Student Teachers' Experiences with Math Education

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Abstract

Student teachers who are studying to teach math in early elementary school in Sweden today have studied less math in secondary school than student teachers in the late 1980´s and the 1990´s. To be able to address the problems of this new group of students, we need to understand and analyze their experiences. The instruments of inquiry were students' letters about their experiences in school math. The starting point of the analysis was to find the student teachers' experiences of certain subtopics aspects of school math. In the second step, relationships between different aspects of school math were identified. These relationships were constructed as activity systems. In the third step, words related to each system were counted to get an indication of what the student teacher had experienced as the most common and least common learning context. This study exposes weaknesses among student teachers when they start their teacher training in mathematics. These weaknesses are now more pronounced when students can begin a teacher training program in math without studying in an intensive math program in secondary school. Almost 80 percent of the student teachers interviewed felt negative emotions toward math, and many see the subject as a set of rules instead of skills. These beliefs can affect their teaching in the future. If teacher training programs don't challenge these beliefs, the student teachers' approaches will be limited.

Introduction

Two studies (Timss, 2004; PISA, 2004) were published in the fall of 2004 showing that Swedish students performed poorly in mathematics compared to students in other countries. Other authors have shown that Swedish students see math as something difficult and boring (NU, 2003). If they percept math as something difficult and boring could depend on a range of factors. One important factor in teaching mathematics is a teacher's attitude toward the subject (Thompson, 1984; Ma, 1999; Samuelsson, 2003, 2006; Lester, McCormick & Kapusuz, 2004). Lester, McCormick and Kapusuz (2004) have, in an American study, shown that a large portion of early elementary student teachers do not believe that they practice effective teaching methods. One explanation for their perceived ineffectiveness is mathematics anxiety. Mathematics anxiety is a complex phenomenon that manifests as panic, fear of failure, and mental disorganisation when solving math problems (Foire, 1999). Bandalos, Yates and Thorndike (1995) defined mathematics anxiety as a combination of low self-confidence, a fear of failure and a negative attitude towards learning math. Symptomatic behaviour includes being uncomfortable performing mathematical tasks (Gierl & Bisanz, 1995). Harper and Daane (1998) as well as Jackson and Leffingwell (1999) have linked mathematics anxiety to prior experiences with formal instruction of the subject at the elementary and secondary level. The sources of these negative attitudes are not fully investigated. This study draws attention to student teachers' prior experiences learning math in a wider range than earlier research.

Math anxiety sources

In the literature of math anxiety researchers discuss classroom methods, math as a subject and teachers as important factors that affect students' anxiety. One source of mathematics anxiety can be traced back to the teaching methods used in classrooms (Greenwood, 1984). A common method in the Swedish classroom is characterized by teachers instructing or imparting knowledge and students then practicing their skills (Lundgren, 1972; Neuman, 1987; Magne, 1998; Lindqvist, Emanuelsson, Lindström & Rönnberg, 2003, Samuelsson, 2003, NU, 2003). This teaching method encourages a dependence on a teacher's confirmation, a book that drills, and a key that gives the right answers. When students give wrong answers and get no confirmation by the teacher, they can feel uneasiness and anxiety (Tobias, 1993). *An overuse of skill and drill exercises creates frustration and anxiety* (Tobias, 1987; Cornell, 1999). Research demonstrates that if the teacher draws attention to right or wrong answers too much, stress increases among students (Magne, 1998). Based on this research, Swedish teachers need to vary their teaching methods. The change is important for students' emotions as well as for their ability to achieve different math competencies. Case (1996) and Samuelsson (2003, 2006) are two researchers arguing that a variation of teaching methods is important because different teaching methods draw attention to different competencies in mathematics.

A second source of anxiety among students is their teachers' behaviours in the classroom. Jackson and Leffingwell's (1999) research of mathematics anxiety illustrates that students usually feel negative emotions in a mathematical context for the first time in their fourth year of school. They interpret the teacher's behaviour as hostile and insensitive. When the students get older, 12 years old, they view teachers as being angry, having unrealistic expectations, *making them feel ashamed in front of the class,* and not caring (Jackson and Leffingwells, 1999). Students complain that the teacher gets angry if he or she needs to explain a concept again, and students who continue to ask questions get verbally attacked and humiliated in front of their classmates (Granström, 2004).

A third source of anxiety is the abstract quality of math. There are several studies (Harper & Daane, 1999; Lindqvist, Emanuelsson, Lindström & Rönnberg, 2003) that show that students often lose interest in math in grade seven or eight (12 to 13 years old). One explanation is that the topics in those years become more abstract. Math is often viewed as a purely cognitive construction (Ingelstam, 2004) with no relation to everyday life (Samuelsson, 2006). Actually, it is imbedded in everyday life, and that is why it is so easy to take math for granted and then question the subject's value (SOU, 2004: 97). Mathematical symbols and their representations are seen as having little connection to real world (Cornell, 1999). Students see math as juggling numbers that have no importance to them (Magne, 1998). Magne (1998) calls this phenomenon *abstraction anxiety*. It occurs if the teacher introduces a new concept in math that demands abstract thinking and the student hasn't understood the earlier, more concrete concepts.

A fourth source of anxiety among student teachers is the lack of understanding of all the factors that comprise mathematical competency (Samuelsson, 2005). *Student teachers don't know the goals of school mathematics*. In pedagogical contexts, researchers earlier discussed conceptual knowledge and procedural knowledge (Carpenter, 1986) as parts of mathematical competency. Conceptual knowledge is defined as a network of facts which can be used flexibly. Procedural knowledge has two parts: knowledge about mathematical symbols and their role in a syntactic system, and rules that tell how to manipulate those symbols (Skemp, 1977). Today researchers include more aspects that together construct mathematic competency. Kilpatrick et al. (2001) stress conceptual understanding, the

calculate; strategic competence, the ability to present, create and solve mathematical problems; adaptive reasoning, the ability to reflect, explain and verify the answers; and productive disposition, the understanding of the need for mathematical knowledge and beliefs.

