European Journal of Educational Studies 7(3), 2015
ISSN 1946-6331

STUDENTS´ BELIEFS ABOUT MATHEMATICS IN SCHOOLS LOCATED IN DIFFERENT SOCIOECONOMIC AREAS

[1]JOAKIM SAMUELSSON*, [2]LISA BJORKLUND-BOISTRUP &[3]PETHER SUNDSTROM

[1, 3] Department of Behavioural Sciences and Learning, Linkoping University, Linkoping, Sweden

[2]Department of Mathematics and Science Education, Stockholm University, Stockholm, Sweden

*E-mail address for correspondence: joakim.samuelsson@liu.se

Abstract:*Over the past few years there have been significant academic and public concerns regarding Swedish students' performances in mathematics, not least concerning the relationship between students' performance and their socioeconomic background. Previously, students from different family backgrounds had a very similar performance in mathematics, but there has been a decrease in the level of equality(Skolverket, 2009). The purpose of this study was to contribute with knowledge about how students in grade 5 (10-11-years-old) in schools in different socioeconomic areas perceive mathematics in school.Schools were selected from different socioeconomic areas, 20 different schools (40 teaching groups), and data from 1,029 students were utilised in this study.Results show that there is a lack of equity in mathematics teaching in Sweden. Students in different socioeconomic areas perceive mathematics teaching in different ways and thereby construct different filters that regulate thinking and actions in mathematics-related situations. Students from schools in high socioeconomic (HSES) areas have a relational vision of mathematics, where teachers focus on reasoning ability significantly more than students from schools in low socioeconomic areas (LSES), who have an instrumental vision of mathematics, where teachers focus on procedures. Thus, the result in this study gives evidence for different affordances in mathematics for students in schools located in different socioeconomic areas.*

Keywords: *mathematics education, belief system, socioeconomic areas, mathematics thinking, mathematical behaviour*

INTRODUCTION

The affective domain was for many years a neglected area in mathematics education research (McLeod & Adams, 1989). After McLeod and Adams' work was presented, attitudes towards mathematics formed a central research topic in the affective domain (affective domain is considered to be attitudes, beliefs and emotions) (Zan, Brown, Evans, &Hannula, 2006). Now researchers seem to agree that cognitive as well as affective factors play an important role in mathematics learning. Leder&Forgasz (2002) argue that both cognitive and affective factors must be investigated in order to understand how learning is to be improved. In this study we understand beliefs as an individual's subjective knowledge and emotions concerning mathematics (cf. Lester, Garofalo& Kroll, 1989). A student's beliefs are based on his or her personal experience (Pehkonen&Pietilä, 2003) of mathematics, the way it is taught and what helps them learn (McDonough, 2002; Yackel& Cobb, 1996). How students are taught in mathematics will therefore have an impact on their beliefs (Pehkonen, 2001). By investigating students' beliefs in mathematics, researchers can gain an insight into what happens in the mathematics classroom (Pehkonen, 2001).

Another major aspect for this research is that there have been significant academic and public concerns regarding Swedish students' performances in mathematics, not least concerning the relation between students' performance and their socioeconomic background. Earlier high levels of equity between students with different family backgrounds and their performances in mathematics have decreased, especially in comparison to other countries (Skolverket, 2009). Socioeconomic factors have been shown to be related both to students' performances in mathematics and final grades in compulsory education (ibid). The impact of students' socioeconomic background has strengthened, and is now greater than the OECD average. Knowledge of how students' perceive mathematics in schools located in different socioeconomic areas could therefore help us to understand differences between socioeconomic groups' performance with respect to mathematics learning. In this study we contribute with knowledge about how students in grade 5 (10-11-years-old) in schools in different socioeconomic areas perceive mathematics in school.

Problem of Research

In the first subsection a presentation of mathematics teaching in Sweden is made, after this section a problem of equity in mathematics education are discussed.

The context of mathematics teaching in Sweden

The Swedish compulsory education system is characterised by a public school for all children between 7 and 16 years of age. For all students, there is a compulsory curriculum of classes that are taken in a fixed order and together with the same classmates for at least the first six years. The same standard of education is to be provided throughout the country and is to provide a platform for further studies. In the first six years (between 7 and 12 years of age) of compulsory school students are often taught by one class teacher who teaches almost every subject. After these six years of primary schooling the students move to the next stage of compulsory education, generally known as lower secondary school (age 13-16).Furthermore, national tests are set by The National Agency of Education three times during compulsory school, in grades 3, 6 and 9.

A common teaching method in Swedish classrooms is characterised by teachers instructing or imparting knowledge and students practising their skills (Lundgren, 1972; Neuman, 1987; Magne, 1998; Engstrom, 1993; Lindqvist, Emanuelsson, Lindstrom &Ronnberg, 2003; NU; 2003; Skolverket 2009). This teaching method encourages dependence on the teacher's confirmation, procedural practice, and a key that gives the right answers. While students in mathematics classes work at their desks, teachers try to support students' learning individually, by moving around in the classroom from desk to desk in order to help students (Skolverket, 2003).

