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**Processes of change in teachers' competence in
mathematics by collaborative learning.**

Paper to be presented at YERME Summer School in Kassel 2014

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Introduction

The purpose of the research project is to study whether changes in attitudes and practices of mathematics teachers may be related to changes in both students' learning and achievement, as well as in their motivation and self-esteem in mathematics.

In recent years, Swedish students' results in national and international studies have followed a downward trend. The latest TIMSS survey, which measures skills in mathematics and science for students in grades 4 and 8, was conducted in 2011 with 50 participating countries (Skolverket, 2012). The results show that Swedish students' performance in mathematics was below average compared to students in other OECD/EU countries in both grades. In grade 8, the results had deteriorated since 2007. It was verified that Sweden is one of the few countries that has had a continuous decrease in mathematics results since the assessment began in 1995.

PISA is a large-scale international programme that aims at enabling international comparisons between educational systems. Furthermore, PISA aims to establish in which degree these educational systems contribute to prepare students for the future. In mathematics, focus lies on to what extent students are able to translate mathematical language to practical contexts. More than 60 countries worldwide, within as well as outside the OECD, are part of the PISA programme. In these countries, 15-year-old students are given tests and surveys in order to study their capabilities in and attitudes towards mathematics, science and reading literacy. In 2012 PISA was held for the fifth time, with mathematics as the main subject. As mathematics also was the main subject in 2003, comparisons between these years are possible to make. PISA 2012 shows that the Swedish results in mathematics have been constantly declining since the first survey in 2003. The number of Swedish students reaching proficiency level 2, which is considered the baseline proficiency level, has decreased with 10 percentage during this period and is now as low as 73 percent. This is the largest decline of all participating countries in PISA 2012 (Skolverket, 2013).

The National Agency for Education (Skolverket, 2004) states in the National Evaluation of Compulsory School that differences connected to both performance and gender in students' results that could be observed from 1992 and onwards, to a certain extent can be attributed to students' motivation and attitudes towards their studies, in particular regarding mathematics. The fact that students' interest in math and science declines between the grades of 4 and 8 was also verified in TIMSS.

OECD (2012) has, in a report, problematized the two concepts "failure at school" and "failure by school". The report criticizes the fact that a great deal of resources are spent on investigating and trying to correct individual students' problems. Instead, it is argued that resources should be spent on making schools more effective in challenging students' skills and interests, while ensuring that students in difficulty are getting the support they need and are entitled to. In the recommendation of the European Parliament and Council to all member states, eight competences are pointed out as particularly important for young people to develop in school in order to be prepared for the adult life, both in regard to further education as well as working life. These key competences include, among others, mathematics, digital skills and learning to learn.

The Institute for Evaluation of Labour Market and Education Policy describes in a research review (IFAU, 2010) that one of the most important explanations to the decrease in

students' results is probably due to changes in instruction, which implies that the teacher to a lesser extent is "in charge" of the teaching. In mathematics, more than in other subjects, teaching is characterized by students' individual work without sufficient tutoring and feedback from the teacher (Skolinspektionen, 2009). Such an approach could result in limited opportunities for reasoning, argumentation and the possibility to discover mathematical relationships.

With regards to the above stated facts, the Swedish Government has stated that the education in mathematics must be improved, in order for Sweden to be competitive in mathematical knowledge and skills. Therefore, the Government has decided to conduct a special in-service training, "Matematiklyftet" [in English: "The Mathematics Initiative"], focusing on didactics for mathematics' teachers. The Swedish National Agency of Education is in charge of the implementation of the programme, which is financed by government grants. A total of 649 million Swedish crowns will be invested in the programme. The head of schools can apply for a smaller grant for each teacher participating in the programme. In addition to increasing student achievement in mathematics, "The Mathematics Initiative" seeks to increase students' interest in the subject and their self-esteem in using mathematics in different situations. The programme will be based on peer learning, a scientifically established method, which is highlighted as one of the reasons to the Finnish schools' high results in all PISA surveys in the 2000s (Sahlberg, 2012).

Purpose and research questions

The purpose of the research project is to study whether changes in attitudes and practices of mathematics teachers may be related to changes in both students' learning and achievement, as well as in their motivation and self-esteem in mathematics. In the academic years of 2013-2015, mathematics teachers, mathematics supervisors and principals at the four schools (Kindergarten – grade 9) included in the study, participate in "The Mathematics Initiative". In this study, the teachers (about 40 individuals) who are participating in the programme with the beginning in the fall of 2013, will be followed through their training. After having completed the in-service training the teachers will be followed during another 3 or 4 years in order to identify changes in the processes described above.

There are five different aims of the proposed thesis, whereas I would like to focus on the last one during this course:

- How do mathematics teachers, mathematics supervisors and principals reason about mathematics as a subject, student skills and qualities in learning?
- How do they view their own skills either when it comes to teaching mathematics or actively leading the work in "The Mathematics Initiative"?
- In which ways has an individualized education in mathematics been expressed in the different schools' practices and in their work with the students, before introducing "The Mathematics Initiative"?
- What changes in reasoning, skills and practices can be identified among mathematics teachers, mathematics supervisors and principals, both during and after the work with "The Mathematics Initiative"?

