KidsKount

Mathematics games for realistic mathematics education in primary school

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Abstract

Educational games on the computer can enrich the mathematics lessons in primary education. For this purpose the Freudenthal institute (Utrecht University) has developed a special educational website (www.kidskount.nl) to experiment with this type of technology use.
The Dutch version of KidsKount (www.rekenweb.nl) has become one of the more popular educational websites in the Netherlands. The popularity is shared among children (age 8-12), the popularity among teachers is growing.
In this paper we discuss the educational opportunities of KidsKount, based upon the experiences of three years of educational use.

KidsKount

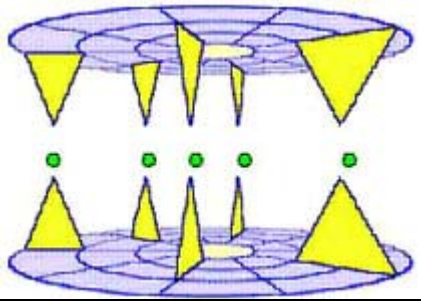
KidsKount is a educational website, hosted by the Freudenthal institute, for international users. It contains a collection of small computer tools, so called applets, that can be used at home and at school.

An overview of mathematical games at KidsKount

They are written for the several mathematical strands for elementary school (age 6-12)

- number sense
- number and estimation
- measurement
- geometry

The KidsKount website is one of the products of the 'Arithmetic Net' (Boswinkel, 2000). This Dutch project, started in 1999, consists of two levels:



Educational website KidsKount

- for kids, teachers and parents

Network of teachers

- annual conference for teachers
- annual Arithmetic Day

The Arithmetic Net

It is very important that an educational website is developed by the end users, the teachers that actually will work with the materials, the news, etc.
Both the website and the network of teachers have found their place the support of mathematics education in primary schools.

Realistic Mathematics Education

KidsKount finds its roots in the development of realistic mathematics education in the Netherlands. Since 1971, the Freudenthal Institute has developed a theoretical approach towards the learning and teaching of mathematics known as 'Realistic Mathematics Education' (RME).
RME incorporates views on what mathematics is, how students learn mathematics, and how mathematics should be taught. The principles that underlie this approach are strongly influenced by Hans Freudenthal's concept of 'mathematics as a human activity'. He felt that students should not be considered as passive recipients of ready-made mathematics, but rather that education should guide the students towards using opportunities to reinvent mathematics by doing it themselves (Gravemeijer, 1994). This concept can be recognized in the problem solving activities of KidsKount.

Collaborative learning

We believe that working with computers must be placed in a social environment, in order to create a rich learning environment. In a sense that's how we like to define computer-supported collaborative learning (CSCL). CSCL is one of the innovations to improve teaching and learning with the help of modern information and communication technology. Collaborative or group learning refers to instructional methods in which students are encouraged or required to work together on learning tasks.

There is a growing amount of international research in this area (e.g. see the references at the CSCL 2003 conference, June 14-18, Bergen, Norway).
Students that work with interactive mathematics applets from KidsKount and WisWeb (both sites developed by the Freudenthal institute, Utrecht University, one for primary level, one for secondary level) work together various ways:

- at school with both students and teachers
- at home with their family/friends

From research we know that collaborative learning can enhance students' performance (Mercer, 1996), we also know that new skills for the teacher are necessary to guide this process (Fischer, 2000). More research has been undertaken to investigate how the 'asynchronous' learning (at the computer, not all students at one time during the instruction process) does fit into the 'synchronous' classroom activities, especially the setting in which the negotiation of the several different problem solving strategies is worked out by the teacher and the students. What are the conditions to get an optimal transfer between these two settings?

The traditional mathematics classroom is arranged around the intended classroom activities: teacher instruction, students that work individually and possibilities to work in groups if necessary.
If computers are added to this setting, the ideal situation is that about 3 to 4 computers (at a group size of 18 to 24 students) are placed in one of the corners or sides of the classroom. Of course students can work individually at the computer (and they will, for some tasks), but on the other hand it is very important that they can help each other finding solutions, exchanging different ways of exploration and solution.

It is obvious that the teacher must make changes to the normal teaching process. Not all students will be working on the same problem at the same time. The teacher must make a schedule in which classroom instruction and group work are planned carefully. When working on the computer, there will be questions from students about the software. This means that the teacher must be familiar with the software used. During the computer sessions there will be differences in time and level of solution.