The mathematics curriculum during compulsory school in Sweden has many components, but there is a strong emphasis on concepts of numbers and operations with numbers. From an international perspective, mathematics knowledge is defined as something more complex than the concept of numbers and operations with numbers. Kilpatrick et al. (2001) argue for five strands which together build students' mathematical proficiency. The five strands provide a framework for discussing the knowledge, skills, abilities, and beliefs that constitute mathematical proficiency. In their report they discuss:

1. *ConceptualUnderstanding* is about comprehension of mathematical concepts, operations, and relationships. Students with conceptual understanding know more than isolated facts and methods. Items measuring conceptual understanding are for instance: "Your number is 123.45. Change the hundreds and the tenths. What is your new number?
2. *Procedural Fluency* refers to skills in carrying out procedures flexibly, accurately, efficiently, and appropriately. Students need to be efficient in performing basic computations with whole numbers (e.g., 6+7, 17–9, 8×4) without always having to refer to tables or other aids.
3. *Strategic Competence* is the ability to formulate, represent, and solve mathematical problems. Kilpatrick et al. (2001, p. 126) give the following example of an item testing strategic competence: "A cycle shop has a total of 36 bicycles and tricycles in stock. All together there are 80 wheels. How many bikes and how many tricycles are there?"

4. *Adaptive Reasoning* refers to the capacity for logical thought, reflection, explanation, and justification. Kilpatrick et al. (2001) give the following example where students can use their adaptive reasoning. “Through a carefully constructed sequence of activities about adding and removing marbles from a bag containing many marbles, second graders can reason that 5+(–6)=–1. In the context of cutting short bows from a 12-metre spool of ribbon and using physical models to calculate that 12 divided by 1/3 is 36, fifth graders can reason that 12 divided by 2/3 cannot be 72 because that would mean getting *more* bows from a spool when the individual bow is *larger*, which does not make sense” (p.130).
5. “*Productive Disposition* is the habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy” (Kilpatrick et al., 2001, p.5). Items measuring productive disposition are for instance: “How confident are you in the following situations? When you count 8-1=___+3 (completely confident, confident, fairly confident, not at all confident).”
6. These five strands are incorporated in the national curriculum for mathematics in Swedish compulsory school. Teachers must therefore draw the student’s attention to all competencies in the national curriculum in order to develop the student’s mathematical competence.

Mathematics education and equity

The increase in differences between high and low performing students is also reflected in the differences between higher and lower performing schools. Teachers’ expectations and demands, as well as local circumstances, segregation, poverty and socioeconomic status limit opportunities for students’ achievement (Lindgren, 2010). For some years, the Swedish school system has gone through major changes, which have led Sweden’s schooling sector to be classified as one of the most decentralised ones in the OECD (Ahlin&Mork, 2005). However, local income has had a low impact on school spending and teacher density (ibid). In the light of this it may be striking that mathematics education in Sweden is found to be characterised by pedagogical segregation (Hansson, 2011; 2012) connected to socioeconomic areas. Students who are in most need of responsible mathematics teachers have less access to them. These students receive less instruction and work more by themselves at their desks. That could be a problem since Hansson (2011; 2012) found that it is essential for students’ performances that mathematics teachers teach actively and take responsibility for students’ mathematics learning. We know that the actions of teachers is one factor that has an impact on students’ performances (Hattie, 2009). The consequence is that when addressing performances of different groups of students, there is a need to also address the roles of schools and teachers.

Research Focus

The affective domain has been conceptualised in different ways by different researchers. McLeod (1992) suggested that the affective domain is considered to be attitudes, beliefs and emotions. Other researchers focus on other constructs such as motivation (Zan et. al., 2006), identity, self-efficacy and anxiety, with beliefs remaining an area of research activity (Lomas, Grootenboer&Attard, 2012) and values (Bishop, 1988). The amount of construct in the domain could be one explanation as to why several researchers have documented the difficulty of defining beliefs (e.g., Hart, 1989; Pajares, 1992; Thompson, 1992). Pajares (1992) therefore suggests “Defining beliefs is at best a game of player’s choice (p.309)”. In this study we have been inspired by Rokeach (1968) who defines beliefs as “ any simple proposition, conscious or unconscious, inferred from what a person says or does, capable of being preceded by the phrase, ‘I believe that…’”(p.113). This definition was also used by McDonough & Sullivan (2014) when they investigated young children’s beliefs about mathematics and learning. Furinghetti&Pehkonen (2002) argue that beliefs are subjective knowledge, but a person’s beliefs are not fully independent of others. Beliefs are held in groups within belief systems (Green, 1971). Students in a teaching group in mathematics will therefore have a similar belief system in mathematics (Green, 1971). A belief system in mathematics education includes a variety ofconcepts(Furinghetti&Pehkonen, 2002) and could be defined as one’s mathematical view, the view with which one approaches mathematics (Schoenfeld, 1985). Pehkonen (1995) defines students’ beliefs in mathematics with four subgroups: a) beliefs of mathematics as subject, b) beliefs of your ability to do mathematics, c) beliefs of mathematics teaching and d) beliefs of how to learn mathematics. In another study, Op’tEynde et al (2002), argue that belief systems in mathematics include, the nature of mathematics, mathematics teaching, mathematics learning, self-concept, goal-orientation and socio-mathematical-norms. Researchers also argue that the teacher’s beliefs are an important factor that has a substantial impact on the quality of the teaching and learning process and students’ views of mathematics (Spangler, 1992; Pehkonen, 1995).

