 3D visualization of social spaces.

2. Related work

Few recent research solutions are discussed that witness the shift from 2D to 3D environments like Virtual Tourist Guides, Virtual Shopping Malls (Kerr 1999), Virtual Museums (Karoulis 2006) and AquaMOOSE (Elliott 2002). (Ousland 2002) present work that uses different kinds of metaphores (flying and jumping) to impart the aspect of motivation and address the usability problems, user interaction and behavior while navigating in 3D space. To make navigation easy and effective another problematic aspect can be input devices because usability of these devices depends on the task (Hinckley 1997). However similar findings to previous literature are studied that there is no need of specialized 3D input devices (Ousland 2002).

According to (Rankin 2006) "this is not to say that 3D games with their powerful graphical interface have become the panacea to learning rather thoughtful design and application of computer games determine effective digital learning environment". This puts emphasis on the design of 3D applications that has ultimately influence on the usability (Ousland 2002). The size of the virtual environment is another usability problem that may cause obstacle in moves of users (Elliott 2002). Some other e-learning solutions in 2D environment has similar findings about usability, (Kam 2005) educational applications should have usable, efficient and learnable user interfaces so that requirement for extra practice can be eliminated. For 3D spaces, this issue appears to be more critical where learners find totally different environments because 3D environments add extra difficulties for both system and its user (Nielsen 1998). (Ousland 2002) states numerous factors that may affect the performance of the user in 3D environments 1) Differences among individuals, 2) Environment design, 3), Interaction devices, 4) task and 5) metaphor.

Social games in 3D space has potential to provide 1) Learning-by-themselves and 2) Social interaction but there is a need to design these artifacts using potential of achievements of studies previously performed in 3D spaces to augment the ease of use and universal accessibility. One of the fundamental goals of our research is to synergize these worthy achievements and to extend the intended work towards further findings and new experiences.

3. Social games for learning in SL

3.1 ESL learning scenario

To introduce new learners to classes in a 3D space we usually put up some 3D games which can be accessed collaboratively. This way the primary learning aim – learning a language – dominates. In the same time the participants learn about how to handle the MUVE application.

In addition we reduce all available visual elements to the minimum required for the game. For first time attendees in a MUVE the experience can be overwhelming, the limited own abilities combined with the presence of other people in a rich setting creates a lot of stress.

To obtain all these objectives we select scenarios which we hope to be already well known by the participants, like games from TV quiz-shows. And which require only very limited abilities to handle the MUVE application, like using only one channel of communication.

One of the tested scenarios were the popular German kid's game "1, 2 or 3" where a question is asked and the kids need to decide which of the 3 possible answers is right. They vote as a group by moving themselves on the according field on the ground. It turned out, that training grammar this way is experienced being fun. In the same time the students train to move their character in the MUVE application and they have no need to use other communication channels like chat or voice. Thus it's the perfect game and ice-breaker to start a new course.

3.2 Implementation in SL

Figure 1: "1-2 or 3" in Secondlife the game principle is to choose one of the answers by moving the avatar over it. Even though the game is almost trivially simple, it is fun to play because of the social dynamics of group behavior

The implementation in Second Life is quite simple, only using a texture on the ground, and a slide-presenter which flips through questions and answers. Correct answers can be detected automatically, by detecting on which field a character is positioned. The moderator has the role to animate the users and guide newbies.

4. Findings and experiences

We learned from the previous studies that usability and accessibility issues are a major obstacle in the learning process as learners have to spent most of the time to get familiar with the system. The learning as such is pushed to a secondary level. Our investigation during this research highlights the need of Multi-User Virtual Environments (MUVEs) like Second Life (SL) for education.

In SL settings learners are there to learn the subject (like Language) in the first place, NOT *how to handle the environment*. This brings the learning process to primary level from secondary level. It focuses on the principles of careful selection of black boxes (Resnick 2005). The proposed solution also supports people who are skeptical of computers, game-like environments and learning activities due to complexities. It has potential to entice the target audience because of better usability settings. Working learners are unable to approach traditional learning environments due to lack of time, using proposed settings they can save a lot of time by participating in online learning. Also time spent on traveling (to approach real learning environments) seems to be accounted differently than time spent in learning something even unwanted (how to use the application?).