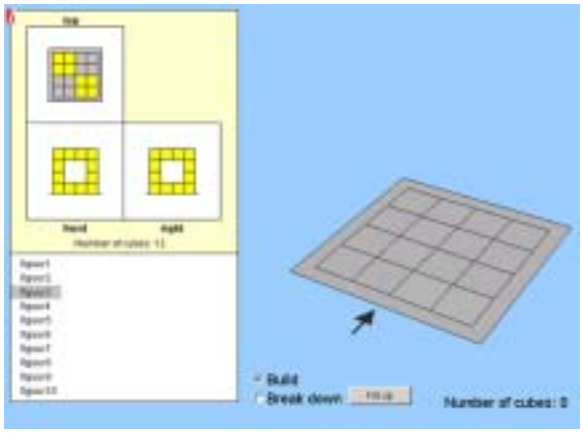
The computer sessions can be worked out with a great variety of software, ranging from exploratory tools (for a first introduction in a new subject) to more focussed single-subject software (for a better insight and variations in exercises). In this research a selection of mathematics 'applets' (small interactive tools on the internet) will be used.

To get a classroom situation in which the activities of KidsKount can take place and where they can enrich the educational setting, we now describe four goals of KidsKount:

- to enrich the mathematics lesson;
- to explore the possibilities of internet use (for example game elements);
- to facilitate collaborative learning;
- try to make the gap smaller between school-learning and home-learning.

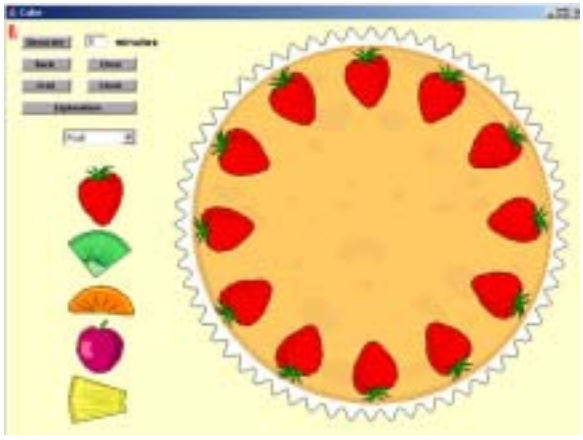
Goal 1: to enrich the mathematics lesson

The current textbooks for mathematics education in the Netherlands are rich illustrated books with colorful illustrations, clear problem items and a rich set of exercises. They have rich contexts to get the children real involved in the stated problems. Still, a lot of children do have difficulties with solving the problems of measurement, geometry, number and other mathematical contexts.
On KidsKount we investigate what kind of 'dynamic' use of computer tools can be added to the normal textbook items, that can enrich the mathematics lesson.



Blocks

In this game you can build a lot of houses according to the views that are given in the upper left corner (top, front and right view). At the right you can simply click the blocks in the grid that is given. This kind of exercises must be accompanied with work with real blocks, otherwise the computer activity will not be related to the real world. But this learning environment is a strong enrichment for this kind of exercises from the textbook.


Pie

In this game children can work with the circle that is divided into 60 minutes (like a clock) and they can use their knowlegde of de division of the clock in quarters, in 12 parts of 5 minutes etc.

From student work we see that this kind of additional activities in the classroom can help children to get a better grasp of the mentioned phenomena (views of 3D-objects, division of a circle in equal parts).

Goal 2: to explore the possibilities of internet use

When we are looking at goal 1 (enrich the mathematics lesson) it can all be managed by 'traditional' software that has come to the classroom the last 10 years and that can be installed 'standalone' on the computers. You don't need the internet, although things get easier when it is available online of course.
In goal 2 we like to search for additional possibilities when all users work on the internet and can make use of the same resources, and possibly could communicate with each other.
For this reason we invented the 'Problem of the Month', a monthly mathematics interactive problem, that is placed in the heart of the website. At the Dutch equivalent of KidsKount we now have thousands of children (from grade 4 to 6) who play this game and send their answers to a central database. Now we can look at often used problem solving strategies and have small discussions about how to solve this kind of problems in general.
We still have to do a lot of work for good usability of our software (Squires 1999, Wishart 1990), like an easy-to-use interface, possibilities to share and collect work, etc. But we are encouraged by the thousands of children who already visit our website and come with additional problems and tips for better use.

