Student teachers’ participation in a research project in mathematics education

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Summary
Teacher education is meant to be research based and many teacher educators try in different ways to achieve this aim also for the school practice during education. We report on an experiment to design a new form for inclusion of research during practice. A group of student teachers have during their fifth semester carried out interviews with pupils. The classroom observations and interviews take their starting point in data that have been collected in other parts of a larger ongoing research project. The students transcribe, analyse and report their results in written essays. We will describe the design, its results and evaluation. The theoretical framework used is the model for teacher competencies by Niss [1]. The research questions in the paper are (1) ‘In what ways is it meaningful to involve student teachers during practice in a research project?’ and (2) ‘What kind of elements of learning do the students perceive in such a situation?’

Background of the project
In Norway as in Sweden teacher education is expected to be research based as well as based on well reflected experience from work in school. What this means has been discussed widely among teacher educators [2, 3, 4, 5, 6, 7]. Over the last ten years the content and structure of teacher education in mathematics has been in focus of research [8]. In Norway the ‘Rammeplan for Allmänlärerutdanningen’ is the curriculum of teacher education decided by the Department of Education [9]. In this plan there is a description of five competencies a teacher is expected to have: ‘subject competence, social competence, competence for change and development, and competence in professional ethics’ [9]. Teacher education normally consists of more theoretical studies at university combined with periods of practice in school. It is well documented that student teachers do not always see these two parts being well integrated.
A new initiative at Agder University College

At Agder University College (AUC) we have designed a new type of practice for student teachers in order to link research, theory and practice in a more meaningful way for the students. This design was tried out for the first time in autumn 2005 and is now being evaluated and redesigned. The national plan or curriculum for teacher education in Norway gives the background for the new design: Teacher education will through teaching, research and development work give the subject matter knowledge, pedagogical knowledge and practical training that is necessary for planning, carrying out and evaluation of teaching, learning and upbringing [9]. We will try to present the main ideas of this design and discuss the value of the initiative.

Teachers’ competencies, practice and research in the curriculum

One of the competencies pointed out for teachers in the plan for teacher education is to be able to change and develop in order to renew the pedagogical activities. “They must be able to see in children and young pupils the development, learning and upbringing in connection to changes in society.” [9]. Further, in relation to practice the plan says: “The field of practice must also be used in the subject studies in order to work with theoretical issues in a practical situation. When the students work with experiences from practice they can develop an analytical ability and skills to vary forms of work and approaches.” [9, authors’ translation].

According to the plan research and development work is especially well aimed for identifying and evaluating different approaches and to understand how practical-pedagogical challenges can be dealt with [9]. The plan also claims that research closely linked to practice and research in today’s school can make the education relevant and stimulating and students’ participation in such projects can stimulate the ability and ambition to renew.

The research project LCM

With these aims in mind students were offered to take part in a larger research project that is going on at AUC, called the Learning communities in mathematics project (LCM). The two leading theoretical concepts in this project are inquiry and community. Through the building of learning communities with teachers and didacticians, who together inquire in/into mathematics, mathematics learning, and mathematics teaching, we are aiming at a long term improvement of mathematics learning. Inquiry here means to be curious, ask questions and search for knowledge. One part of this project is a longitudinal study where
researchers and teachers inquire into pupils’ knowledge in mathematics and the development of that knowledge over time in the project. For more information about the LCM-project see http://fag.hia.no/lcm/.

The longitudinal part of LCM refers to learning in mathematics over time in numbers and algebra and geometry and statistics. The instruments used are written tests given regularly in the beginning and at the end of school years 4, 7, 9 and 11 (at ages 10, 13, 15 and 16). The analysis and reporting from the tests are carried out by researchers in collaboration with masters’ students and doctoral students. Interviews can complement written tests but are demanding more resources in time and access to interviewers. In the analysis of test results a number of interesting questions were found where the group of researchers wanted to inquire deeper through interviews with some of pupils that took part in the tests. Here we saw a valuable part of work for the student teachers. Thus the research for student teachers was based on this opportunity. During their school visits they carried out interviews on issues suggested by the masters’ students and the researchers. The interviews were tape-recorded, transcribed and analysed and students reported back through written essays.

The research questions in this paper

The research questions are: (1) In what ways is it meaningful to involve student teachers in a research project during practice? and (2) What learning outcomes do the students experience in such a situation?