Student teachers' experiences of the different aspects of teaching such as teacher leadership in classrooms, the subject, and the students' goals can affect their teaching in the future (Noyes, 2004). To be able to challenge the student teachers, we need to describe and analyze their experiences. If we don't do that, student teachers will hold onto their fear of math as well as their limited vision of how it should be taught (Stigler & Hiebert, 1999; Ebby, 2000; Klein, 2001). This study is significant in that the importance of well educated teachers have been discussed in several studies. There is a high correlation between teaching behaviours and increased student achievement (Patrick & Smart, 1998; Tang, 1997). This study will help teacher educators to learn about their students as well as it will help teachers to give attention to how different aspects of their teaching affect students.

Important concepts in the study

In this study I use concepts used in the activity theory for the purpose of interpreting the students' experiences. The theory makes it possible for the researcher to draw attention to different aspects of an activity (Leontiev, 1981; Engeström, 1999; Samuelsson, 2003, 2006; Krumsvik, 2004) that has been experienced. In this case, the experienced activity is school mathematics. To understand the experiences among student teachers, I will relate their experiences to entire concepts in an activity system artefacts, subject, rules, community, and division of labor, object and outcome (eg. Engeström, 1999; Krumsvik, 2005; Samuelsson, 2006).

Artefacts: This refers to the instruments used in the learning of mathematics. In this case these are *computers, elaborative material, pictures and symbols, among others*.

Subject: This refers to the individual whose agency is chosen as the point of view in the analysis. In this case it is the student teacher.

Object: The object refers to the raw material at which the activity is directed. In this case it is the school *mathematics*.

Outcome: This refers to the competencies that the subjects learn in the activity.

Community: These are the people that share the same object. In this case it is *the group climate* that is created in the math classroom.

Division of Labor: This refers to both horizontal division of tasks between the members of the community and the vertical division of power and status. One example of this is roles in group work.

A study of student teachers' experiences of the activity, school math, can be related to something more than just the object, mathematics. To understand their experiences, we need to draw attention to the context in which they tried to learn mathematics (Kuutti, 1996). In Figure 1, I give a concrete form to concepts related to the activity school mathematics inspired by Engeström (1999).

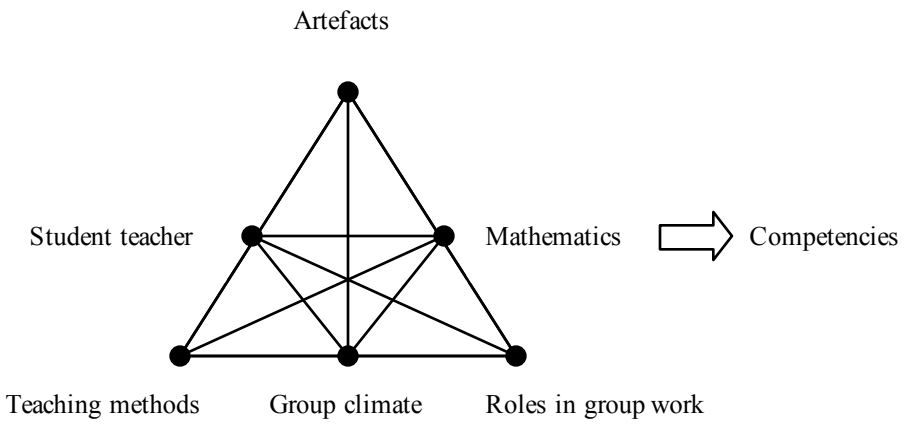

Figure 1. Aspects of the Activity, School Math

Looking at Figure 1, teachers affect many of the factors in the classroom; teaching methods, group climate, the subject and not knowing what competencies students should develop are teacher-influenced aspects that can contribute to the development of negative feelings toward teaching math.

Aim of the study

The purpose of this study is to contribute knowledge about how student teachers' experienced different aspects of school math. The questions are:

(a) How do different aspects as artefacts, the subject math, teaching methods, group climate, and competencies in school math and roles in groups affect students' attitudes toward school math?

(b) What relations can be found between different aspects as artefacts, the subject math, teaching methods, group climate, and competencies in school math and roles in groups in the student teachers' experiences?

Method

The instruments of inquiry were students' letters about their experiences in school math. Letters are written or printed information, which is a kind of document (Persinning, 2002). The stories of student teachers are an immediate and powerful way to depict the concrete particulars of experience (Paley, 1986). Stories of prior classroom experience can effectively portray our practice as complex, situational (Kuutti, 1996), and uncertain activity that is full of obstacles and possibilities (Loughran & Northfield, 1996). Connelly and Clandinin (1990) have argued that stories are an important way of capturing experiences. Accordingly, it seems reasonable to use student teachers letter, stories, in orders to give a picture of their experience.

As described above, the starting point of the analysis was to find the student teachers' experiences in the document. The purpose was to find subtopics to certain aspects of school math within their memories. In the second step, relationships between different aspects of the system were identified. These relationships were constructed as activity systems.

In the third step, words related to each system were counted to get an indication of what the student teacher had experienced as the most common and least common activity systems. The words used in documents and their frequencies can indicate if the student group has had a biased and therefore a limited experience of school math. The examination of the frequencies of words together with a thematic analysis gives a deeper understanding of the phenomenon (Bryman, 2001).