Goal 3: to facilitate collaborative learning

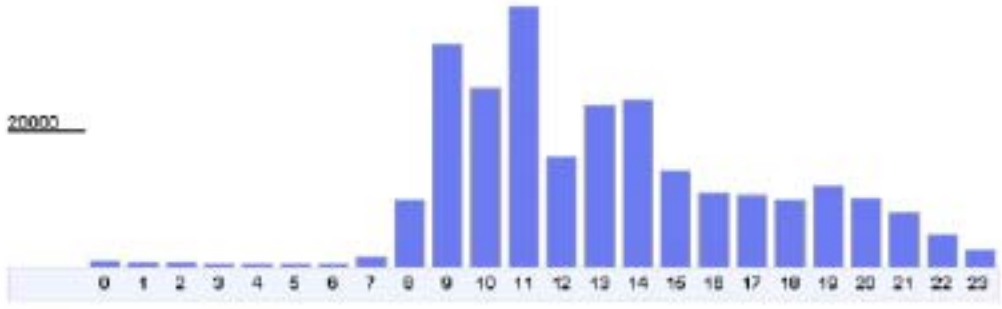
Technology use should be an easy en enriching part of the mathematics lesson. Here we have to deal with the different roles of the children and the teacher. We like to have a good collaboration between children, between a single student and a teacher, and between a group of children (small groups and the whole class) and a teacher.
This requires a good organisation of technology use and other classroom activities. We discussed this point with a group of teachers and they see possibilities to let the Problem of the Month be part of the normal lessons:

- Every child works out the problem at the computer (preferably two children at one computer, because the discussion between children is very important for exchanging ideas and problem solving strategies);
- Children can make a print of their solution, or write the solution down on a worksheet.
- When all children have worked with the Problem of the Month, the several solutions are discussed in a classroom setting, where the teacher guided the discussion process.

To reach goal 3 a lot has to be done. In the Netherlands we experience a long way of teacher involvement and getting educational publishers interested in this kind of collaboration in order to get a new structure in their textbook series. This is not strange, the introduction of realistic mathematics education happened in the early 1970's, and we are still working on the implementation of this it.

Goal 4: try to make the gap smaller between school-learning and home-learning

This subject of home-learning is particularly interesting, because we see an interesting side effect of our educational website. Below you see a 'normal' distribution of internet use per day (24 hours).



One day of visits of KidsKount

Throughout the day this is an expected distribution (with peaks at 9 am, 11 am and 2 pm). Interesting is the last –smaller- peak at 7 pm. This internet use is not during school time, so this must be at home.
This is surprising, because we never intended to make something for the home market. Apparently, children like to go to this website, to play the same or other games then they did previously. We think this internet-use is interesting, because there must be some intrinsic motivation to return to the same (educational) games. And of course that is very interesting for the place and effectiveness of mathematics education. If children like to return to this kind of problems, we get an idea of how motivation is working outside the classroom boundaries. This is what we like to investigate in a separate research in 2005.

Conclusion

KidsKount is getting popular in the Netherlands, especially the free use by children, not embedded in a classroom situation. But there is a growing amount of teachers who like to integrate this kind of technology use. We see similar mathematics education websites throughout Europe and abroad, both for primary and secondary level (see references). We like to work together with researchers from abroad to find out what the strength can be of technology use in a classroom setting and for home learning.
Our first findings in the area of home learning are promising, but further research must make clear what is exactly learned and how we can build a bridge between school use and home use.

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- www.mathforum.org
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About the authors

Frans van Galen
Drs. Frans van Galen is a senior staff member of the FI and works mostly in the area of mathematics education for primary school. Frans is an experienced developer, both for traditional paperwork but especially for technology.
At the moment Frans is involved in a project on longitudinal teaching-learning trajectories for mathematics in primary school.

Vincent Jonker
Drs. Vincent Jonker is a junior staff member of the FI. His special expertise is the use of technology in mathematics education, both primary and secondary level.
Especially the use of internet and interactive tools, as part of the mathematics curriculum (to become a good mix with the current textbook series).
Another interest is the use of games in the context of mathematics education. Research is carried out on competitive elements, interaction, simulation and animation possibilities.

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