Ernest (1991) describes five educational ideologies in mathematics, ideologies which are similar to what Pehkonen (1995) and Op'tEynde et al. (2002) describe as a beliefs systems. He claims that teachers' views of the subject of mathematics affect their teaching and thereby students' views of mathematics. Researchers also argue that different teaching methods draw attention to different learning outcomes (Cobb, 1998; Case, 1996; Suchman, 1997; Vygotsky, 1934/1986; Wertsch, 1998; Boaler, 2002, Samuelsson, 2008). The beliefs of students from different socioeconomic areas will, in this study, be described using Ernest's (1991) five ideologies. The first ideology is ”The Industrial Trainer”. In this ideology the teacher sees mathematics as a set of facts and rules. Teaching involves processes such as authoritarian, transmission and drill. Students' learning is marked by hard work, effort, practice and rote learning. The second ideology is ”Technological Pragmatist”. In this ideology mathematics is seen as an unquestioned body of useful knowledge. The teacher works as a skills instructor and motivates mathematics through its work-relevance. Learning is characterised by skill acquisition and practical experience. The third ideology Ernest (1991) called ”Old Humanist” and this views mathematics as a body of pure structured knowledge. Teachers explain, motivate and try to pass on the subject's structure so that the student can understand and use mathematics and its applications. The fourth ideology ”Progressive Educator” is characterised by a teaching process where the teacher facilitates personal exploration and tries to prevent failure. The learning process is marked by activity, play and exploration. The last and fifth ideology is ”Public Educator”. Teachers see mathematics as social constructivism where teaching involves discussions, cognitive conflicts, questioning of content and pedagogy. Students learn by questioning, decision-making and negotiation. Thus, Ernest's (1991) five ideologies are different as regards their view of mathematics, view of mathematics teaching and learning. Therefore, different beliefs in mathematics can be discussed with reference to these five ideologies.

Di Martino &Zan (2011) suggest an alternative perspective related to the nature of mathematics. They suggest a dichotomy: an instrumental vision with focus on remembering and rules and a relational vision focusing on relationships and processes, as argued by Skemp (1976). Thus Ernest's (1991) first two ideologies are similar to what Skemp (1976) calls an instrumental vision, and the last three more similar to a relational view of the nature of mathematics.

METHODOLOGY

General Background of Research

As it can be seen from the theoretical background of the study, there is a body of knowledge about connections between students' performances and the socioeconomic background as well as schools and teachers. What we do not know much about is if there are any differences between mathematics teachings in schools located in different socioeconomic areas. With the support of Pehkonen (2001), we argue that by investigating students' beliefs about mathematics we can gain an insight into what happens in mathematics classrooms in schools located in different socioeconomic areas.

The aim of the study was to investigate if there were any differences in students' (10-11-years-old) beliefs about mathematics, view of the nature of mathematics teaching, view of mathematics learning, the student's self-concept and goal orientation (cf. Op'tEynde et al., 2002), in schools located in different socioeconomic areas.

Sample Selection

Results from this survey - which included 40 different schools (40 teaching groups) and data from 1,029 students - were utilised in this study. “Statistics Sweden” helped us select schools from different socioeconomic areas- 20 schools, 504 students (251 boys and 253 girls) located in an area with low socioeconomic standard (LSES) and 20 schools, 525 (269 boys and 256 girls) students located in an area with high socioeconomic standard (HSES). Earlier research has shown that the location of schools is closely related to the social and economic conditions of students (Sirin, 2005).

Instrument and Procedures

In order to answer the research question, if there are any differences between students' (10-11-years-old) beliefs about mathematics in different socioeconomic areas, a questionnaire was constructed. The questions covered areas such as view of the nature of mathematics teaching, view of mathematics learning, the student's self-concept and goal orientation (cf. Op'tEynde et al., 2002).

The test of students´ view of mathematics education employed in this study was developed by an expert group of researchers in Australia, New Zealand and Sweden. The entire questionnaire is composed of about 21 statements related to students' beliefs about mathematics (5 statements covered students' view of the nature of mathematics, 4 statements covered the view of mathematics teaching, 4 statements covered the view of mathematics learning, 4 statements covered the student's self-concept and 4 statements covered goal orientation). All items in the questionnaire were presented as statements, to which the students had to respond on a four-point scale (don't agree = 1; totally agree = 4).