Participants and Procedure

The participants were 197 education students (188 female, 11 male). This was their first course designed to prepare them for teaching careers as math teachers at the elementary school level. Most of the students only studied 150 hours of math in secondary school. Nine of them had studied 250 hours.

The students were asked to write a letter on the topic, "Mathematics and Me", and send the letters by email to a mailbox.

The intention was that the student teachers would give their experiences of mathematics in general and in school math specifically. The reasons for writing and not using oral interviews were the following: (a) the writing situation makes the person reflect and process their experiences in a deeper way, (b) the interaction between the writer and text are a presumption to catch the experiences, (c) the author will be able to write without interacting with someone, which can interfere with responses (Green & Hartman, 1992).

A computer program that counts the frequencies of specific words in a document was used.

Analysis

Identifying Subtopics

A number of steps were taken to analyze the student teachers' letters. The letters were read and comments identifying subtopics were made in the margin. The comments helped then to create sub-topics for the main concepts, which are artefacts, mathematics, competencies, teaching method, group climate and roles in the group. Indications of different themes were words or phrases used by the student teacher (Bryman, 2001). With support of the computer, parts of the text were cut and pasted under different headings. Then I returned to the original text with the purpose of validating my results. In this section I also tried to find out if the student teachers wrote about the identified subtopics in a positive or negative way. Therefore it was important to return to the original text in order to see in what context the subtopic was described.

Identifying Relationships

In the description of school math, I found common subtopics to my main concepts. The analytic approach is inspired of what Dey (1999) call comparative analyse. Categories (sub-topics) and there relation have been focused in the analyses of the empirical material. The following steps were used: (a) identifying concepts (b) sort these concepts to different groups (activity system), (c) return to the original text in order to see in what context the concept was described and if the interpretation of what group the concept were placed in was reasonable (e.g. Dey, 1999). By using that analytical approach it was possible to see how different concepts used in the student teachers stories where related to each other. These themes established relationships which can be understood as different learning contexts or as activity systems.

The Occurrence of Different Activity System

Every activity system contains certain code words. How common a system is can be investigated by counting words related to different systems (Bryman, 2001). These words are the same concepts observed in the first analysis. Some words exist in more than one activity system. These words have not been split between different systems; instead they are incorporated in both systems.

Results

This study drew attention to certain aspects of school math and whole activity system. The results illustrate that a lot of aspects are connected to and affect student teachers' experiences in school math. It's not just the object, mathematics, which affects students; the experience is often associated to the context where mathematics is taught, and therefore aspects such as methods, group climate, artefacts also are important to investigate. In the first part student teachers experiences of aspects as artefacts, the subject math, teaching methods, group climate, and competencies in school math and roles in groups and how these aspects affected their attitudes are presented.

Experiences of Artifacts

Students´ comfort with school math and artefacts used in the learning process are affected by how the teacher chose to use different tools. When teachers draw attention to the value of mathematics in other contexts outside of the classroom, students seem to appreciate the artefacts used in the learning process. They give example of activities related to everyday life and using elaborative material.

> *I remember we got yellow books and we always counted. We used plastic money. It was fun because you could see the results of what you were doing.*

Negative attitudes come from mathematic symbols, spoken and written, used in a math community. Instead of departing from the concrete source, which is the nature of mathematics, and reasoning on an abstract level, students seem to appreciate the opportunity to go back to a concrete model.

Students also write about an exercise book that was used very often. If the tasks were easy to solve, they seemed to like the book, but if the tasks were too difficult, they didn't appreciate the book.

Earlier research has argued for the importance of concrete mathematics with elaborative material associated with everyday life to develop and expand the students' concept of math. I find that it's also important in order to develop positive attitudes towards mathematics learning.

Experiences of Mathematics

The student group can be divided into two groups: those who view math as fun and interesting, and those who see math as boring, difficult, abstract, unreasonable rules and something that is only fun for smart students. Student teachers see math as a subject they usually view as an unrelated collection of skills, techniques, and verbalisation rather than as a connected and meaningful activity that they might enjoy. Negative attitudes can manifest as abstraction anxiety. Seeing mathematics as a cognitive construction, it is only reasonable that students see math as abstract.

Some of the student teachers wrote that their problems with math disappeared when they

> *This teacher told me it's like learning a language. He said that if you manage the words in mathematics you will be able to build sentences and understand. Seeing mathematics as a language made it easier to accept my problems with the subject.*

It isn't possible to see if the student's teacher used scientific concepts or everyday words in situations like the one above.

Experiences of Group Glimate

Students' interests in mathematics and their attitudes to mathematics are dependent on teachers' actions in classrooms. Teachers' behaviour can affect students in a positive and a negative way. A teacher sensitive to students' needs who draws attention to conceptual knowledge constructs a positive group climate, and that affects students' attitudes in a positive way.

> *Beyond interesting tasks as exercises, my teacher was an unbelievable pedagogue and he could explain for hours if we didn't understood. He always tried to find out the specific model that would work for each student.*

If teachers don't have patience and engagement and if they react with anger to students when they need help, it leads to negative attitudes.

> *When I didn't understand, my teacher reacted with anger and shouted at me.*

Student teachers' experiences of math show us that teaching math is something more than just communicating the subject. A vital aspect is also how to meet students' needs. It's about leadership in the mathematics classroom.