Another potential application of the proposed 3D world in education might be in *minority groups* who have a hard time with the computer; like illiterate people, older people, socially excluded people (prisoners, people with illnesses), challenged people. Using virtual identities, it is not necessary to be physically exposed to any other user of the system. Especially for these potential users, the usability is major issue. They have self-consciousness "I can do it!" but unfortunately current user interfaces in SL have no room for them. There is a huge gap between the potential and what can be realized today, to overcome these obstacles to some extent we introduce two measures as initiative:

- Use of social games (like the "1, 2 or 3" game) to learn both how to use the application and learn about the "real" learning subject. In this way one can start with very limited UI inputs from the user AND there are peers to help/orientate. In 3D worlds people seem to orientate others (Ousland 2002) and also skeptic people can be motivated and enticed.
- Build a simplified user-interface, this can be a specialized Client (there are some alternative available) or - like in our case - using Video Streaming and VoIP to "onboard" new participants.

Another interesting effect is that well known games like "1-2 or 3" are not that well known as one might think; an American native speaker teaching English to Germans might not know how this game works (the student do), although providing the native speaker with information about the game is formally correct, but often they do not read the instructions upfront. (Looking to the 3D games like World of Warcraft - similar things happen there. No one seems to read the quest assignment, but everyone seems to discuss "how can I solve quest 1234" in social discussion forums) or even if the native speaker knows how the game works, he/she might not know how to flip slides. During creation and preparation of a 3D environment it is necessary to simplify everything wherever possible. By analyzing typically problematic situations with the help of automatically gathered data a sensible simplification of user interaction is achievable.

5. Proposed usability measures

As pointed out above, the approach chosen is to focus on social aspects of the applicational context, as well as on the user interface. Doing so, it is necessary to access 3D applications by using an interface application, commonly called "viewer". As identified by Kelle and Crespo (2007) the degree of usability in 3D spaces thus depends on the degree of usability of the interface and its sub-applications. It has been pointed out that this can be quantified by a usability quality indicator *U* with

$$U = \| \varphi \cdot \omega \cdot S \|$$

where φ denotes the general interface usability score and ω denotes the application usability score. *S* denotes the "specification" score achieved by the sub-applications of the interface to be employed for use in the 3D application. For example the "chat" sub-application may be used more frequently for using social communication than an exhibition (which can be used contemplatively by a single user) therefore has to be weighted with a higher factor in this context. Therefore the measure is

$$S = \sum_{i=1}^{n} \mu_i a_i$$

where out of a total of *n* sub-applications μ denotes the *i*-th sub-application's individual usability and *a* the factor of applicability (frequency and importance of use on a specific application).

Regarding accessibility, as evaluation criteria the following factors have been identified:

- Principle 1: Perceivable *(p)* - Information and user interface components must be perceivable by users
- Principle 2: Operable *(o)* - User interface components must be operable by users
- Principle 3: Understandable *(u)* - Information and operation of user interface must be understandable by users
- Principle 4: Robust *(r)* - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies

A global accessibility indicator *A* can be obtained considering all these factors:

$$A = \| p \cdot o \cdot u \cdot r \|$$

Also, although a global measure is necessary, distinguishing the accessibility degree for a specific disability is of importance. Therefore it makes sense to break down this global measure into a more detailed metric, the components of which correspond to specific accessibility measures for different handicaps.