In the area of the nature of mathematics, two statements identified mathematics as an unquestioned body of knowledge that is signified by facts and rules and three statements highlighting mathematics as individual exploration and something more than transmission and drill. Students' view of teaching and learning mathematics included two statements with an instrumental focus and two statements with a relational focus each. Self-concept included four statements of how students judge their mathematical ability and how they act working with mathematics. Goal orientation included two statements focused on facts and rules and two statements focused on reasoning ability. Reliability Cronbach α was calculated on statements with the same focus.

The same test has been used in an international comparative study highlighting students' beliefs about mathematics education in Australia, Great Britain, New Zealand and Sweden (Young-Loveridge et al. in prep).

Data Analysis

The analysis was carried out with an independent t-test.In order for us to be able achieve our results, t-tests for an independent sample to compare means related to the students' view of mathematics – in different socioeconomic areas – were carried out. These analyses made it possible to see if there were any differences on students' view of mathematics on each item. The t-test was performed on raw scores across the entire sample.

The magnitude of mean differences on item level was calculated using Cohens´s*d* (Cohen, 1988). Cohen´s *d* can be interpreted in terms of the percentage of non-overlap in two distributions. An effect size lower than 0.3 is considered to be small, 0.5 is considered to be moderate and 0.8 is large.

RESULTS

The findings of the study are organised into five subsections a) views of the nature of mathematics, b) views of mathematics teaching, c) views of mathematics learning d) student´s self-concept and e) goal orientation.

Nature of mathematics

In the first subsection we present students' view of the nature of mathematics.This category was comprised of five items. Two statements (item 1 and 2) could be related to a view of mathematics as an unquestioned body of knowledge that is signified by facts and rules (α=.92). Three items (item 3-5) state that mathematics involves personal exploration and something more than transmission and drill (α=.81).

Table 1: Items related to views of the nature of mathematics

Item	HSES		LSES		
	M	SD	M	SD	*d*
Mathematics is only a set of facts and rules.	1.60	.26	1.81	.22	0.40*
There is only one correct answer to mathematical problems.	1.87	.36	2.44	.46	0.44*
Adding, subtracting, multiplying and dividing are only a small part of mathematics.	3.12	1.09	2.91	.8	0.27*
I can come up with my own ways to solve mathematics problems.	3.35	.67	2.61	.43	0.22*
It is okay to make mistakes in mathematics.	3.68	.62	3.28	.99	0.48*

*Note: *p<.05*

There were significant differences between groups on all five items. The first two items "Mathematics is only a set of facts and rules" (t=4.716, df=1027, p<.001), "There is only one correct answer to mathematical problems" (t=5.216, df=1027, p<.011), show that students in schools in low socioeconomic areas view mathematics as an unquestioned subject that only comprises fact and rules significantly more than students in schools in high socioeconomic areas. Students from high socioeconomic areas view mathematics more as a subject where your personal experiences are important and mistakes are allowed than students from low socioeconomic areas. They also see mathematics as something more than drill practice, learning to count. There were significant differences on all three items, "Adding, subtracting, multiplying and dividing are only a small part of mathematics"(t=3.716, df=1027, p<.042),"I can come up with my own ways to solve mathematics problems"(t=5.16, df=1027, p<.001),"It is okay to make mistakes in mathematics"(t=2.35, df=1027, p<.018). Cohen's *d* test showed small effect sizes on each item.

Thus, the result indicates that students from schools in high socioeconomic areas and students from schools in low socioeconomic areas have significantly different views of the nature of mathematics. Students from schools in high socioeconomic areas have a more relational view of mathematics than students from low socioeconomic areas, who view mathematics as more instrumental.

Mathematics teaching

Mathematics teaching, in this study, includes statements of how teachers act in the classroom and students' view of the teacher's authority. Students' view of mathematics teaching includes four statements. Two statements could be related to an instrumental view of mathematics teaching (item 1 and 2, α=.76) and two statements could be related to a relational view of mathematics teaching (item 3 and 4, α=.79).

Table 2: Items related to views of mathematics teaching

Item	HSES		LSES		
	M	SD	M	SD	*D*
A characteristic of mathematics teaching is that the teacher talks and students listen.	2.60	.86	3.41	.92	0.91*
When two children don't agree on an answer in mathematics they need to ask the teacher to see who is correct.	2.53	1.4	2.44	.85	No. sig
A characteristic of mathematics teaching is group work, discussions and decision making.	2.91	1.09	1.87	.8	1.09*
When two children don't agree on an answer to a mathematics problem they can usually think through the problem together until they work it out.	3.25	.93	2.61	.83	0.72*

*Note: *p<.05*

There were statistically significant differences between students' view of mathematics teaching in HSES and LSES areas on three statements. Students from low socioeconomic areas view teaching as a process where the teacher talks and students listen significantly more than students from high socioeconomic areas (t=5.716, *df*=1027, *p*<.001). On the two statements that could be associated with a relational view of mathematics teaching, students from high socioeconomic areas had a more relational view of mathematics teaching than students from schools in low socioeconomic areas. They stated significantly more that their view of teaching was characterised by group work, discussions and decision making (*t*=5.426, *df*=1027, *p*<.001) and an activity where students are active and solve the problem together (*t*=4.416, *df*=1027, *p*<.031).