Experiences of Competencies

The results of student teachers learning math can be viewed in three parts:

- Knowledge *in* mathematics (conceptual knowledge and procedures)
- Knowledge *about* mathematics (productive disposition)
- Knowledge about their own ability in relation to mathematics (A meta-cognitive aspect)

The students learned certain concepts and procedures which helped them to solve math problems in classroom as well in everyday life. When they understood how to solve math problems they were pleased and developed positive attitudes. Another aspect important to student's attitudes was knowledge about math. When they understood the importance of math in other contexts than school they sensed more motivated to learn. In Sweden, we have new categories of students in math teacher training programs compare to the late 1980´s and 1990´s. A common assumption is that if you are going to teach math, you should be particularly good at math yourself. This study finds something different: A lot of the student teachers believe that their ability in math is low. Almost 80 percent of them don't feel comfortable when they have to do math. Some students have learned that mathematics is difficult and they don't trust their own ability. They feel shame and react physically when they didn't understand the concepts.

I'm not just terrified of the subject; I'm also lousy in it. If someone asks me to count, I will get stiff, sweaty, nervous and afraid to answer. And when I answer a question, it's often not correct.

Experiences of Pedagogical Traditions

The traditional teaching method for math in Swedish schools is characterized by drills. Student teachers' experiences of school math reinforce the impression that teachers teach, instructing and imparting knowledge, while students practice their skills. The variation of methods exists, but it is unbalanced. The student teachers see elaborative methods as something positive for their attitudes toward school math. Negative attitudes were created because of too much individual training and learn-by-heart practice.

For many of the student teachers, math was a competition where they tried to do task as fast as possible. If they were fast, they felt proud; if they didn't manage to solve the tasks in a specific time, they felt dumb.

My motivation disappeared when math became a competition. I had no problem with the tasks but I was slow.

Experiences of Roles in Group Work

In the national curriculum problem solving was seen as a specific area that should be taught in mathematics. At the same time, math educators were discussing mathematics as a specific language. Seeing mathematics as a language the student is to discover and conquer might mean that attention could be drawn to the student's communicative ability. A common topic in math teachers' training during the 1980´s was how to organize for problem solving in groups. The student teachers in this study were students in the lower secondary school when the discussion about this subject occurred. In spite of all efforts, none of the students mention group activities in their letters. In this study we do not include one important aspect of the activity system, division of labor. We could have discussed different roles in group activities in math, but in this case, maths seems to be a very individual activity for the studied students.

Summary

Student teachers' ideas about how mathematics should be taught and their beliefs about the nature of math can be a limitation in the future. Content and methods in teacher training programs need to be adjusted for these students. The main concepts discussed are. In this study I have shown how different aspects, artefacts, mathematics, competencies, pedagogical traditions and group climate, have affected student teachers during their time in school. Topics that affected the students in a positive way is followed by (+), and negative experiences are followed by (-). If their experiences couldn't be related to either a positive or a negative emotion, it is followed by (0).

Table 1. *Main Concepts and Sub-Topics*

Main Concepts	Sub-Topics
Artefacts	Elaborative material (+)
	Everyday events (+)
	Skill training books (+) (-)
	Pictures (0)
	Mathematic symbols (-)

Mathematics	A fun subject (+) A language (+) A difficult, boring subject (-) An abstract subject (-) A subject only for smart students (-)
Group climate	Teachers who draw attention to conceptual knowledge, vary their explanations and have faith in the pupils (+) Teacher arranges activities where students compete, don't have patience and cannot or will not explain(-)
Results	Confidence in their ability (+) Conceptual knowledge (+) Procedures (0) Physical aversion (-) Shame (-)
Pedagogical traditions	Elaborative methods (+) Competition (0) Individual exercise (-) Rote memorization (-)

Relationships between subtopics

This section presents different relationships discovered in the material. The results of this study draw attention to five activity systems: (a) a drill activity, (b) an unpleasant activity, (c) a structural intra-mathematics activity, (d) an elaborative activity and (e) an discussion activity.

Characteristics of a drill activity are a teacher who teaches rules and tries to transfer procedures, and a student who drills using distinct tasks in a math book. The model can be visually represented by Figure 2.

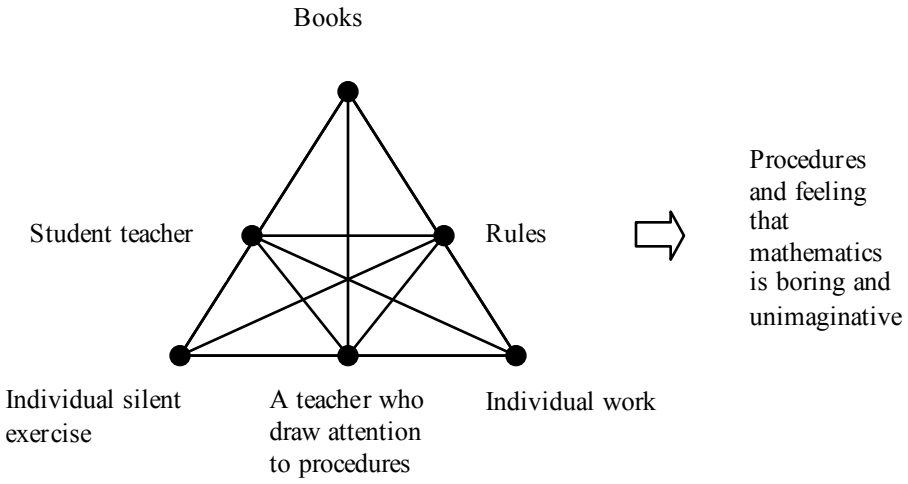

Figure 2. A Drill Activity

Words drawn from the materials related to this activity system are individual drill,

A key characteristic of an unpleasant activity is that students feel shame as a result of their confusion. The activity also causes physical aversion. Words from the materials related to this activity system are incomprehensible, shame, anger, boring, dumb, smart, a judgmental teacher, anxiety, competition, abstract, difficult, panic, and students who don't understand. This activity system contains a lot of words probably because this activity system was very well described in the students' letter.