Theoretical framework

For the analysis of the data collected we use a theoretical framework on mathematical competence by Mogens Niss [1], who gives the definition: Possessing mathematical competence means having knowledge of, understanding, doing and using mathematics and having a well founded opinion about it, in a variety of situations and contexts where mathematics plays or can play a role. He has in the Danish KOM-project [9] identified eight such mathematical competencies forming two clusters (KOM means competence and mathematics):

1 The ability to ask and answer questions in and with mathematics
2 The ability to deal with mathematical language and tools

Niss [1] also gives a model for mathematics teachers’ specific competencies. They are four connected to work with pupils: Curriculum competency, Teaching competency, Uncovering of learning competency, and Assessment competency. Another two are connected to the teacher’s position in professional environments and they are: Collaboration competency, and Professional development competency.
We consider these six competencies to be a more precise version of the five competencies given in the curriculum for teacher education [9] and thus use Niss’ model in order to interpret the data we have from student teachers’ practice.

**The course MA 119 Number theory and subject didactics**

The changes we made in the course are based on a wish to offer students opportunity to experience a practice period that is inspired from a research project and a wish to offer students insight into what it means to do research. The course parts consist of theoretical studies based on research papers, presentations and discussions, and practice with classroom observations and interviews of pupils in school. The course literature consists of both scientific books [3, 10, 11] and journal papers [12, 13]. Students make transcriptions of the taped interviews and carry out an analysis based on the theoretical studies. Writing a scientific essay offers further learning opportunities. During the writing process they get feedback and response both from the teachers and fellow students. Finally they answer a questionnaire in order to give a basis for evaluation of their experiences and learning.

**Analysis and results**

In students reports (essays) we have found evidence of learning inside all six competencies for teachers except for two of them in two cases. We will give some examples of the evidence we found.

**Curriculum competence**

Thus in the first three years in school pupils should have knowledge about the different operations for calculation. They should also get training in putting words to their understanding and explaining how they think. Pupils start with addition early in schooling while multiplication comes a little later. (S2)

**Teaching competence:**

What I mean is important is that the teachers must have an open mind to be critical to his own teaching, and to be able to reflect upon what could have been done better. With diagnostic tests he can find out if teaching is bad, if all pupils have problems in the same area or if most of them have captured it. (S1)

The aim is that in school we should create a bridge from mathematics in everyday life to the formal mathematics such that pupils perceive it meaningful related to their experiences. Word problems can be used to connect the formal mathematics to the everyday mathematics in such a way as the tasks used in the interviews do. (S2)

In what ever way you plan the teaching you make decisions based on the view on learning, knowledge, pupils and so on. It is important that one as teacher makes these decisions based on conscious and well thought through reflections. (S3)
Thus it is important to focus on understanding and preferably show pupils that there is more than one way to solve a mathematical problem. In this way pupils will see what they are working with. After understanding the problem the algorithm for the solving method can be introduced. (S4)

Uncovering of learning competence

I and a fellow student visited year 9 in order to observe and interview some pupils. The pupils that were selected were on average level in the class. The tasks we wanted to interview about were diagnostic tasks. Diagnostic tasks are problems one can use in order to uncover difficulties and misconceptions. They can also expose the concepts and understanding of the pupil. Further in my work I will inquire into misconceptions and number sense and see where they are created when pupils are solving a problem. (S1)

In advance we had of course used some time to prepare the interview, by thinking through the questions and different scenarios that could develop. We did that to be better prepared to tackle elements that could show up. The questions we posed to pupils should be simple and understandable, so pupils did not have to doubt what we were asking. It was also important to formulate them in such a way that pupils had to answer more than yes or no, as such questions are of no help in an analysis. Additionally we were prepared to dig for information, ask pupils many questions about how, why and what they did think and act on the different tasks. The element to be prepared did that we got more out of the interviews. (S4)

Evaluation competence

Diagnostic tests might well come in the start of the teaching. The tests will probably give many mistakes. It is important that the pupils understand the aim of the tests and that it will not be used in assessment or for ranking of pupils. The result can give the teacher good advice about how he or she can plan the teaching and what to observe, especially if pupils are asked to explain how they came to the answers. (S3)

Collaboration competence

During interviews we were two students together with the pupil. One had the main responsibility for the interview, but the fellow student and I agreed that also the one that was not the main responsible could say something or ask questions in the process. (S2)

