



MATHEMATICS TEACHER EDUCATORS' PROFESSIONAL DEVELOPMENT AS BY-PRODUCT OF PRACTICE BASED RESEARCH: THE ELWIER RESEARCH GROUP

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ABSTRACT

In the ELWIER (Expertise centre mathematics teacher education) research group about 25 mathematics teacher educators in primary teacher education reflect on mathematics in primary teacher education. This group developed from a network group which started in the 1980's. About ten years ago the group refocused becoming a research group. Members in the group perform practice based research aimed at improving their practice or participate in the group as critical friends for others. In doing so, they share ideas, methods and results in the research group meetings and on a LinkedIn forum. Reasons for participating are the felt need to improve teacher education practice and in doing so learn about teacher education and research on teacher education. Although never an aim in itself, the ELWIER research group functions as professional learning community (PLC). This research in retrospective focuses at the ELWIER research group as PLC and answers the question why and how this group could become an effective professional learning community as it is, while becoming a learning community was never opted for.

INTRODUCTION

The ELWIER research group is a group of mathematics teacher educators, who perform practice based research in their teacher education practice, that is primary mathematics teacher education. ELWIER is a Dutch acronym for 'Expertisecentrum Lerarenopleiding Wiskunde en Rekenen', in English 'Expertise Center for



Mathematics Teacher Education'. The group aims at improving primary mathematics teacher education by performing research in or helpful for primary mathematics teacher education. The group developed from a network of mathematics teacher educators, which is active from the 1980's. Discussions within the group generally take place in face-to-face settings, although sometimes arguments are shared using the group's LinkedIn-pages. About 10-15 mathematics teacher educators and researchers attend the face-to-face meetings. More than 110 educators, researchers and other professionals interested in the group's work participate in the ELWIEr online (LinkedIn) community.

As improving mathematics teacher education is the group's aim, ideas, discussions and research results are not only shared within the group, but also to a larger audience, when researchers from the group publish and present their research. These publications for example answer research questions coming forward from discussing how institutes and student teachers try to deal with two nationwide test for mathematics in primary teacher education in the first and third year in teacher education. These nationwide mathematics tests in the Netherlands cause the drop out of several student teachers from teacher education. In order to support the students who are at risk of dropping out, it is necessary to know more about their characteristics. We found that these student teachers can be characterized by refrain from self-reflection related to their mathematical knowledge and skills. As a consequence, they can be characterized by blaming the test and teacher education for their failure passing the test (Keijzer & Boersma, 2017).

Another issue that the group focusses upon is the relation between student teachers' mathematics content knowledge and their PCK. Also here the nationwide mathematics tests formed a starting point for the research. Namely, the tests assess content knowledge but are introduced as a means to safeguard student teachers' PCK development. We showed that there are specific differences in teaching between student teachers who are high achieving in mathematics and those who are low achieving in mathematics (Gardebroek-van der Linde, Keijzer, Van Doornik-Beemer, & Van Bruggen, 2018). Low achievers for example stick to the textbook and express how difficult mathematics is, while high achievers discuss mathematics with students without referring to the textbook and do not talk about the problems' difficulty.

In the Netherlands the focus in mathematics education is mainly on low achievers (Mullis, Martin, Foy, & Arora, 2012). This is not different in primary teacher education. Some group members, however, did want to focus on high achievers. They did so by asking and supporting these student teachers in developing test items for a site their peers could use in practicing for the third year nationwide test. Analyzing these high achievers' development showed they all can learn how to construct these test items, but only can do so with specific scaffolding (Kool & Keijzer, 2015).

The two nationwide mathematics tests in Dutch primary teacher education are discussed frequently in the ELWIEr research group, because these tests form a concern in (nearly) every institute. The discussions lead to the idea that the first year



test might predict the score in the third year test. The group compared two tests and indeed uncovered how the first test predicts the score on the second. The group actually proved that the pass mark for the entrance test was insufficient for passing another nationwide test student teachers need to pass in their third year in teacher education (Keijzer & Hendrikse, 2013).

IN RETROSPECTIVE

The ELWIEr research group was not developed as professional learning community (PLC). As stated above, the group's activities started from mathematics teacher educators shared concerns. The group did not reflect on learning in the group. However, in a research group, work is shared and discussed and this evidently leads to learning. In other words, although the group was not developed as a PLC, it may have accidentally developed into one. And if this is so, developing a PLC might be best developed by working as a group on shared concerns, like the ELWIEr research group does for primary mathematics teacher education. That is what this paper is about: can a group develop into a PLC by just co-operatively doing practice based research in one's field of expertise, without explicit reflecting on learning in the group.