Each accessibility component can be analyzed regarding specific disabilities:

$$\vec{P} = (p_v, p_a, p_m, p_t)$$

where p_v, p_a, p_m and p_t signify components each representing specific accessibility indicators regarding visual, auditive, motor and technical handicaps, respectively. An individualized metric for a given user ($\mathcal{A}_u$) can be calculated from a user model vector, which weighs the importance of each disability for such user, and the accessibility measures projected into each disability axis:

$$\mathcal{A}_u = (u_v, u_a, u_m, u_t) \cdot \begin{pmatrix} p_v & o_v & u_v & r_v \\ p_a & o_a & u_a & r_a \\ p_m & o_m & u_m & r_m \\ p_t & o_t & u_t & r_t \end{pmatrix}$$
$$= (p_u, o_u, u_u, r_u)$$

Hence, a holistic personalized accessibility indicator can be calculated from the general formula:

$$\mathcal{A}_u = \| p_u \cdot o_u \cdot u_u \cdot r_u \|$$

Finally, to account for the accessibility criterion as factor for the overall usability value, Kelle and Crespo propose a metric that accounts for a universal quality measure Q, bringing together Web 3D usability an accessibility scores including all their subsets and criteria:

$$Q = \| A \cdot U \| + c$$

where the variable *c* can be used for bias or tolerance because usability and accessibility are never completely independent.

This Web 3D specific usability/accessibility metric has been chosen because of its versatility and theoretically well-founded completeness. Therefore it will be applied and used for our evaluation purposes.

6. Conclusion and future work

As illustrated, the initial assumption that someone with basic computer skills would be able to accomplish simple tasks in a MUVE appeared wrong. Established usage paradigms well known in a 2D environment are not recognized as soon as the user interface becomes 3D (example: flipping the slide with the "next" button), which demands for a more specific usability evaluation model like the one described above.

Assumptions about what people know proved wrong as well (most people in Central Europe know "1, 2 or 3", but not the English natives).

This is a challenge and an opportunity to rethink principles of usability and focus on what users want to achieve in the first place. Future research efforts will make use of the wide source of experimental data available in Talkademy as a controlled environment in order to deliver valuable input for further improvement of this novel approach in learning.

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Using Games Classifications to Support the Design of Learning Games

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Abstract: To reinforce learners' motivation while maintaining reasonable cost levels, the professional training sector is now focusing on Learning Games. Our work concentrates more specifically on role-playing games that use computers as the supporting environment for remote group work. This initial choice is based on the well-known benefits of role-playing games in various areas of professional training. It is also explained by the fact that role-playing games can respond to key issues identified in the use of Learning Games such as the need for flexibility and the will to use group work situations. Our goal is to provide designers with models and support tools to help them build a technological and human training device geared towards creating a collective learning experience based on role-playing games. The specification of the support tools under consideration is based on results of previous work on the sharing of learning scenarios. It also requires a homogenized description of the provided games scenario models. This paper outlines the methodology used to construct a description grid for game scenarios. It presents in particular our study of existing game classifications so as to establish a set of criteria to constitute the grid. Seven classifications were selected. Each one is presented in this article and the relevant elements for our grid are brought to the foreground. The main features of the resulting description grid and its organisation are explained. A practical example of the grid is provided at the end of the article. This allows the description of a role-playing game used in professional training to be formalised and its structure to be revealed. As a conclusion, issues and needs raised by the tests of the grid are discussed. Further applications of the description grid are mentioned at the end of the paper: for example, its capacity to describe role-playing games scenarios so as to facilitate their adaptation for contexts of use different from the initial one (distance learning vs. face-to-face learning).

Keywords: Professional training, learning games, computer-supported design, role-playing games, learning scenarios

1. Introduction

1.1 Context

To reinforce learners' motivation while maintaining reasonable cost levels, the professional training sector is now focusing on Learning Games. A Learning Game can be defined as a pedagogical system using game mechanics for acquisition or formalization of knowledge or skills.

Our line of research is based on three key issues identified with these methods: no methodologies or tools exist that guarantee efficient use of games in learning; current solutions are too inflexible to be able to cater for the short life cycle of certain training contents; there is a need for systems to support knowledge co-construction and the transfer of non-formalised skills.