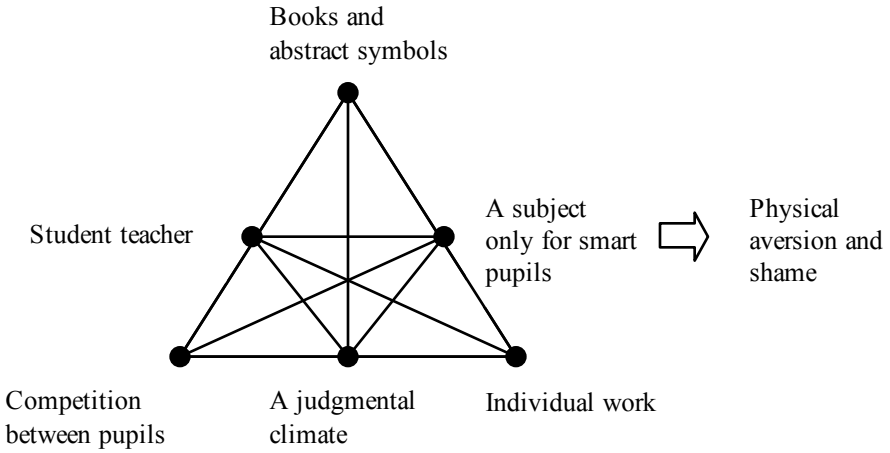

Figure 3. An Unpleasant Activity

The unpleasant activity is often a result of a drill activity. Parts of the drill activity may construct an unpleasant activity, like when teachers don't draw attention to understanding, when pupils competing with each other, and when the teacher sees mathematics as rules.

A student in a structural intra-mathematics activity is supposed to understand the mathematical concepts and their relationships. Teachers are supposed to draw attention to these relationships. According to this system, it's not important to know how mathematics is related to everyday life.

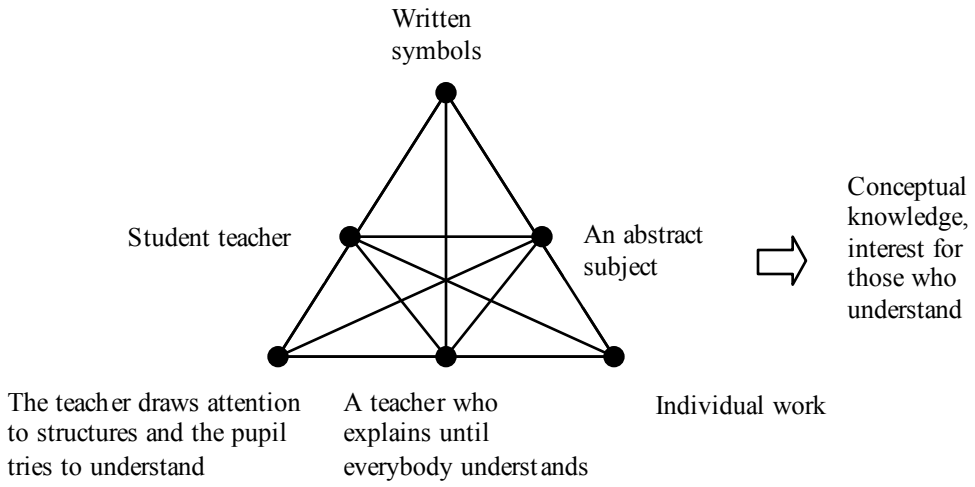

Figure 4. A Structural Intra-Mathematics Activity

Words from the materials related to a structural intra-mathematic activity are pupils understand, abstract, symbols, a teacher who explains so everyone can understand, interesting and fun. A lot of the student experienced that mathematics was very interesting and fun when they understood the concepts and their relations.

The key characteristic of an elaborative activity is a teacher who creates an environment where students construct knowledge and see the concept's value in everyday life. The students are supposed to learn concepts as well as rules by using all senses. Words from the materials related to an elaborative activity are interests, fun, pictures, mathematics in everyday life, concrete, material, elaborative and a teacher who create a good learning environment.

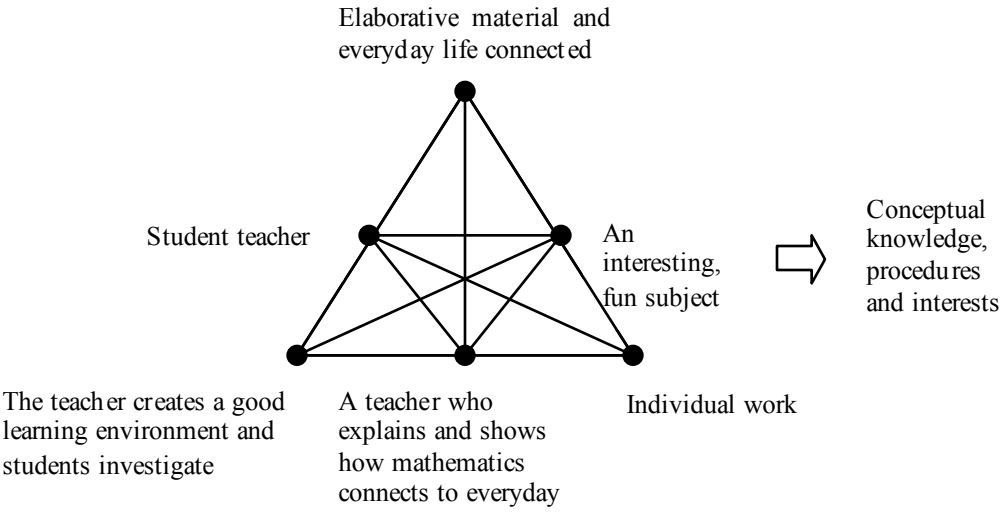

Figure 5. An Elaborative Activity

A teacher and a student talking with each other in order to develop the student's mathematical language characterizes a discussion activity. Words from the materials related to this activity are language and a teacher who is sensitive of how pupils express in a mathematical context.