When turning to learning within the ELWIEr research group it might be helpful sketching the group members' context, namely primary mathematics teacher education or more generally mathematics as educational domain. In mathematics teacher education, although not wanted by mathematics teacher educators, mathematics is used as selection instrument. Nationwide tests for both language and mathematics cause that teacher education focusses on mathematics and language. And although many student teachers develop their interest in mathematics learning and teaching, student teachers' motives to start primary teacher education is rarely that they are interested in mathematics teaching or pupils' mathematics learning processes. This context sets the scene for mathematics teacher educators concerns. They need to stimulate student teachers for their subject, while this subject at the same time is used as selection instrument. They need to deal with their fellow educators, who see student teachers dropping out when they are unable to pass mathematics tests although they might from fellow educators' point of view be perfect candidates for teaching practice (Keijzer, 2015).

Apart from their specific position in teacher education, primary mathematics teacher educators are also confronted with opinions in society about mathematics in primary schools. These opinions include that,

- most primary school teachers are low achievers in mathematics and this is also true for student teachers (Weel, 2006; KNAW, 2009),
- educational results for mathematics in primary schools are miserable (cf. Mullis, Martin, Foy, & Arora, 2012), and



- mathematics in primary education should focus mainly on algorithms for addition, subtraction, multiplication and division, and definitely has nothing to do with any form of creative thinking or inquiry based learning (Beter Onderwijs Nederland, 2013).

RESEARCH QUESTIONS

In this paper we explore to what extent the ELWIEr research group can be considered a PLC in an educational setting, namely in the setting of primary teacher education. Several review studies on PLC's in education provide characteristics for effective PLC's. We here follow Louise Stoll and her colleagues (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). They characterize PLC's in education when:

- PLC members share beliefs and understandings,
- the group shows interaction between members and participation of all members,
- these PLC members depend on each other,
- they concern for individual and minority views, and
- cultivate meaningful relationships with the world outside the PLC.

In an effective PLC members of the PLC:

- share values and vision,
- are collectively responsible for the group and its learning
- are involved in reflective professional inquiry, that is discussing serious educational issues and examining teachers' practice,
- collaborate and by doing so promote both group learning and individual learning, and
- are aimed at student learning.

For the ELWIEr research group this last aspect is translated as 'student teacher learning', as the group consists of teacher educators whereas PLC's in the review by Stoll and her colleagues focus on teachers in primary and secondary education.

From this notion of PLC's the following two research questions are answered here:

1. To what extent did the ELWIEr research group develop into an effective professional learning community?
2. To what extent and how do the group's characteristics strengthen this development?



METHOD

We performed a case study in answering these research questions. We took arguments from Yin (2009) why a case study is appropriate here. We want to explain how the group develops and operates, meaning we actually are exploring relations within the case, which is typically for case study research. Moreover, the explorative nature of the research also points in the direction of performing a case study. This study is explorative as we never looked at the group from the perspective of being a PLC. This explorative nature of the study makes that there are ‘many variables’ to explore. We want to know what they are and how they are connected.

However, Yin also warns for using case study in this situation. As the group forms the case, creating distance might be somewhat difficult. On the other hand performing our own case study makes we could build the case from first hand. In order to create necessary distance a critical friend, being the second author, did review and comment the case.

We did build the case from the chair’s personal field notes and individual experiences and perceptions about what is discussed in the group and how this relates to desired teacher education development. This initial case, being a narrative about how the group is functioning, derived from these notes and the chair’s individual experiences and perceptions was shared with group members. This member check lead to comments, which next were used in updating the case. This amended case was shared a second time and commented a second time. Finally, from this last round of comments a case was developed were all group members agreed upon.

As the case was developed to provide insight in the ELWIEr research group as PLC, we explicated the groups’ learning in the case descriptions. In doing so we took the PLC characteristics from Stoll and colleagues (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006) into consideration. We, thus, followed Yin’s (2009) recommendation considering the case in a relevant theoretical framework.