This work concentrates more specifically on role-playing games (Proust & Boutros 2008) that use computers as the supporting environment for distant group work. This initial choice is based on the well-known benefits of role-playing games in various areas of professional training. There are two other reasons why these tools are favored: first, role-playing games offer flexibility, with simple scenarios (few rules) and a possible variety of external resources upon which to base them, which is an essential characteristic when we consider the short life cycle of some training contents; second, by creating group work situations, role-playing games can support the co-construction of knowledge and the transfer of non-formalised skills, thus responding to new challenges facing companies.

1.2 Goal of our work

In this context, our goal is to provide designers with models and support tools to help them design a technological and human training device geared towards creating a "collective learning experience" based on role-playing games.

The authoring environment will guide the designers throughout the specification stages of the system (target audience, objectives, constraints, etc.). The support tools under consideration are specified based on the results of previous work on the creation and sharing of learning scenarios. It must also rely on a homogenized description of game scenario models. Thus, the first stage of our work involved establishing a set of criteria that would constitute a description grid for game scenarios.

This paper highlights the methodology used to construct the description grid. The resulting description grid is presented throughout the description of a role-playing game used in professional training. Finally further applications of the grid are mentioned.

2. Methodology

2.1 Work on learning scenario design

Our environment to support the design of Learning Games is specified based on results of research on learning scenarios (Koper & Tattersall 2005, Kinshuk 2006). The support environment is organised around three stages identified in the creation of a Learning Game scenario:

- *general specifications* of the system (target audience, objectives, possible constraints);
- *general scenario design* based on “games scenario models ” linked with the previously defined specifications;
- *adaptation and operationalization* to contextualise and adjust the parameters where necessary in order to run the scenario on a computer platform.

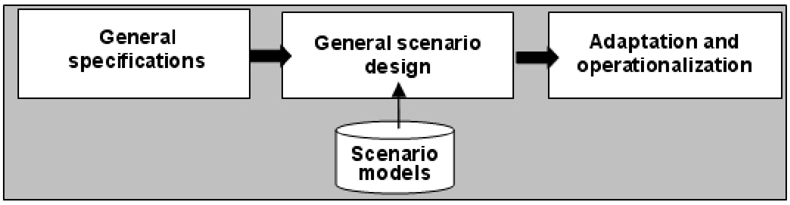

Figure 1: Structure of the design support environment

Research on design support and reuse of learning scenarios puts into perspective the need for the definition of a formal description frame. This frame should possess essential elements such as formulation of intentions or presentation of pre-existing uses (Villiot-Leclercq 2007, Pernin et al 2008). In the context of our work, this formal frame will take shape as a description grid for games scenarios.

The Pleiads method (Villiot-Leclercq 2007) aims at “expressing the learning scenarios in a formalized and instrumentable way” by defining descriptive and organising properties. For our particular goal we will pay particular attention to the following properties: granularity of the scenario components, status (required or optional), density (number of stages), list of stages and orchestration.

Our work is about specific scenarios: training games scenarios. To define their description criteria we also need to take interest in games classifications.

2.2 Study of existing games classifications

To gain a broad vision of the field of gaming, we examined classifications covering “traditional” games, video games and training games, established both by researchers and professionals in the field. We also studied a classification of Serious Games that is, games with a serious purpose including Learning Games. Seven classifications were selected to present diversified points of view and objectives as well as various periods of games history. For each one we bring to the foreground relevant elements that can support the definition of our particular description grid for games scenarios.

2.2.1 “Traditional” games classifications

Caillois’s work on game’s social role (1967) is considered as a reference in this field. In order to better understand the subject of his own study, Caillois built up a classification which outlines four categories of games according to “player’s attitude”: *Agôn* for competition games, *Alea* for those where chance intervenes, *Mimicry* for imitation (players pretending to be someone) and *Ilinx* for vertigo. Caillois has also defined two points to describe games according to the presence of rules: the *païda* element of free-form games (no-rule games) as opposed to the *ludus* element of games laying down clearly defined rules and conventions.