Mathematics learning

Mathematics learning includes statements of students' activity in the mathematics classroom in order to learn mathematics. Two statements were related to an individual learning activity (item 1 and 2, α=.91), and two statements were related to group activities where students are involved in discussions (item 3 and 4, α=83).

Table 3: Items related to views of mathematics learning

Item	HSES		LSES		
	M	SD	M	SD	*d*
I practise individually almost every mathematics lesson.	3.01	1.22	3.67	.54	0.70*
When I solve a problem in mathematics I often do it individually.	2.33	1.1	3.24	.85	0.92*
I talk about my ideas in mathematics in a group or with a partner.	2.91	0.91	2.34	.8	0.67*
It is important for me to listen to how other children in my class solved a problem in mathematics.	3.42	.82	2.79	.74	0.81*

*Note: *p<.05*

There were significant differences between groups on all four statements. Students from schools in low socioeconomic areas seem to be more involved in individual activities than students in school in high socioeconomic areas. Results of independent t-test on the first and second item gave the following result: "I practise individually almost every mathematics lesson" (*t*=4.726, *df*=1027, *p*<.001), "When I solve a problem in mathematics I often do it individually" (*t*=5.714, *df*=1027, *p*<.001).

Accordingly, students from schools in high socioeconomic areas seem to be more involved in group activities where they discuss, explain and listen to each other: "I talk about my ideas in mathematics in a group or with a partner"(*t*=4.526, *df*=1027, *p*<.001), "It is important for me to listen to how other children in my class solved a problem in mathematics" (*t*=5.336, *df*=1027, *p*<.001).

Students´ self-concept

Four statements were associated with students´ self-concept. Independent t-test showed no significant differences between students from schools in low socioeconomic areas and students from schools in high socioeconomic areas with respect to their self-concept.

Table 4: Items related to students´ self-concept

Item	HSES		LSES		
	M	SD	M	SD	*d*
When my work in mathematics is hard I don't give up	3.63	0.58	3.53	.68	No sig
I am good at mathematics	3.37	0.54	3.45	.75	No sig
I learn mathematics quickly	3.11	0.81	3.34	.93	No sig
Mathematics is difficult for me	1.91	.98	1.98	.67	No sig

*Note: *p<.05*

Goal orientation

The last area that was investigated was students' goal orientation when they learn mathematics. Two statements showed that mathematics learning focuses on facts and rules that you don't need to understand (item 1 and 2, α=.87) and two statements showed that mathematics learning focuses on reasoning ability and understanding (item 3 and 4, α=81). There were significant differences between groups on each statement. Students from schools in low socioeconomic areas view mathematics learning with respect to goal orientation as something you don't need to understand (t=3.726, df=1027, p<.031), mostly facts and rules (t=5.226, df=1027, p<.001), significantly more than students from schools in high socioeconomic areas. On the other hand, students from schools in high socioeconomic areas view mathematics learning more as reasoning ability and understanding than students from low socioeconomic areas:"Knowing why an answer is correct in mathematics is just as important as getting the right answer"(t=5.726, df=1027, p<.001), "Learning mathematics involves more thinking than remembering"(t=5.726, df=1027, p<.001).

Table 5: Items related to students´ goal orientation

Item	HSES		LSES		
	M	SD	M	SD	*d*
Learning mathematics is mostly remembering facts and rules.	2.92	0.63	3.23	.99	.37*
You can be good at mathematics without understanding it.	2.09	1.0	2.62	.85	.57*
Knowing why an answer is correct in mathematics is just as important as getting the right answer	3.56	.50	3.16	.79	.61*
Learning mathematics involves more thinking than remembering	3.3	.86	2.83	.74	.59*

*Note: *p<.05*

DISCUSSION

The overall aim of this study was to investigate if there were any differences with respect to students' beliefs about mathematics as a school subject, in schools located in different socioeconomic areas. In Sweden we have a history of equity between students with different family backgrounds and their mathematics performance (Skolverket, 2009). Thus, in the past years this equity has decreased in comparison to other countries. This study is one contribution to understanding why there is a difference in students' performances in mathematics in schools in different socioeconomic areas.Studying students´ subjective knowledge and emotions concerning mathematics (Lester, Garfalo& Kroll, 1989) will therefore give researchers an insight into what happens in mathematics classrooms (Pehkonen, 2001).