INITIAL CASE

The ELWIEr research group started as mathematics teacher educators’ network. The groups’ reason for forming a group were shared concerns about mathematics in primary teacher education and the idea that forming a group would enable (re)developing and improving primary mathematics teacher education. Group members shared concerns and choose performing practice based research as tool to deal with these concerns. In the research preformed in the group members take their role as researcher or as critical friend. This results in a continuous dialogue in a shared language, unique to mathematics in primary teacher education. This, however, there is a good reason for negotiate on this language. Institutes have



different curricula, both in general as for mathematics (Keijzer, 2017). Group members therefore need to explicate one's situation. Doing so research group members express themselves as they use within their institute. Next, in the group these local situations are elaborated as such that every group member understands the context and also practice based research originating from this context.

Thus, the group's concerns are elaborated into research that is helpful for group's participants professional context. This research sometimes results in activities which can be exploited in teacher education. However, more often this practice based research leads to underpinning to be used in primary mathematics teacher education (re)development.

The following example shows how group concerns form the basis for small scale practice based research. As mentioned student teachers in the Netherlands need to pass two nationwide mathematics tests. These tests are discussed frequently in the ELWIEr research group. One of the tests is a third year test. Low achievers in mathematics often fail to pass the test (Keijzer & Boersma, 2017). Many of them complain that they need more time to complete the test. Group members reflected on these complains. They hypothesed that these complaining student teachers, having trouble passing the third year mathematics test, might fail the test because of their ineffective use of mathematical strategies. Two group members tested this hypothesis by analyzing scrap paper student teachers produced when doing the test. The analysis confirmed our hypotheses. Many student teachers showed inefficient mathematics strategies, which explained the need for more time to finish the test (Keijzer & De Vries, 2014).

This example illustrates how the ELWIEr research group, while working on this particular concern, show effective PLC characteristics. Namely, the example expresses how group member concerns are related to student teacher learning. Hypothesing on student teacher strategy use in solving mathematics test items resulted from analyzing student teachers complains on time pressure finalizing a nationwide test. ELWIEr research group members shared these student teachers complains from their own practice (reflective professional inquiry). When these experiences are discussed, arguments on the situation are formulated, for example:

- are there specific topics within the test especially difficult for student teachers,
- is there something wrong with the test,
- how can we find out what student teachers who complain about time pressure do during the test.

In sharing these arguments every group member is involved, for example by connecting arguments with experiences in teaching practice (collaboration). In the discussion the group consensus on these arguments is sought for (collective responsibility). Here the consensus led the group in analyzing scrap paper in order to see how student teachers use mathematical strategies and find out that inefficient strategy use might well explain lack of time in finishing the test (promoting group learning and individual learning).



In table 1 arguments as given above are described more general as characteristics for the ELWIEr research group. In this we relate this group characteristics to the characteristics for effective PLC's, as formulated by Stoll and colleagues (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006).

Table 1. ELWIEr research group as PLC (initial case)

characteristic Stoll, et al., 2006	group's characteristics
shared values and vision	mathematics in primary teacher education is seen as important, considering students in primary education deserve excellent mathematics teaching
collective responsibility	group members help each other understanding various teacher education contexts and arguments related to teacher education practices
reflective professional inquiry	experiences in teacher education forms the starting point for formulating hypotheses or research questions
collaboration	in discussions every group member is involved as researcher or as critical friends
promoting group learning and individual learning	research results provide arguments that are discussed and are translated into individual professional contexts
aimed at student teacher learning	student teacher learning and developing is the starting point for discussions in the group

AMENDED CASE

The case, as described in the previous paragraph, was presented in the research group. Group members amended the case. They agreed on how the group and its activities were presented. They especially stated that the group formulates issues in mathematics teacher education. But this did not mean the group is uniform and non-differentiated. The group in many cases offered surprising new perspectives, as ideas from other institutes from another part of the country entered the discussions. Moreover, group members said that they appreciated the possibility of role changing from researcher to that of critical friend and from critical friend to that of researcher. Further, they stated that the initial case description did not mention things that were done to secure the group's continuity. This continuity is guaranteed by the group's chair, who sets meetings over the academic year and arranges an agenda for each meeting.

From the viewpoint of effective PLC's (cf. Stoll, Bolam, McMahon, Wallace, & Thomas, 2006), one could say this continuity sets the stage for collaboration within the group. Further, changing roles from researcher to critical friend and the other



way around links up with collective responsibility as everyone takes their role at a given time. This also links up with both promoting group learning and individual learning, as these roles provide for a setting where one is discussing one's own research and learns from others, while discussing the research itself makes that all group members learn about mathematics teacher education. Moreover, the surprising new perspectives, as mentioned by the group members, result in reflective professional inquiry, as will be elaborated on in the following example.