Professional development competence

As a research assistant I feel that I have learnt a great deal. Among other things about how research work is done and how I can use it in my own praxis in order to improve teaching. Besides to have ability to critically reflect on one’s own practice, something a teacher must have independently of research on own practice, I am of the opinion that research can contribute to a deeper understanding of and better ability in mathematics didactics. From this you cannot only become a good mathematician but also a good teacher in the subject. I see the potential of the teacher becoming his own researcher in the classroom. But is this possible today in a teachers’ everyday situation? (S2)

For both the interviewee and the students the situation was uncommon. Thus it was sometimes very hard to pose the good questions. This is not the fault of the
interviewee but they are influenced if the interviewers are insecure. The next step was the transcriptions. It took very long time. The first thing I noticed was that we as interviewers had a lack of routine and we could well have gone deeper and dug more. But after a while I could also hear from the tapes that we actually had exposed many interesting things. (S3)

Mathematics didactics is important for a mathematics teacher. If the teacher is not thinking through what is the foundation of how the teaching is carried out, the pupils might end up with no learning. It is extremely important for a teacher to be critical to himself and how one is teaching. Thus suggestions from other teachers, new teaching methods, and results from research in mathematics didactics are important elements in order to make teaching best possible for the pupils. (S4)

We claim that these quotations show examples of the fact that the students have experienced opportunities to develop learning in all the competencies and have had the opportunity to articulate it in discussions with peers and teachers and to write it down. In principle all students have one or several propositions in each of the competencies in their essays. For space reasons we cannot give examples from all of the students.

**The judgement of the teacher educators**

We base our conclusions on the interviews, the essays, the answers to the evaluation, the conversations with students and the evaluation of the external censor of the course. Generally we are impressed by how well the students carried out the hard task we gave them. All nine of them have managed to contact the practice school, to select and interview pupils, to transcribe the interviews and to write an essay based on the content of the course, the observations and the interviews with pupils. The time they had got for the practice part of the course was only 30 hours and we were highly unsure how far one could come within this timeframe. We estimate that they on average had to use 2-3 hours for the observations, 2-3 hours for the interviews, 5 hours for transcriptions and 19-21 hours for the writing of the essay. Students were given special support in the writing process by working with peer groups for response and continuously they got comments from the teacher and supervisors. Still we suppose that some students have used more time than was expected for the work. One of the essays we judge as of low quality but many of them are on top level and also got the highest grade. The external censor agreed with us that the students have performed well and have written mature and valuable essays. Only one student cannot see any value in this part of the education. Several of them mention that they will use interviews as a working method when they start working as teachers. We are pleased so far but see some opportunities to improve the design we used.
Further results, redesign and implications

The answers to our research questions are that students, by working as research assistants and carrying out interviews, have experienced meaningful learning through participation in the research project. They witness that this learning is of another character than other learning in the teacher education. There may be other ways to do it but at least this way works well. Their learning is inside all of the six competencies for teachers [1] as can be seen from the examples.

They have also had opportunity to develop a professional language both through the learning and the writing process. The development of a professional language is not an evident part of all teacher educations [6]. The students experience the writing process as a powerful learning opportunity.

The evaluation shows that all students except one are positive to the new design of the practice. Students have given several useful suggestions for improvement of the course, which we will use next time. The data collected is used by other researchers and masters students in the project and thus meaningful in several ways. The modifications we plan to make for the course next time is to start earlier in the semester in order to give students more time to carry out the work in school and to transcribe and write the essay, to place the examination earlier, and to give more clear information about the aims of the work and the content and demands of the course. We also plan to produce a video that demonstrates an interview, which can be used by the course teacher in lectures as a starting point for the discussion about how to interview in a fruitful way. As students have no prior experience of making interviews this it frightening for some of them. We also want to produce a scheme for the observations in order to link the classroom observations to the studied theories in the articles. Students will also get a template for the essay, which will support with both the layout and the structure for the writing. Many of them have never written a scientific essay before and therefore both oral and written guidance is needed.

The conclusion is that the way we designed the practice to include research is a valuable way to make the practice research based in mathematics teacher education. Students indicate that mathematics didactics is the most valuable part of their education. Mathematics didactics has an important part to play in the development of teacher competence [14].

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