Beliefs about mathematics in different socioeconomic areas

Results in this study show that students in schools located in high and low socioeconomic areas percept their mathematics teaching in different ways and thereby construct different filters that regulate thinking, actions in mathematics-related situations and get different learning opportunities. This is important to consider in discussions of equity in mathematics education, since students' beliefs are a significant element which has considerable influence on the teaching and learning processes in mathematics classrooms (Spangler, 1992; Pehkonen, 1995; Leder&Forgasz, 2002).

Op'tEynde et al.'s (2002) perspectives on beliefs systems have formed the theoretical basis in the previous study. The empirical findings demonstrate significant differences between students' beliefs about mathematics as a subject, mathematics teaching, mathematics learning and goal orientation when they learn mathematics.

Students from schools in high socioeconomic areas view mathematics significantly more as a subject where they communicate and give reasons for their activity than students from schools in low socioeconomic areas, who view mathematics more as a subject with a set of facts and rules. The results show that students from high socioeconomic areas seem to be more involved in education marked by discussions, cognitive conflicts and questioning - an education ideology similar to what Ernest (1991) calls “Public Educator” - than students in low socioeconomic areas. In low socioeconomic areas students view mathematics more as a subject where they learn facts and rules - an education ideology similar to what Ernest (1991) calls “Industrial Trainer” and what earlier research describes as traditional mathematics teaching in Sweden (Lundgren, 1972; Neuman, 1987; Magne, 1998; Engstrom, 1993; Lindqvist, Emanuelsson, Lindstrom &Ronnberg, 2003; NU, 2003; Skolverket, 2009). Using the perspective suggested by Di Martino &Zan (2011), who is inspired by Skemp (1976), students from low socioeconomic areas seem to have a more instrumental view of mathematics than students from high socioeconomic areas, who have a more relational vision of mathematics.

Looking at the results of students’ view of mathematics teaching and learning strengthened the impression that students from schools in high socioeconomic areas are involved in more relational mathematics education than students in low socioeconomic areas, who seem to be more involved in an instrumental mathematics education.

Students from high socioeconomic areas view mathematics teaching as an activity marked by group work with peers significantly more than students in low socioeconomic areas, who listen to teachers who talk. When students describe how they act when they learn mathematics LSES students seem to practice more individually than HSES students, who seem to discuss, explain and listen to their peers significantly more. The empirical findings further demonstrate that LSES have their goal orientation towards facts and rules significantly more than HSES students, who focus their attention towards understanding and reasoning more than LSES students. A result of these different teaching processes could be that LSES learn procedures while HSES learn concept and adaptive reasoning (cf. Kilpatrick, 2001).

The empirical findings further demonstrate no significant differences between LSES and HSES with respect to their self-concept. The result could give the impression that both groups judge their self-concept to be equal. In this study we need to discuss what mathematics they judge their self-concept in relation to. Students’ view of mathematics as a subject, mathematics teaching and learning and their goal orientation indicates that they judge their self-concept in relation to different educational practices.

Equity in mathematics education

Results in this study are consistent with results presented by Hansson (2011, 2012), who showed that mathematics education in Sweden is noted for its pedagogical segregationconsidered and that teachers use different pedagogies according to their awareness of their group’s social structure. If students’ beliefs give an insight into what happens in classrooms (Pehkonen, 2001) and if students’ beliefs are the filter that regulates thinking and actions in mathematics education, the result in this study gives evidence for different affordances for students in schools located in different socioeconomic areas. Many researchers argue that different teaching methods lead to different learning outcomes (Cobb, 1998; Case, 1996; Suchman, 1997; Vygotsky, 1934/1986; Wertsch, 1998; Boaler, 2002, Samuelsson, 2008). The results in this study therefore give one explanation as to why LSES students perform on another level than HSES students. Students who have experience of mathematics as a communicative and reasoning activity have been exposed to other mathematical competencies than students who have experience of mathematics as a subject characterised by facts, rules and procedures to learn (Ernest, 1991; Kilpatrick, 2001). One possible explanation is that students who work in groups were exposed to a higher level of reasoning. In traditional work, the students generally interact with the teacher, while students working in groups interact with both their peers and their teachers. Active participation and the communication of thought processes with people of higher ability may be critical underlying factors when students are developing their mathematical proficiency. Language is a medium for discussing how to proceed and for restructuring ideas of peers’ divergent and sophisticated range of strategies. From this perspective, discussion provides students with the opportunity to explore variations between their own and their partners’ knowledge and thinking, correct misconceptions and fill gaps in understanding.

The following figure (figure 1) could summarise the results from this study. Students from high socioeconomic (HSES) areas have a relational vision of mathematics focusing their reasoning ability significantly more than students from low socioeconomic areas (LSES), who have an instrumental vision of mathematics, where you learn procedures.

