Teaching and learning mathematics through the use of "Stegark"

A collaborative project between Oslo University College and three lower secondary schools in Oslo

Background

Throughout many years there have been constantly ongoing discussions about pupils' performances in mathematics. Large scale international comparative studies in mathematics (TIMSS and PISA) have shown that Norwegian pupils perform relatively poor and significantly lower than the mean of all countries (Grønmo, 2004; Kjærnsli, Lie, Olsen, Roe, & Turmo, 2004; Lie, 2001; Lie, Brekke, & Kjærnsli, 1997).

Studies have suggested that the educational reform that took place in Norway in 1997 R97 and the associated curriculum L97 not is implemented as intended (Alseth, Brekke, & Breiteig, 2003; Haug, 2003). Alseth et al (2003) carried out a classroom study which suggests that the teaching in Norway still followed a traditional pattern, that specified skills were in focus and were being drilled rather than understood. This was in great contrast to what was intended in L97 where students were supposed to develop their own mathematical concepts and skills were supposed to be based on understanding and general concepts and principles within the subject. Studies comparing pupils performances on the same tasks in mathematics before and after the reform was implemented show that pupils perform generally lower in 2001 than in 1995 (Alseth, Brekke, & Breiteig, 2003; Kleve, 2003). Broadhead (2001) examined constructs from L97 more closely and carried out a study in which she recognised the difficult relation between the ideological underpinnings in L97, which are based on constructivist theory and the reality of teaching practice.

Also international studies of reform movements in mathematics in other countries suggest that implementing a curriculum reform is not a straight forward process, and that there are many obstacles and constraints between the intended curriculum, as it is written in the documents, and the enacted curriculum which is the curriculum jointly constructed of teachers, pupils and teaching materials in the classroom (Manouchehri & Goodman, 1998; Norton, McRobbie, & Cooper, 2002; Prawat, 1992; Skott, 2004).

The new curriculum in Norway LK06 is built on the General part of L97. Principles and Guidelines in L97 which was the "bridge" between the general part and the subject syllabus is exchanged with a "Learning Programme" (Læringsplakat) which comprises "*Important principles for the school's activity and must be seen as relation with law and regulation and the general part of the curriculum*" (Kunnskapsdepartementet, 2006). The competence in the subject is not described as detailed in LK06 as it was in L97. There are stated clearly aims for competence, not for each class but for each stage (1-4., 5-7., 8-10. and for each year of upper secondary school). Working methods and ways of organising teaching activities are not specified in the same way in LK06 as they were in L97. However, "problem-solving" is emphasised and exploring activities, creativity are encouraged together with exercising skills. Thus teachers have more freedom to choose working methods and there are options for "mixed age schooling".

Main aims and goals for the project

HiO is carrying out collaborative projects with several schools in Oslo and within several subjects. These projects are funded by Program for Skoleutvikling, (Program for School Development) PSU. One of these projects is the one which we are part of and that will be part of the Research Consortium. The mathematics teachers in three lower secondary schools (Kastellet, Hauketo and Lofsrud) have asked mathematics teacher educators (didacticians) to collaborate with them and supervise them in their use of "stegark", and associated pre-tests and multiple choice tests.

According to the teachers and school leaders in these schools Stegark, or "benchmark", is a sheet with concrete goals and criteria to which pupils are supposed to work accordingly. For mathematics in lower secondary school benchmarks should be developed within all mathematical topics and from grade 8 to 10. The purpose is that each pupil can find relevant challenges and get the feeling of mastering on his/her own level. Benchmarks can also be used in charting each pupil's knowledge which again can make the teacher able to give each pupil a benchmark which s/he will master. An important issue is thus to find the relevant benchmark for each pupil. Pre-tests will be developed within each topic to chart what level each student ought to start on.
The main aims expressed by the teachers and school leaders in the three schools involved are:

- That pupils in grade 8 and 9 will experience increased motivation and enhanced learning in mathematics
- That all pupils shall work with the same topics at the same time, however on each individual's own level.
- Each individual student shall be supervised according to his/her individual need

The aims of the project for us will further be:

- To identify essential developmental stages for pupils' conceptual development within the mathematical topics they work with
- To develop teaching materials based on the requirement that pupils need clear demands in their work with mathematics.
- Identify and characterise the learning which takes place when pupils engage in certain activities.
- Relate the observed learning to learning goals in LK06

Theoretical perspectives

The ultimate goal for the project is to enhance pupils' learning of mathematics, so they can build up relational understanding between concepts. It is natural to draw on various theories of teaching and learning mathematics. LK06 is supposed to build on more socio-cultural theories than L97 did. I L97 was built on constructivist principles which developed out of the dissatisfaction with the view that knowledge can be transferred from one person to another. Thus it is important to see knowledge as something to be constructed (Glasersfeld, 1995) or developed through social participation ((Lerman, 2000). L97 put a greater weight on conceptual knowledge than exercising skills and procedures (Hiebert & Lefevre, 1986).
In this project we will draw on both constructivist theory and socio-cultural theories. The notion "Communities of Inquiry" (Jaworski, 2004) is the foundation of our project. That involves willingness to "wonder, to ask questions, and to seek to understand by collaborating with others in the attempt to make answers to them" (Wells, 1999). Inquiring means to ask a question, to acquire information and to search for knowledge. In our work with the teachers it is important to understand and characterise the learning which takes place through several

ways of working and we will seek to collaboratively develop teaching strategies to enhance pupils' work to reach benchmarks.

Research methods

A challenge for us who are didacticians is how we can build on the given framework (the use of stegark) to reach the ultimate goal which is to enhance pupils' learning of mathematics and thus building up relational understanding between concepts. How can we together with the teachers develop teaching strategies which enhance pupils' learning to reach the benchmarks? First of all it is important to collaborate with the teachers in their use of such benchmarks and tests, but also for all participants in the project to have a joint understanding of what "stegark" is and what the purpose of using "stegark" is and a joint understanding of how to use these tools in the teaching and learning of mathematics. In this work an important factor is to take the teachers' work and project description as a starting point and work with them along the lines they initiate but also to embed the project into the inquiry model. Hopefully the teachers will be researchers on their own practice, and it will be the responsibility of the didacticians to organise research training for those teachers involved.

Data will be collected from group conversations with the teachers and their school leaders, from interviews of teachers and pupils (and parents?). We will have classroom observations which will be audio recorded and if possible video-recorded for the purpose of studying and discussing the enacted curriculum with the teachers. Field notes and transcriptions from audio-recorded lessons will also be analysed.

Collaboration in the Consortium

The proposed project is part of a consortium involving didacticians in mathematics at the University Colleges at Agder (HiA), Bergen (HiB), Bodø (HiBo) and Trondheim (HiST). The work in all projects within the consortium is based on the common theoretical foundation "Communities of Inquiry". This implies that all projects also link to the ongoing KUL projects at HiA and draw on experiences on these projects. The collaborators in the consortium will establish various arenas for exchanging information and comparing results and experiences. All partners will connect to a varying number of schools in their district and given the geographical distance between the partners, this will mean that the activity in the consortium altogether will represent a large scale investigation into the activity in mathematics classroom.

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