- How are different expressions of individualized education in mathematics related to students' knowledge and performance in mathematics and to their motivation and self-esteem in mathematics both before, during and after the schools' participation in "The Mathematics Initiative"?

Theoretical framework

There are several theoretical perspectives that could be necessary and/or useful in order to answer the research questions. At this point, I would like to focus on research on motivation and school effectiveness as I believe they are closely linked to teachers' competence. In a hearing held at the University of Gothenburg in January 2014 about the Swedish PISA results, professor Jan-Eric Gustafsson explained the negative trend in mathematics mainly as an effect of impaired teacher competence and forms of teaching. Hattie (2009), in his meta-analyses, concludes that "Teachers are among the most powerful influences in learning." (p.238).

Methodology

The proposed dissertation will be based on both quantitative and qualitative methodologies. By using equivalent analytical and statistical models from other studies, direct comparisons of the results of the studies can be made. In this way, some longitudinal trends can be discovered while, at the same time, a study's reliability is tested. Comparing information from teachers with information from students makes a perspective-taking from different actors possible, and also enables a study's ecological validity to be tested. That is to what extent different results can be meaningful and useful in the perspective of the different actors.

Within the framework of the thesis, mathematics teachers that in the fall of 2013 teach students in grade 5 and all mathematics teachers that these students will have until they leave grade 9 will be followed through. During the first two years (2013-2015), these teachers will be followed by their participation in "The Mathematics Initiative".

Before constructing surveys and interview questions, a causal model was outlined in order to identify the factors believed to be most prominent in the process of change among the teachers, as well as the factors among the students that were considered the most likely to be affected by this process. These factors formed the guideline in the work of finding relevant survey questions.

There are three studies planned to be part of this dissertation. Each study can be related to the research questions. During this course I would like to focus on Study 3, as it relates to the last of my research questions.

Study 1. In which ways has an individualized education in mathematics been expressed in the various schools' practice before the introduction of "The Mathematics Initiative"?

Related to the following research questions:

- How do mathematics teachers, mathematics supervisors and principals reason about mathematics as a subject, student skills and qualities in learning?

- How do they view their own skills either when it comes to teaching mathematics or actively leading the work in "The Mathematics Initiative"?
- In which ways has an individualized education in mathematics been expressed in the different schools' practices and in their work with the students before introducing "The Mathematics Initiative"?

In order to get a deeper picture of the mathematics education and the effects over time of "The Mathematics Initiative", a survey was conducted with the grade 5 students at the four schools in the fall of 2013. The survey will also be performed with the same students during the fall in grade 7 and 9. The survey is designed on the computer and is sent out by e-mail to the participating students. The questions in the survey have been chosen from other relevant surveys to enable comparisons between research studies, and thereby make the results more reliable. The surveys used are: PALS, Schoenfeld, the National Evaluation 2003, the student survey from the National Agency for Education 2003 and a survey from the National Centre of Mathematics. Out of a total of 163 grade 5 students, 148 provided consent to participate in the survey. Of these, 133 students were present at the time the survey was conducted, and also submitted their answers.

In the spring of 2014 a survey was conducted to all teachers at the four schools, mathematics teachers as well as teachers in other subjects. The reason for including all teachers was the relatively low number of mathematics teachers. The survey questions were focused on teachers' professional self-esteem ("teacher efficacy"), their engagement, their views on learning, their practice and their communication with students. Questions concerning external conditions for their work, such as interaction between colleagues, support from school leaders, colleagues and parents and access to relevant resources were also included in the survey. After having analysed the result of the survey, focus interviews will be performed with the mathematics teachers, with the aim to get deeper knowledge of certain questions.

Study 2. How is an individualized teaching in mathematics expressed during and after the various schools' participation in "The Mathematics Initiative"?

Related to the following research question:

- What changes in reasoning, skills and practices can be identified among mathematics teachers, mathematics supervisors and principals, both during and after the work with "The Mathematics Initiative"?

In this study, mathematics teachers', mathematics supervisors' and principals' activities within "The Mathematics Initiative" will be documented. In the teacher training program various elements such as lectures, collaborative discussions and practical exercises in the mathematics teaching are included. The program is organized based on a controlled schedule with four recurring parts (individual reading, group discussion + planning of lesson, performing a lesson, and group reflection of the lesson). Each part is performed during a period of two weeks. The supervisors and principals receive special training within the programme. The documentation will consist of teachers' discussion notes, teachers' individual reflections and the researcher's observations of teachers' meetings (notes and recordings).

Study 3. How are changes in attitudes and practices of mathematics teachers related to changes in students' learning as well as in their achievements, motivation and self-esteem in mathematics?

Related to the following research question:

- How are different expressions of individualized education in mathematics related to students' knowledge and performance in mathematics and to their motivation and self-esteem in mathematics both before, during and after the schools' participation in "The Mathematics Initiative"?

The student survey that is conducted in grade 5 during the first year, will be followed by two more when the students are in grade 7 and 9. They will then answer the same survey questions in order to find patterns of change in students' learning, achievements, motivation and self-esteem in mathematics. In addition to survey data, complementing information in terms of interviews and observations will be collected from the students and set against information collected from teachers. The purpose of this study is to study the effects, or rather different consequences, of "The Mathematics Initiative" on students' learning and development over a four-year-period.

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