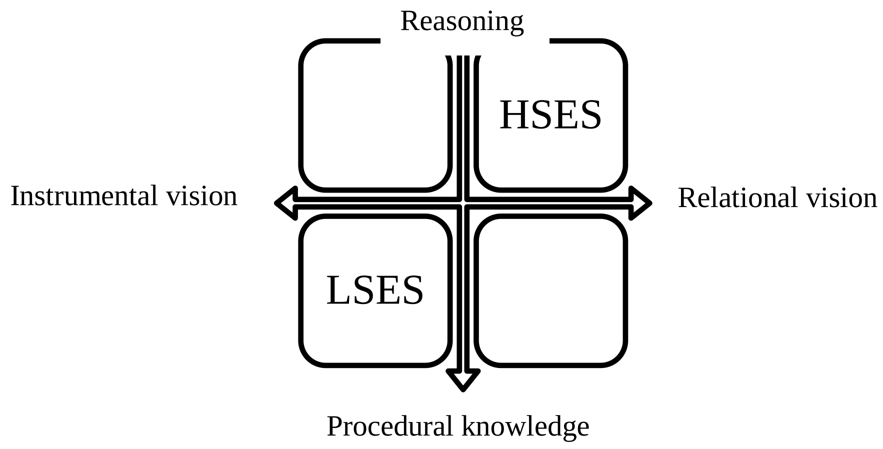

Figure 1: LSES and HSES beliefs systems with respect to activity and learning affordances in mathematics classrooms

Limitations

In this study one limitation was the selection of participants. More precise information concerning students' socioeconomic background has not been collected. Thus, most important was that the school was located in a low or high socioeconomic area. Information on socioeconomic status in the areas was gathered from the national agency "Statistics Sweden". Sirin (2005) showed that the location of schools is closely associated to the social and economic conditions of students.

A second limitation was the questionnaire. Students may perhaps respond how they think they should answer. In this study we had defined beliefs about mathematics with the support of McDonough & Sullivan (2014) who argue that beliefs could be investigated by a phrase which starts with "I believe that…". Thus, what students believe was the main concern in this study.

CONCLUSION

The result in this study state that teachers need to pay considerable attention to beliefs students have about mathematics. Knowledge of students´ beliefs can help teachers to understand why students act as they do in mathematics classrooms. If students´ beliefs are the filter that regulates thinking in mathematics classrooms, teachers ought to investigate students' beliefs in order to change teaching practices. Of course, teachers cannot use a range of methods with all their students. But if they have a student that is hard to reach, knowledge of the student's beliefs might reveal productive approaches to intervention.

The result from this study show that students from schools in different socioeconomic areas are involved in different mathematics teaching and thereby different learning affordances. There is a lack of equity in mathematics teaching in Sweden. Further investigation is needed, focusing on why these differences occur.

REFERENCES

Ahlin, Å.,&Mork, E. (2005). *Vad hände med resurserna när den svenska skolandecentraliserades?*[[What happen with resources in a de-centralized school?] Rapport 2005:1, IFAU – Institutet for arbetsmarknadspolitiskutvärdering.

Bishop, A. J. (1988). *Mathematical enculturation: A cultural perspective on mathematics education.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

Boaler, J. (2002). The development of disciplinary relationships: Knowledge, practice, and identity in mathematics classroom.*Proceedings of the annual meeting of the International Group for Psychology of Mathematics Education (1-9)*. Norwich, United Kingdom.

Case, R. (1996).Changing views of knowledge and their impact on educational research and practice. In D. R. Olsson, & N. Torrance (eds.), *The handbook of education and human development. New models of learning, teaching and schooling* (75-99). London: Blackwell Publishers.

Cobb, P. (1998). Analyzing the mathematical learning of classroom community: The case of statistical data analysis.*Proceedings of 22nd Conference of the International Group for Psychology of Mathematics Education, vol 1, 33-48.*South Africa: the University of Stellenbosch.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.).Hillsdale, NJ: Erlbaum.

Davies, G., & Thomas, M. (1989).*Effective schools and effective teacher.*Boston: Allyn & Bacon.

Di Martino, P., & Zan, R. (2011). Attitude towards mathematics: A bridge between beliefs and emotions. *ZDM Mathematics Education, 43*, 471–482.

Engstrom, A. (1993). *Om de rationella talen i den grundläggande matematikundervisningen.* [Rationals in early mathematics] Pedagogisk-psykologiska problem. Nr 579. Malmo: Lärarhogskolan.

Ernest, P. (1991). *The philosophy of mathematics education*. London: The Falmer Press.

Furinghetti, F., &Pehkonen, E. (2002).Rethinking characterization of beliefs. In G. C. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 39–57). Dordrecht: Kluwer.

Green, T. F. (1971). *The activities of teaching.* New York: McGraw-Hill.

Hansson, Å. (2011). *Ansvar for matematiklärande. Effekter av undervisningsansvar i det flerspråkiga klassrummet*. [[Responsibility for teaching.Effects of teachers' responsibility in multilingual classrooms].Goteborg: Gothenburg University.

Hansson, Å. (2012). The meaning of mathematics instruction in multilingual classrooms: analyzing the importance of responsibility for learning. *Educational Studies in Mathematics, 81*, 103-125.