By inserting these criteria into a structured game description, we would like to outline a link between the game mechanics defined by Caillois and group work pedagogical activities, or even specific knowledge or skills.

2.2.2 Videogames classifications

One of the first videogames taxonomies (Crawford 1982) pursues a goal shared with our own work: it aims at guiding design. This taxonomy makes a distinction between two broad categories: on one hand, “skill-and-actions games” that emphasize motor and perceptual skills, and on the other hand “strategy games” that emphasize cognitive efforts.

In the nineties, a new videogames classification was built (Le Diberder 1998). This time, the goal was to guide users in their choice of videogames. This classification based on the history of the video games industry, presents three major categories: puzzle games, arcade or action games and simulation games.

These works outline a description element that can not be ignored when planning to use a game as a training course that is, the kind of skills that is at stake.

In the field of information and communication sciences, a more recent study (Alvarez 2007) presents a classification aiming at defining the characteristic elements of a Serious Game as compared to a classical videogame. This videogames classification relies upon the definition of bricks. Two kinds have been identified: *game bricks* related to the goals of the game (i.e “DESTROY”) and *play bricks* corresponding to the means to reach these goals (i.e “SHOOT”).

Following this work, a description system has been built and is applied on the website www.gameclassification.com (Alvarez & Djaouti 2009). This system is called GPS which stands for Gameplay, Purpose and Scope. This system uses the formal game analysis resulting from the definition of *Gameplay* bricks (the formal aspect). It has been enriched with two others aspects: *Purpose* (the cultural aspect, related to the author’s intentions) and *Scope* (the pragmatic aspect, related to the use of the game).

The definition of the Gameplay bricks is presented as sometimes difficult to objectify (Alvarez 2007). That’s the reason why the use of these criteria for a homogenized description of games scenarios is not suitable. However, the methodology presented throughout the GPS system must be retained. It proposes a presentation of the formal aspects of the game, the designer’s intention and information related to the use of the game. This description is close to the framework defined by Klabbers bringing to the forefront the general specifications (in particular author’s intentions), the game syntax (its configuration) and its pragmatics (usage).

2.2.3 Classifications of games for professional training

In the field of games for professional training we have retained Thiagarajan’s work. This particular interest is due to the fact that one of his goals is close to ours: it aims at defining games models.

The presentation of games models also called “Thiagi framegames” (Thiagarajan 2004, The Thiagi Group’s website 2009) uncovers two kinds of classifications: the first one related to the game’s position in the training session (i.e. opener, closer, debriefing, etc.), the second one related to the type of support or activity (i.e. roleplay, card game, puzzle game, audio game, etc.).

These classification elements are part of the description frame proposed by Thiagi which aims at structuring the presentation of games so as to make their appropriation easier. From this description, we also notice the principle of the”topogram” used by Hourst (Hourst & Thiagarajan 2007) that is, a diagram displaying the rules and structure of a game. Using this kind of display in a design support environment seems relevant as it offers a simplified and structured view of the game phases layout.

2.2.4 Classification of serious games

Sawyer is usually presented as the Serious Games' father in the United States, and thereby considered a reference in the field. The taxonomy he defined (Sawyer 2008) gives an overview of the possible uses of Serious Games and can be useful for companies planning to develop such games. A first level in this taxonomy shows the possible purposes (advertising, training, etc.) related to industry types (healthcare, defence, etc). It is completed by a more detailed taxonomy for each kind of purpose.

The description criteria defined by Sawyer do not appear to be very homogenous, in particular in detailed taxonomies. Thus it is difficult to use them to provide a homogenised description of games scenarios. However this work points out the fact that a presentation of possible games uses is needed in order to guide customers or designers in their choices.

2.2.5 A transverse classification

Through the definition of a taxonomy to classify games and simulations, Klabbers (2008) aims at constructing a frame to describe games – "traditional" as well as video games, for leisure as well as for training (Learning Games).