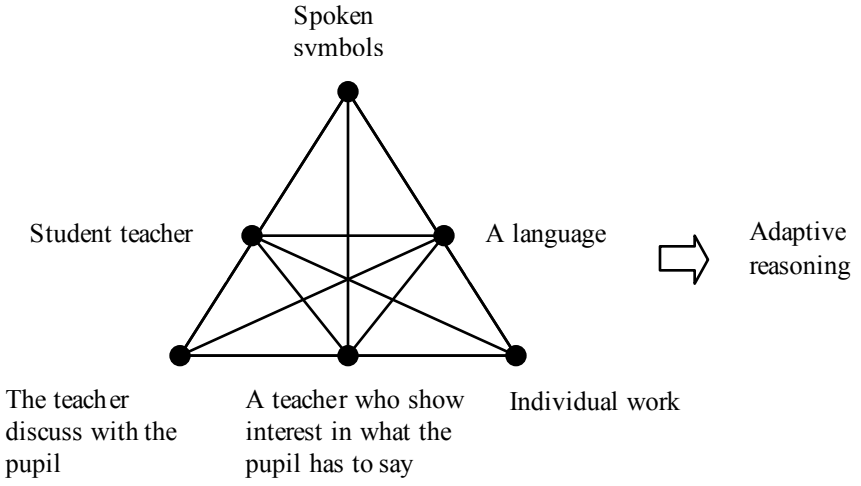

Figure 6. A Discussion Activity

Student teacher experiences of school math can be related to five different activity system, a drill activity, an unpleasant activity, a structural intra-mathematic activity, An

elaborative activity and a discussion activity. How common a system is have been investigated by counting words, concepts, sub-topics related to every system.

Tabel 2. *Activity System and Number of Words Related to the System*

Activity System	Number of Words
A drill activity	1322
An unpleasant activity	872
A structural intra-mathematic activity	296
An elaborative activity	285
A discussion activity	130

The dominate activity system student teachers have experience of is the exercising activity. If we assume that the unpleasant activity is a part of the exercising activity, it is clear that the Swedish school math is unbalanced.

Discussion

Teachers of mathematics in elementary school in Sweden have received a lot of criticism (Timss, 2004; PISA, 2004; Nu, 2003). The reviewers say that Swedish students perform worse than students in other countries, and they have negative attitudes towards school math. Researchers stress that students do not see how they can use math in everyday life and that math is taught in a way that is too abstract (Lindqvist, Emanuelsson & Rönnberg, 2003).

One group able to change negative trends in math education in Swedish schools is student teachers in teacher training programs. Students who will teach early elementary school math have studied less math (in sense of hours) in secondary school than students who wanted to teach elementary math in the late 1980´s and 1990´s. To be able to help these new students to improve, the teacher educators need to know about the students' experiences in the activity school math.

In the following discussion important issues related to math teaching and teacher education will be discussed. I will draw attention to experiences that will be limited for student teacher in their future teaching (eg. Lester, McCormick & Kapusuz, 2004).

One limitation is student's experiences of *school math as a competition.* Teachers need to pay particular attention to this aspect of the individual training because it causes so many negative emotions. For many of the student teachers, math was a competition where they tried to do tasks as fast as possible. If they were fast, they felt proud; if they didn't manage to solve the tasks in a specific time, they felt dumb. Math competency has nothing to do with the speed of counting; other qualities are more important (Skemp, 1976; Carpenter, 1986; Kilpatrick et al. 2001). Teacher educators need to show student teachers the wide range of abilities their students are supposed to learn in math and how to teach them. Only then can teacher students prevent their own pupils from developing negative emotions toward math as result of classroom practices.

A second limitation among student teachers is their experiences of their *teacher's actions in classroom*. The result of this study reinforces the result Jackson and Leffingwell (1999) found regarding the teachers actions in classroom. Students' attitudes to mathematics

engagement and if they react with anger to students when they need help, it leads to negative attitudes (eg. Jackson & Leffingwell, 1999). The teacher's knowledge of how a group of students should be treated is something student teachers as well as teachers working with them need to discuss. Student teachers' experiences of math show us that teaching math is something more than just communicating the subject. A vital aspect is also how to meet students' needs. It's about leadership in the mathematics classroom. A teacher's behaviour has such a strong influence on teaching and learning math that it is very important to discuss leadership in the math classroom.

A third limitation among student teachers is their experiences of math as a subject. A great deal of the students' descriptions of *math experiences is about skill training*. Seeing mathematics as counting and skill development is limited: Students with that idea will only draw attention to one form of knowledge (Case, 1996; Samuelsson, 2003; 2006), the procedures (Kilpatrick et al 2001). Student teachers' limited views about math as rules will also lead to stress among their students (Noyes, 2004) if they overemphasize right or wrong answers (Magne, 1998). How teachers lead students in the classroom will therefore be particularly important in school math. Leadership is dependent on a teacher's view of mathematics. Different attitudes about the subject lead to different behaviours by teachers and students in the community (Samuelsson, 2003; 2006). Teacher educators need to reform both aspects discussed above, and students comprehension of the subject. If they don't, student teachers will reproduce the teaching they experienced (Stigler & Hiebert, 1999; Ebby, 2000; Klein, 2001). This pattern can be the answer to why Swedish students get worse and worse in math compared to students in other countries. If student teachers' attitudes toward the subject affect their teaching (Thompson, 1984, 1992; Ernest, 1991; Ma, 1999; Foss & Kleinsasser, 2001; Samuelsson, 2006; Wilson & Cooney, 2002; Lester, McCormick & Kapusuz, 2004), teacher educators need to, in a conscious way, work with this group's beliefs and expand their knowledge in and about mathematics. This is important so that student teachers will be able to understand their own anxiety about math. Knowledge about what mathematics is (Kilpatrick et al. 2001) and what causes the emotions (Greenwood, 1984; Tobias, 1987, 1993) must be an important focus in the teacher training program for elementary teachers in Sweden.