Hart, L. E. (1989). Describing the affective domain: Saying what we mean. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective* (pp. 37–45). New York: Springer.

Hattie, J. (2009). *Visible learning.A synthesis of over 800 meta-analyses relating to achievement.* New York: Routledge.

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

Leder, G. C., & Forgasz, H. J. (2002). Measuring mathematical beliefs and their impact on the learning of mathematics: A new approach. In G. C. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 95–113). Dordrecht: Kluwer

Lester, F., Garofalo, J., & Kroll, D. (1989). *The role of metacognition in mathematical problem solving: A study of two grade seven classes.* Final report to the National Science Foundation of NSF Project, MDR 85-50346.

Lindgren, J. (2010). *Spaces, mobilities, and youth biographies in the New Sweden: Studies on education governance and social inclusion and exclusion*. Umeå: Umeå universitet.

Lindqvist, U., Emanuelsson, L., Lindstrom, J-O., & Ronnberg, I.(2003). *Lusten att lära –med fokus på matematik*. [[Motivated to learn mathematics]. Skolverket rapport nr 252. Stockholm: Skolverket.

Lomas, G., Grootenboer, P., & Attard, C. (2012). The affective domain and mathematics education. In B. Perry, T. Lowrie, T. Logan, A. MacDonald, & J. Greenlees (Eds.), *Research in mathematics education in Australasia 2008–2011* (pp. 23–38). Rotterdam: Sense Publishers.

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

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

McDonough, A. (2002). *Naïve and yet knowing: Young learners portray beliefs about mathematics and learning.*Unpublished doctoral thesis.Australian Catholic University.

McDonough, A., & Sullivan, P. (2014).Seeking insights into young children's beliefs about mathematics and learning.*Educational Studies in Mathematics, 87*, 279-296.

McLeod D.B., & Adams V.M. (1989).*Affect and Mathematical Problem Solving: A New Perspective*. NewYork: Springer-Verlag.

McLeod, D. M. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575–596). New York: Macmillan.

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

NU 2003 (2004) *Nationella utvärderingen av grundskolan 2003*. [[National assessment of compulsory school 2003]. Skolverket: Rapport 250.

Op 't Eynde, P., De Corte, E., & Verschaffel, L. (2002). Framing students' mathematics-related beliefs.A quest for conceptual clarity and a comprehensive categorization. In G. C. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 13–37). Dordrecht: Kluwer.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*, 307–332.

Pehkonen, E. (1995). *Pupils view of mathematics: Initial report for an international comparison project*. University of Helsinki. Department of Teacher Education: Research Report 152.

Pehkonen, E. (2001). Lärares och elevers uppfattningar som en dold faktor i matematikundervisningen. I B.Grevholm (red.), *Matematikdidaktik – ett nordiskt perspektiv* (s. 230-253). Lund: Studentlitteratur.

Pehkonen, E.,&Pietilä, A. (2003).*On Relationships between Beliefs and Knowledge in Mathematics Education.* In: Proceedings of the CERME-3 (Bellaria) meeting.http://www.dm.unipi.it/~didattica/CERME3/draft/proceedings_draft/TG2_draft/

Rokeach, M. (1968).*Beliefs, attitudes, and values: A theory of organizational change.* San Francisco: Jossey-Bass.

Samuelsson, J. (2008). The impact of different teaching methods on students' arithmetic and self-regulated learning skills.*Educational Psychology in Practice,3,* 237-250.

Schoenfeld, A. H. (1985). *Mathematical problem solving.* Orlando, FL: Academic

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*, 417-453.

Skemp, R. R. (1976). Relational and instrumental understanding.*Mathematics Teaching, 77*, 20–26.

Skolverket. (2009). *Vad påverkar resultaten I svensk grundskola? Kunskapsoversiktbetydelsenavolikafaktorer* [[What affects the results of Swedish compulsory education? Systematic review of the importance of various factors]. Stockholm: Skolverket.

Spangler, D. A. (1992).Assessing Students Beliefs about Mathematics.*Arithmetic Teacher, 40*, 148-152.

Suchman, L. (1997). Centres of coordination. In L. Resnick, R, Säljo, C, Pontecorvo and B, Burge (eds.), *Discourse, tools and reasoning – Essays on situated cognition*. New York: Springer-Verlag.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127–146). New York: Macmillan.

Vygotsky, L. S. (1934/1986). *Thought and language*.[A. Kozulin, Trans.]. Cambridge, Mass.: MIT Press.

Wertsch, J. (1998). *Mind as action.* Cambridge, MA: Harvard University Press.

Yackel, E., & Cobb, P. (1996).Sociomathematical norms, argumentation, and autonomy in mathematics.*Journal for Research in Mathematics Education, 27*, 458–477.

Zan, R., Brown, L., Evans, J., &Hannula, M. S. (2006). Affect in mathematics education: An introduction. *Educational Studies in Mathematics, 63*, 113–121.