Klabbers's taxonomy stands apart from other classifications as it considers a game as a social system composed of actors, rules and resources. Each one of these elements is described according to three points of view corresponding to the linguistic approach of the semiotic theory of gaming by Marshev & Popov (in Klabbers 2008): syntax (form of the game, components' arrangement and rules), semantics (content, interpretation and meaning of the game components) and pragmatics (information useful for the design and the use of the game). Klabbers also considers using this framework in order to design new games. With that purpose some elements to prepare the design specification are added: client, game purposes, subject matter, target audience, context of use.

We got particularly interested in Klabbers's taxonomy as it appears relevant for our work with its objectives similar to ours. Indeed, the first goal of this taxonomy is to reveal the structure of existing games. The second one is to guide the design of new games. Moreover both goals apply to all kinds of games whatever their format or purpose, computer games or not, "serious" or not.

2.2.6 Criteria for our description grid: a synthesis

As an outcome of the study of these classifications, we based the construction of our description grid on Klabbers's taxonomy (Klabbers, 2008). With the goal of describing games structure, this work will be useful for defining models of games scenarios.

Table 1: Synthesis of description criteria selected from studied classifications

Classification	Elements used in our description grid
Caillois (1967)	• Game mechanics: competition, chance, playing a role, vertigo • Degree of freedom: from *païda* to *ludus* • Possible combinations of game mechanics and resulting effects
Crawford (1982) Le Diberder (1998)	• Kind of skills trained through the game
Alvarez & Djaouti (2009)	• Author's intentions • Formal aspect of the game (structure) • Elements related to the use of the game
Thiagi (2004)	• Position of the game in the training session • Main support of the game (board, computer, cards, role-play etc.) • *Topogram* for a graphical representation of the game organisation
Sawyer (2008)	In a perspective of supporting reuse of existing scenarios: • Presentation of possible uses of the game (specific context and goals etc.)
Klabbers (2008)	• Games as social systems composed of three blocks: actors, rules and ressources • Three points of view: syntax, semantics, pragmatics

Klabbers's taxonomy has been altered to suit our particular context. The construction of this grid also takes into account criteria from the classifications mentioned previously. Table 2 summarizes the main elements we take into account from the studied classifications. Those elements are integrated into the description grid we present in the following section of the article.

3. Presentation of the description grid

An aim of our grid is to describe scenarios of games for training as completely as possible. In this way it differs from most of the existing work studied. The grid we are working on has to put on relief the game structure to help defining scenario models. Thus, in the specific context of Learning Games, the description must present all the phases of the scenario including the essential debriefing part (Crookall, 1992). The elaboration of the grid is still in progress. Therefore the terminology is not definitely fixed: we will try to adjust it to the users (pedagogical designers) habits: for instance by establishing correspondence with learning design languages such as IMS-LD. (Koper & Tattersall, 2005).

3.1 General features

The description grid is divided into two parts. In the first part, general specifications provide an overall definition of the system and its context of use: client, industry, general purpose, target skills, intended audience (profile, number, organisational constraints, constraints related to the company's characteristics), place of the game in the training course, synopsis, duration and planning.

In the second part, the game architecture is described at several levels depending on the granularity of the system. The *macro level* provides an overall view of the game organisation. The *micro level* reveals in a more detailed way each of the phases identified at the macro level. Actors, rules and functions of the game system are described from three points of view: syntax, semantics and pragmatics. The functions mentioned here are quite similar to the notion of "resources" specified by Klabbers, but the initial definition has been modified to better fit our needs.