In this second example the context is again nationwide mathematics tests in Dutch primary teacher education. In earlier research group members showed that the pass mark set for the entrance test is insufficient for passing the third year nationwide mathematics test. Namely, the score on the entrance test predicts the score of the nationwide third test. If a student teacher scores the cut score on the entrance test, generally he/she will not be able to pass the second test (Keijzer & Hendrikse, 2013). ELWleR research group members articulated that raising the entrance test pass mark would result in a lower number of student teachers dropping out in their third year in teacher education. However many institutes are reluctant doing so. The principals of the institutes fear that raising the pass mark will result in an unacceptable number of student teachers dropping out in the first year in teacher education. They further state that improving teacher education – without raising the pass mark – will help all students passing the entrance test in succeeding passing the nationwide third year test.

The new perspective here came forward from one of the institutes that did raise the pass mark. A case study showed that something different happened than was expected by institutes' principals. Student teachers did work harder. Moreover, the number of drop outs did not really change, however these student teachers dropped out at an earlier stage than their peers did who had to deal with a lower pass mark (Keijzer, 2015). This result set the stage for reflective personal inquiry, being a search for arguments why raising the entrance test pass mark did not lead to a higher number of drop outs.

CHALLENGES

In reviewing the initial case, group members mentioned several aspects that in their opinion show the group's strength. They stated that the group is strong, because group members generally do not complain about mathematics in teacher education, but instead are doing research. Doing so the group develops knowledge on primary mathematics teacher education and collects arguments for discussions at individual institutes concerning mathematics education. This implies group members' reflective professional inquiry. Group members also mentioned that the group's strength has to do with the clear focus on teacher education in relation to mathematics in society. This links up with the care for student teacher learning.



Finally they state that the group is a secure place for all participants. Group members are collectively responsible for the group and its development. Moreover, the group is a secure place where all contributions are valued, which sets the stage for effective collaboration.

This, however, does not mean that the group does not face challenges. There are challenges and they are quite crucial for the group's functioning. For example the group developed bottom up. Primary mathematics educators sharing concerns for teacher education gather aiming at improving teacher education. However, the ELWIEr research group had and has no priority in most of the institutes. This results in conflicting schedules, when educators are scheduled to teach instead of joining the ELWIEr research meeting. This results in some group members not being able to participate in all of the group's meetings. Moreover, several group members choose to participate in private time.

Having limited time, there is no time for sharing – apart from working on research papers. Further, as participation is not guaranteed from meeting to meeting, it is difficult to have discussions over the meetings. Finally group members state that the group highly depends on its chair.

CONCLUSION

This paper describes the development of the ELWIEr research group from the perspective of PLC's. In a case description we sought answers for the following research questions:

To what extent did the ELWIEr research group develop into an effective professional learning community?

To what extent and how do the group's characteristics strengthen this development?

The case description showed that primary mathematics teacher educators group members formed a group from more or less shared values and vision. Both values and vision are related to student teacher learning. We could say that the group developed being a PLC because of this focus.

We also saw that collective responsibility, reflective professional inquiry, collaboration were all group characteristics and also characteristics for effective PLC's. These characteristics for effective PLC's served as means in the development. This answers the second research question. We noticed, however, that these means are challenged by the context of the group – as group that is not really valued by the institutes' management.

Finally the promotion of individual and group learning is characteristic for the ELWIEr research group. This is welcomed, but not an explicit group aim. In fact it is a consequence of how the group is functioning.



REFLECTION

This paragraph provides a reflection on the ELWIER case narrative. The reflection elaborates on the case with the question: how does the ELWIER research group provide professional development for its members?

All professional development requires ‘learning’. There are several possibilities to learn for professionals, such as formal or less formal routes and individual- or team-development. The case of the ELWIER research group will be discussed from four different angles.