A fourth limitation is their *abstraction anxiety* (eg. Magne, 1998). One reason for anxiety is the specific terms and concepts used in teaching and learning mathematics: When we speak about arithmetic, geometry and algebra, we use words that do not exist in everyday life, and there are a few people who use them in their regular life. These words may make it problematic for teachers to break old patterns. Researchers and teachers need to discuss the necessity of looking at math as an object in a new way. An intellectual experiment is to see math as topic where "know" and "know how to use" are more strongly connected. The following are examples of this connection:

- Position system – A practical innovation.
- Aid for calculation – Algorithms, calculator and computer.
- Orientation in the room – Measure, words of position and concepts.
- Changes – Increase and decrease, discount, interest, velocity.
- Accidental occurrence – Statistics and probability.
- Mathematics in professions – Tie together with other subject such as social studies and science.

The problems in school math, such as students who see mathematics as abstract, non relevant and the cause of negative emotions (Lindqvist, Emanuelsson, Lindström & Rönnberg, 2003), possibly will disappear or at least decrease if we start talking about and

These results reinforce earlier studies about school mathematics in Sweden (Lundgren, 1972; Neuman, 1987; Magne, 1998; Lindqvist, Emanuelsson, Lindström & Rönnberg, 2003; NU, 2003). Math is experienced as unrelated collection of skills and techniques. These limited experiences can be a problem for future math classes if teachers training programs not are able to help these students where they need it. If teacher educators don't manage to challenge these students' beliefs, student teachers will teach as they have been taught (Noyes, 2004). They will just focus on a small portion of the knowledge important for math competency (Samuelsson, 2006). As a result, student teachers may, avoid math as a result of their negative feelings toward mathematical activities (Harper & Daane, 1998).

There is no doubt that we have a new group of student teachers in teacher training programs and they have different experiences in math than student teachers in the late 1980´s and in the 1990´s. These students need to be educated about how their roles as teachers affect their students. They need to be competent in a variety of areas so they don't transfer negative attitudes about mathematics to their own students.

Pedagogical Implications

This study highlights deficits among student teachers when they start their teacher training in mathematics. These deficits have not been as obvious before as they are now when students can begin a teacher training program in math without completing an intensive math program in secondary school. In this part, with support of my results, I will make suggestions to teacher educators who will teach elementary school student teachers.

- A student teacher needs to pay attention to the complexity of mathematics competence in order to be able to draw attention to different forms of knowledge (see Kilpatrick et al. 2001). To be a teacher, you need to have knowledge in mathematics as well as about mathematics and how mathematics affects the learners.
- A student teacher needs to pay attention to his or her leadership in the math classrooms. I suggest that leadership is important because this aspect of the activity system causes many negative emotions among pupils.
- A student teacher needs to pay attention to how different teaching methods draw attention to different competences in mathematics.
- A student teacher needs to pay attention to how different aspects of an activity system affect students' attitudes in negative and positive ways.

What happens if teacher educators teach students what mathematics is and how different factors affect the activity system? Is it possible to change the students' attitudes toward mathematics in school? Are their beliefs too deeply rooted? How can a teacher training program help students if the education in school is an important part of their teacher training? Teacher educators at universities can talk about the importance of varied teaching, but if a teacher educator out in schools doesn't support these ideas, the methods will not change. If we are to change math education in Sweden, we have to do it on every level, from pre-school to university.

References

Bandalos, D. L., Yates, K., & Thorndike-Christ, T. (1995). Effects of math self-concept, perceived self-efficacy, and attributions for failure and success on test anxiety. *Journal of Educational Psychology, 87*, 611-623.

Bryman, A. (2002). Samhällsvetenskapliga metoder. Malmö: Liber Ekonomi.

Carpenter, T. P. (1986). Conceptual knowledge as a foundation for procedural knowledge. Implications from research on the initial learning of arithmetic. I J. Hiebert (Ed.). *Conceptual and procedural knowledge: The case of mathematic* (113-132). Hillsdale, N.J.: Erlbaum.

Case, R. (1996). Changing views of knowledge and their impact on educational research and practice. I D. R. Olsson, & N. Torrance (Eds.). *The handbook of education and human development. New models of learning, teaching and schooling*. Blackwell Publishers, 75–99.Cornell, C. (1999). ´I hate math! I couldn't learn it and I cant teach it!´ *Childhood Education, 75*, 225-230.

Conelly, F. M., & Clandining, D. J. (1990). Stories of experience and narrative inquiry. *Educational Researcher, 19*, 2-14.

Dey, I. (1999). *Grounding grounded theory. Guidelines for qualitative inquiry.* San Diego: Academic Press.

Ebby, C. B. (2000). Learning to teach differently: The interaction between coursework and fieldwork for preservice teach*ers*. *Journal of Mathematics teacher education, 3*, 69-97.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen, & R-L. Punamäki (Eds.). *Perspectives on activity theory* (19-38). Cambridge University Press.

Foire, G. (1999). Math-abused students: are we prepared to teach them? *Mathematics Teacher, 92*, 403-407.