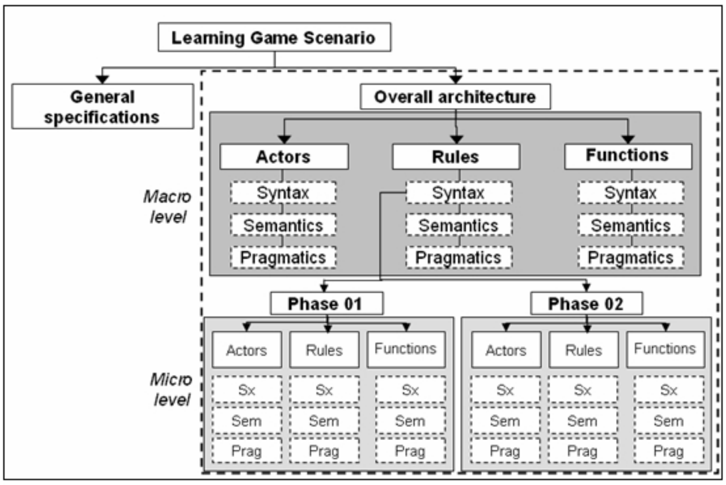

Figure 2: Organisation of the description grid

At macro level, the description of rules and functions mainly focuses on syntax. Semantics and pragmatics are closely related to the various phases of the game and thus they are usually detailed at micro level description.

The actors syntax describes the number of participants (players and game masters or instructors) and the teams' composition. Semantics shows the role of the participants. Pragmatics defines in particular the kinds of learning strategies used (i.e. learning by interaction between participants or learning by acquisition, etc.)

The rules syntax indicates the degree of freedom of the game (from *païda* to *ludus*). It explains the preparatory phases, start and stop rules, the number and organisation of the game phases (status – required or optional; characteristics – collective, collaborative, cooperative, individual; duration). A diagram reveals the overall structure of the game and enables visualisation of the various phases and their organisation. The semantic description gives details of the role of rules for each phase. It indicates which game mechanics (defined by Caillois) are present (*agôn, mimicry, alea, ilinx*). For each phase, pragmatics point out the instructor's actions and the possible assessment and evaluation functions.

First, the "functions" part of the grid defines the main supports needed for the practical use of the game and thus defines the type of game (i.e. board game, cards, computer game, role-playing game, etc.). Second, the presence of resource functions (provided or produced documents, provided tools, etc.), communication functions and organisation functions (i.e. planning function) is indicated at a syntactic level. And lastly the role of these functions (semantics) and their practical aspect (pragmatics) are also detailed.

3.2 Test of the grid: description of a role-playing game

In order to test our grid in the description of a role-playing game, we applied it on a framegame for conflicts management training that was found on Thiagi's website.

This test aims at verifying the ability of our model to provide a complete and non-ambiguous description of a role-playing game. And this organised description should enable mutualisation and reuse of the structure and game scenario.

3.2.1 General specifications

The game described here takes place in a 90 minutes long face-to-face training session. It is composed of three roleplays based on realistic conflict scenarios occurring in a professional context.

3.2.2 Description of the game: macro level

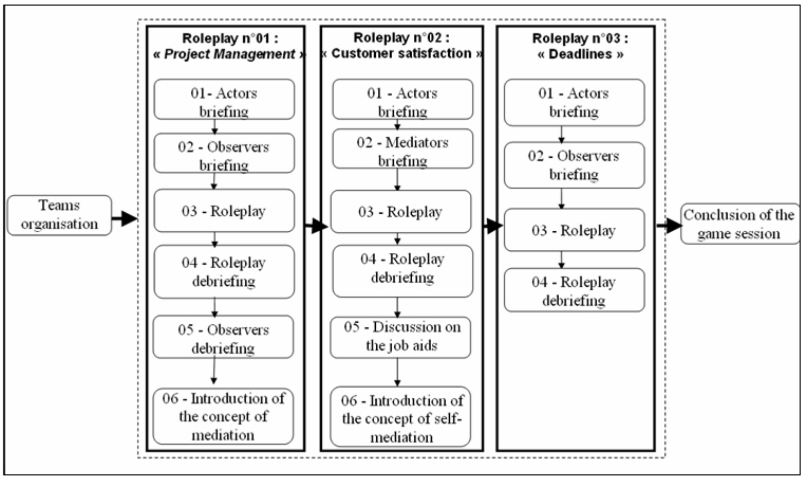

Figure 3; Detailed organisation of the game phases

This game is intended for a group from 3 to 15 participants divided into teams of 3 players. In the first and third roleplays, two participants act as the actors of the conflict as defined by the scenario and the third one acts as an observer of the roleplay. Roles are a bit different in the second roleplay where two participants act as the actors of the conflict, and the third one takes also part in the roleplay acting as a mediator.