The first angle to look at the case is the perspective of formal or informal learning (Eraut, 2004; Kyndt, Gijbels, Grosemans, & Donche, 2016; Tynjälä, 2008; Van der Klink, Boon, & Schlusmans, 2012). We can distinguish learning into these two extremes. However, these two forms of learning should not be dichotomized; in fact, they represent the ends of a sliding scale of formality, ranging from totally unorganized learning as a by-product of working to learning that is organized within an well-defined educational setting. Thus, formal and informal learning should be considered to be on a continuum, although there are also a lot of varieties in between, where characteristics mingle. This is elaborated upon in Table 2. This table presents the characteristics of informal learning at the left hand side. This type of learning is often present at the workplace, where it takes place in and through tasks in the job, although the learner often is not aware of the learning process. The right hand side of the table is about formal learning, represented by a training, a course or our education system. In formal settings, the contents of what there is to learn have been clearly defined and also time, place and learning activities have been designed and set beforehand. Another characteristic of this type of learning is that this most often is rewarded with a certificate.

Table 2. Characteristics of informal and formal learning

	Informal learning	Formal
goal	Self-directed, ownership of learning goals by individual teacher	Ownership of learning goals by other actors (training institute, school management)
Learning objectives	No prescribed learning objectives	Defined learning objectives
Learning activities	Unplanned activities resulting in learning (unaware)	Planned learning activities (aware)
Learning process	Implicit learning and invisibility of learning process	Explicit learning process with visibility of learning by award or certification given by other actors (training institute, school management)
Learning context	Social embedded learning	Focus on individual learning



Comparing the ELWIER research group case description with the above mentioned characteristics, leads to the observation that this case mostly can be type casted as a setting in which informal learning takes place. The participants enrol voluntarily and they set their own goals to work on. The social aspect is also important, according to the case description, the individual group members complement each other in roles, experience and context. They work together on research projects and learning is not the main objective, it just occurs as a side effect. In fact, the learning process and learning outcomes in itself remained invisible, until the chair of the group decided to elaborate this further in the above described narrative about the groups' working process. This elaboration to uncover the learning process might be important for the group members, as it helps them to realise that they not only work together, but also learn together.

A second angle to look at the ELWIER case is the perspective of effective professional learning activities. Recently, some review studies have been published on this topic, elaborating a few aspects that seem to be important in effective professional development activities for teachers (Van Veen, Zwart, Meirink, & Verloop, 2010; Darling-Hammond, Hyler, & Gardner, 2017). In summary, these are:

- Directed towards subject knowledge, PCK and the learning process of pupils (embedded in daily work),
- Active and inquiry based learning,
- In collaboration with others,
- Longer duration (not just 1 afternoon),
- Embedded in school policy,
- A learning culture in the school.

If we compare the ELWIER research group case description with the above mentioned aspects, we can tick four of the six aspects. The ELWIER group has a focus on mathematics in teacher education (subject knowledge) and the concerns of the participants are about the student teachers' learning processes. The group is actively engaged in inquiry and research and they collaborate with each other. The group plans several meetings throughout the academic year in which the participants build on their collective knowledge. There are two aspects that are not entirely covered, namely the embeddedness in the school (or institute) policy and the learning culture within the school (or institute). In the case description these aspects are mentioned as challenges: participation in this group highly depends on voluntarily presence, mostly also in 'private time'. It is a pity that the institutes do not fully recognise and encourage the opportunities for professional learning of the individual teacher educators who participate in this ELWIER group.

A third angle to look at this case is from the perspective of the type of community that the case represents. In the above case description, the framework of Stoll and colleagues (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006) for professional



learning communities is chosen. In this part of the paper another framework is taken into consideration. Vangrieken Meredith, Packer Kyndt (2017) distinguish three types of professional learning communities, namely:

- Formal (*official, government initiative*),
- Member-oriented with pre-set agenda (*initiated by a school, teachers or researchers with a special goal*),
- Formative (*spontaneous, goals develop during the process*).

When we look at the ELWIER case, it is clear that this is not a formal community according to the definition of Vangrieken et al., since this group was not established by a government or another official initiative. The case might have some characteristics of a member-oriented professional learning community, because the members do set agenda's for their meetings, once they have defined their collaborative goal. Since the origins of the groups' existence derives from voluntarily participation and open membership, the characteristics of a formative professional learning community seem to be the most suitable.