Gierl, M. J. & Bisanz, J. (1995). Anxieties and attitudes relatied to Mathematics in grades 3 and 6. *Journal of Experimental Education, 63,* 139-159.

Granström, K. (2004). Arbetsformer och dynamik i klassrummet. I S. Selander (red.). *Kobran, nallen och majen. Tradition och förnyelse i svensk skola och skolforsning.* Stockholm: Liber.

Green, I., & Hartman, S. G. (1992). Barns livssituation och livstolkning. I *LOCUS,* Tidskrift för barn och ungdomsvetenskap nr 1. Stockholm HLS.

Greenwood, J. (1984). My anxieties abouth math anxiety. *Mathematics Teacher, 77,* 662-663.

Hammersley, M., & Atkinson, P. (1995). *Ethnography. Principles in practice*. Second edition. London and New York: Routledge.

Harper, N. W. & Daane,C. J. (1998). Causes and reduction of math anxiety in preservice elementary teachers. *Action in Teacher Education, 19*, 29-38.

Jackson, C. D. & Leffingwell, J. R. (1999). The role of the instructors in creating math anxiety in students from kindergarten through college. *Mathematics Teacher, 92,* 583-587.

Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. Mathematics Learning Study Committee. Washington, D.C.: National Academy Press.

Klein, M.(2001).Constructivist practice, pre-service teacher education and change: the limits of appealing to hearts and minds. *Teachers and Teaching: theory and practice, 7*, 257-269.

Krumsvik, R. (2004). *IKT i det nye laeringsrommet.* Forskningsrapport frå PILOT-prosjektet Högskulen i Volda. ITU skriftserie. Rapport 25.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. I B. A. Nardi (Ed.). *Context and consciousness: Activity theory and human-computer interaction (17-44).* Cambridge, Mass.: MIT Press.

Leontiev, A. N. (1981). The problem of activity in psychology. I J. V. Wertsch (Ed.). *The concept of activity in soviet psychology (37-71).* New York: Sharpe.

Lester, F. K., McCormick, K., & Kapusuz, A. (2004). Preservices Teachers´Belifs about the Nature of Mathematics. *International Perspectives on Learning and Teaching Mathematics*. Göteborg: NCM, Nationellt Centrum för Matematikutbildning.

Lgr 80 (1980). *Läroplan för grundskolan. Allmän del.* Skolöverstyrelsen. Stockholm: Liber Utbildningsförlaget.

Lindqvist, U., Emanuelsson, L., Lindström, J-O., & Rönnberg, I. (2003). *Lusten att lära – med fokus på matematik.* Skolverkets rapport nr (under utgivning).

Loughran, J., & Northfield, J. (1996). Opening the classroom door: Teacher, researcher, learner. London: Falmer Press.

Lundgren, U. P. (1972). *Framefactors and the teaching process*. Stockholm: Almqvist & Wiksell.

Ma, L. (1999). *Knowing and teaching elementary mathematics*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Magne, O. (1998). Matematikinlärning – en resa i det inre. I B. Gran (Red.). *Matematik på elevens villkor* (99-124). Lund: Studentlitteratur.

Neuman, D. (1987). *The origins of arithmetic skills*. Göteborg: Studies in Educational Science, 62. Göteborg: Acta Universitatis Gothoburgensis.

NU 2003 (2004) *Nationella utvärderingen av grundskolan 2003*. Skolverket: Rapport 250.

Paley, V. G. (1986). *Molly is three: Growing up in school.* Chicago, IL: University of Chicago Press.

Patrick, J., & Smart, R. (1998). An empirical evaluation of teacher effectiveness: The emergence of three critical factors. *Assessment & Evaluation in Higher Education, 23*, 165-178.

Persining, J. (2002). ”Using Document analysis in Analysing and Evaluating Performance.” *Performance Improvement. Performance Improvementol. 41*, 36-42.

PISA (2004). *Pisa 2003 - svenska femtonåringars kunskaper och attityder i ett internationellt perspektiv.* Skolverket: Rapport 254.

Samuelsson, J. (2003). *Nytt, på nytt sätt? En studie över datorn som förändringsagent av matematikundervisningens villkor, metoder och resultat i skolår 7-9.* Doktorsavhandling. Uppsala: Pedagogiska institutionen, Uppsala universitet.

Samuelsson, J. (2006). ICT as a change agent of mathematics teaching in Swedish secondary school. *Education and Information Technologies* (in press).

Skemp, R. R. (1976). Relational and instrumental understanding. *Arithmetic Teacher*, *26,* 9–15.

SOU 2004:97. *Att lyfta matematiken – intresse, lärande, kompetens*. Betänkande av matematikdelegationen. Stockholm 2004.

Stigler, J. & Hiebert, J. (1999). The teaching gap. New York: Free Press

Tang, T. (1997). Teaching evaluation at a public institution of higher education: Factors related to overall teaching effectiveness. *Public Personnel Management, 26*, 370-389.

Thompson, A. G. (1984). The relationships between teachers conceptions of mathematics and mathematics teaching to instructional practice. Educational Studies in Mathematics, 15, 105-109.

Timss (2004). *Svenska elevers kunskaper i matematik och naturvetenskap i skolår 8 i ett nationellt och internationellt perspektiv.* Skoverket. Rapport 255.

Tobias, S. (1987). *Succeed with math*. The College Board Publications.

Tobias, S. (1993). *Overcoming math anxiety.* W. W. Norton & Company Inc.

Wyndhamn, J., Riesbeck, E., & Schoultz, J. (2000). *Problemlösning som metafor och praktik.* Linköpings universitet: Institutionen för tillämpad lärarkunskap.