3.2.3 Description of game elements at a micro level

To illustrate the content of the grid at a micro level, we focus on the second phase of the game ("Roleplay n°2") which is composed of 6 steps: 1- Briefing the actors; 2- Briefing the mediators; 3-Roleplay; 4- Debriefing the roleplay; 5- Discussion about the job aids; 6- Introduction of the self-mediation concept. At a micro level, this phase and its actors, rules and functions are precisely described in the grid from the three points of view (syntax, semantics and pragmatics). An extract is presented in figure 4 showing the part related to the game functions description.

Functions				
Syntax		*Semantics*	*Pragmatics*	*Related steps*
Main support	**Oral communication (roleplay)**			
Resources functions	**Yes** / No	***Provided instructions documents***		
		Bob's story : for conflict actor (B)	Paper doc	1, 3
		Cathy's story : for conflict actor (C)	Paper doc	1, 3
		Mediation check-list for mediator	Paper doc	2, 3, 5
		Mediation guidelines for mediator	Paper doc	2, 3, 5
		Searched resources documents - N/A		
		Produced documents		
		Trainer's notes about interesting mediation activities observed during the roleplay	Paper doc	3, 4
Communication functions	**Yes** / No	*Social interaction*	N/A	
		Group work/ collaborative tasks	Face-to-face oral communication	All
		Negociation	N/A	
		Choice - Convergence	N/A	
Organisation functions	**Yes** / No	*Profiles management*	N/A	
		Planning : Management of roleplay timing	Timer	3

Figure 4: Micro level – game phase n°2: description of the game functions

4. Conclusion

This test allows us to have a first verification about the expressiveness of this description grid's underlying model.

Moreover the test put on relief the need for some adjustments in order to improve the understanding of the criteria and to make easier the use of the grid:

- First, terminological and definition issues have been raised. Some criteria need to be defined more clearly and some components of the grid should be described along with relevant examples. We should also use a more explicit and suitable terminology. Regarding our goals and the corresponding pedagogical context, we have to think about making closer links with learning design terminology.
- Secondly, our aim of using the grid to support pedagogical design is leading us to add specific description elements such as the pedagogical objectives of each phase of the scenario.
- Moreover, it appears that the grid must remain flexible enough in order to fit the diversity of possible game scenarios. Only when relevant, the game mechanics could be quantified. If necessary, they could even be specified associated to each step of the game scenario at a micro level of description.
- Another question raised by the tests is about the degree of freedom specified in the syntax of rules. The degree of freedom considered here is the one offered by the game to the players. Perhaps should we consider the freedom given to instructors in the possible way of leading the game scenario? Keeping in mind the pedagogical purpose of the game scenarios that we aim at designing, we should think some criteria from both points of view: in one hand, we should consider the point of view of the instructor, and in the other hand, we should consider the point of view of the learners.

Further tests will be conducted in order to verify that the grid suits our intended audience, pedagogical designers for professional training.

Moreover, we work at enriching it with the concept of activities' "*play potential*" ("*potentiel ludique*" in French) as presented by Brougère (2005). The elements defined in this concept could complete the description of game aspects relevant for a learning purpose.

Another goal is now to test the grid's ability to describe existing role-playing games in order to use them in a context different from the initial one. In that way, the existing games scenarios will serve as models and we take particular interest in adapting these types of games to distance training courses, intended for a geographically spread audience, and using digital tools such as videoconferencing, LCMS platforms, etc.

Our design support environment will focus on features related to game mechanics and aspects of games that could motivate and enhance learning (i.e. features to create competition, features to make chance intervene in a scenario, etc.). In particular we will work on role-playing games' mechanics and look for a way to reinforce players' immersion (into the graphical universe, into the story or the roles they have to play out).

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