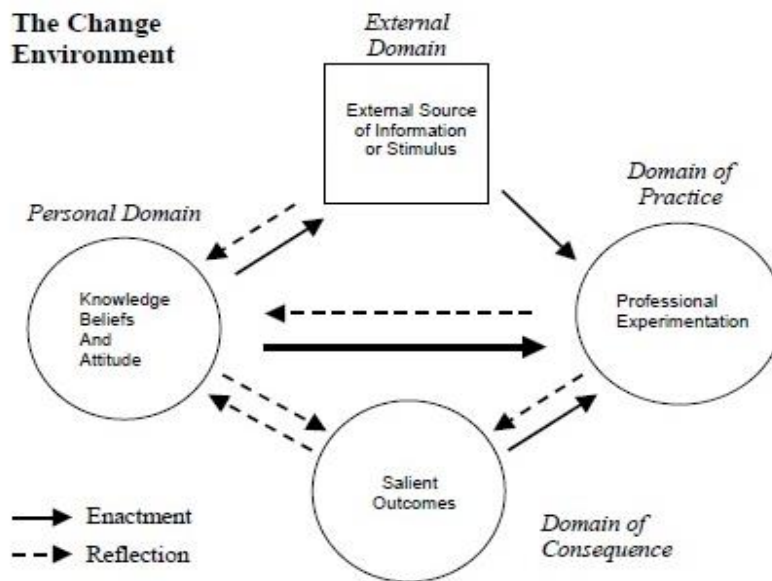


Figure 1. Clarke and Hollingsworth's professional growth model (2002, p. 951).

The fourth and final angle to look at this case is based on Clarke & Hollingsworth's professional growth model (2002). In their model (Figure 1), the authors describe both the possible learning outcomes as well as the learning processes that take place whilst teachers (or teacher educators) are learning. The model is especially helpful when it comes to elaborating the outcomes of informal learning, since this often takes



place unnoticed. The model consists of four domains, which are connected by arrows of ‘reflection’ and ‘enactment’.

For example a learning process could start at the external domain, with a meeting in which literature on a specific topic is discussed. This might lead to new ideas and beliefs (personal domain) of the participant. (S)he then might be tempted to apply the new ideas in his or her practice (domain of practice), and observe what happens with the students (domain of consequence).

When we apply this model to the ELWIEr case (Figure 2), we recognize outcomes in the four domains. The group starts from their concern about student teachers test results on the nationwide mathematics tests (domain of consequence). This is not consistent with their beliefs and practical wisdom (domain of practice), so they decide to investigate this more in-depth in their own institutes. They gather data (domain of practice), read and discuss literature on the topic (external domain) and come to conclusions, which leads to both recommendations to their own institutes (domain of consequence). They even add an extra arrow to the original model of professional growth, since they also publish their findings and thus contribute to the external domain.

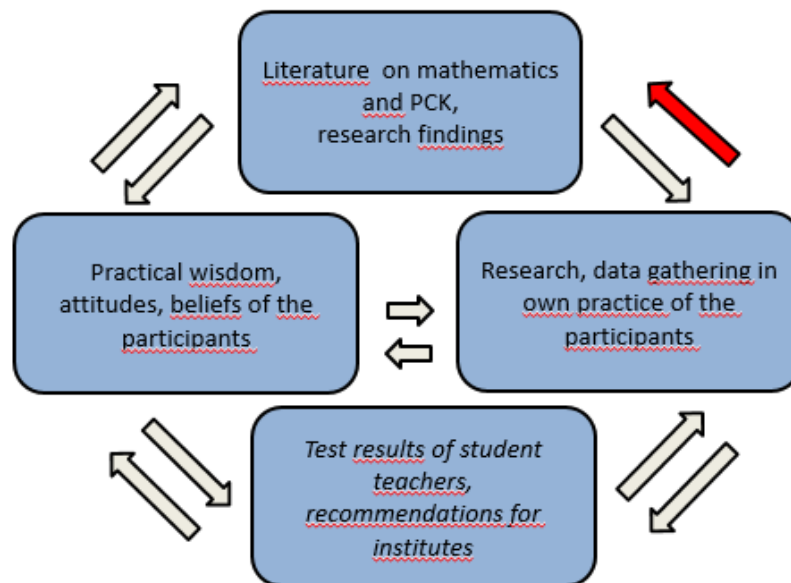


Figure 2. The professional growth model with the specific outcomes of the ELWIEr case

Summarizing, the reflection from four different angles of professional development to the ELWIEr case leads to the conclusion that this group – unintendedly – was indeed a professional learning community. They learn mostly informal, the activities



they undertake do have characteristics of effective professional learning activities, their group can be type casted as a formative professional learning group and they did yield outcomes on all domains that are distinguished in the professional growth model. In order to make their learning processes more visible for themselves and others, they should more often evaluate on their own learning process, by analysing their group narrative or by collectively discussing their process with the help of the professional growth model.

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