Development of self-regulated learning skills in mathematics in lower secondary school in Sweden

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In this study, the development of 219 students' self-regulated learning skills in lower secondary school across ability groups were investigated and related to measures of students' performance in mathematics. Self-regulated learning skills were assessed with a questionnaire originally designed and used in PISA 2003. Pre-testing was performed during the first two weeks in school in seventh grade. The first post-test was performed after one term in eighth grade, in January 2008. The second post-test was performed during the last two weeks in grade 9, in June 2009. All testing was performed by the class teacher. However, the result states that internal motivation, instrumental motivation as well as self-concept decline across year in lower secondary school. The development of interest and enjoyment of mathematics, self-concept in mathematics and anxiety in mathematics was similar in each ability group. No interaction effects across groups were significant in the study. This study highlights the importance of taking affective factors into account in discussions about the results of mathematics teaching and learning. The strong correlation between affective factors and achievement in mathematics helps us to identify some weaknesses in the Swedish education system.

In discussions about the effect of teaching in school, cognitive outcomes often receive a lot of the attention. In OECD (2004) the authors argue that another important component in mathematics teaching is self-regulated learning skills. Self-regulated learning skills are important goals in the Swedish national curriculum as well as being individually related to students performance in mathematics (Törnroos et al., 2006). As people are not only hosts of internal mechanisms but rather agents of experiences, investigations of affective factors such as self-regulated learning skills attest to the importance of one's perceived self for successful functioning

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and adaption across many different domains (Bandura, 2001). Bandura (2001) also showed that the human intellect is not just thoughtless but rather generative, creative, and proactive. Self-construct which provides students with a sense of agency to motivate their learning through use of such self-regulatory processes are for instance self-monitoring and self-evaluation (Bandura, 1997). Students in grade 7–9 are typically in early adolescence, which appears to be a critical stage in their affective development. In mathematics education evidence points to a decline in levels of positive affect as students progress school (Fredricks & Eccles, 2002) with such levels reaching a minimum in year 9 (Watt, 2004). A better understanding of these issues is important, since it can help schools to draw attention to these aspects in the classroom, and find ways of helping every student to reach his or her highest and to develop positive self-regulated learning skills. The first aim of the present study was to compare the development of self-regulated learning skills in mathematics through lower secondary school across subgroups of children with a) low ability (LA), average ability (AA), and high ability (HA) in mathematics. The second aim was to analyze to what extent the four factors related to self-regulated learning skills predict learning outcomes in mathematics.

Self-regulated learning skills and mathematics performance

Within the framework of PISA 2003 (OECD, 2004), self-regulated learning skills are internal motivation (students' interest in and enjoyment of mathematics), instrumental motivation in mathematics, self-concept in mathematics and anxiety in mathematics.

Internal motivation in mathematics

Internal motivation means that your motivation to accomplish your goal comes from within you. Your motivation is from you. It is determined by your own values and goals. Thus, internal motivation to learn is characterised by an intention to engage in learning activities because it is considered interesting, exciting, challenging etc (OECD, 2004). Lately, interest has been differentiated in two forms in the literature (Hidi & Harackiewicz, 2000; Krapp, 2000; Schraw & Lehman, 2001). Situational interest can be characterised as transient, context-dependent enjoyment trigged by environmental factors. This type of interest is often a necessary first step in the development of more stable individual interest (Hidi & Renninger, 2006). Several researchers argue that individual interest is an important prerequisite to attend certain objects and activities (Hidi & Ainley, 2002; Köller, Baumert, & Schnabel, 2001; Krapp, 2000; Schraw & Lehman, 2001). In interest-driven activities, the activity is associated with favourable learning outcomes. Students experience competence and personal control, feelings of autonomy, by an experience of flow in which the student and the object of interest combine (Csikszentmihalyi & Schiefele, 1993).

Törnroos et al. (2006) used hierarchical linear models to explore connections between self-regulated learning skills and students' performances in mathematics. They reported that the interest itself was positively associated with the students' test results but combined with other factors the coefficient became negative. The result is explained by the fact that several students with high self-concept and good results are not interested in mathematics and that students with problems learning mathematics are interested in the subject.

Instrumental motivation in mathematics

Instrumental motivation, in contrast means that your motivation to attain your goal comes from a source outside yourself. This type of motivation is characterised by the desire to engage in a learning process because it has positive outcomes or can help you avoid negative outcomes (OECD, 2004). With instrumental motivation the purpose of mathematics attainment is more practical. Students want to learn mathematics because it will help them in future work, it will help them with the subject that they want to study further in school, they need it for the course they want to study later or it will help them get a job. In the hierarchical linear models presented by Törnroos et al. (2006) instrumental motivation had a small but statistical significant relation to students' performance in mathematics in Finland, Norway, Sweden and OECD but not in Denmark and Iceland.

In contrast to the mixed degree of students that find mathematics interesting or enjoyable, the overwhelming majority of students in OECD understand that it is important to study mathematics because of the future benefits it will bring (OECD, 2004). Boys are somewhat more likely to do so than girls, which is not surprising given that boys have a greater tendency to go on to further studies in disciplines that demand an understanding of mathematics. Yet in the Nordic countries students do not conform to a stereotype in which girls think that mathematics is irrelevant to their future (Törnroos et al., 2006). Samuelsson and Granström (2007) showed that too high instrumental motivation in mathematics could be experienced as unreasonable demands. Demands they found were counter-productive to students' learning of mathematics.

A similar result was found in a study by Artelt (2005), but in that case student's instrumental motivation was negative correlated to reading literacy. Thus, instrumental motivation seems to correlate with performance in different subjects in a positive way as well as in a negative way.

Self-concept in mathematics

Self-concept is defined as self-perceptions about one's abilities and competences that influence the possibility of success (Byrne & Shavelson, 1986) in for instance mathematics. Students with a positive self-concept show more motivated behaviour and greater persistence with challenging tasks (Stipek, 1998). Many researchers have viewed self-concept as an explanatory variable for students' varying performance in school; whereas other researchers insist that self-concept is a consequence and not a cause of students' achievement (Bong & Clark, 1999).

Skaalvik and Hagtvet (1990) argue that the causality between academic self-concept and achievement mainly goes in the direction from self-concept to achievement for older students (age 13, when they start lower secondary school in Sweden) when they are subjected to greater educational demands. Another explanation is that children's self-concept becomes increasingly differentiated as they grow older and as the ability to judge their overall self-worth increases (Harter, 1998; 1999). Thus, as children become adolescents, when they begin lower secondary school, previously confident children experience an increasing awareness of peers and their relative ability, they become more aware of their own competence, more realistic about task demands, and more sensitive to social comparisons (Harter, 1998). In lower secondary school students' self-concept may fall due to doubts resulting from school transition, less personalised instruction, and perceptions of increased pressures (Pajares & Cheong, 2003). In other studies researchers have found strong relations between self-concept and achievement established within two years of starting school (Chapman, Tummer, & Prochnow, 2000).

Self-concept is positively related to mathematics achievement in a variety of settings across school and across countries (Dermitzaki, Leondari & Goudas, 2009; Ireson & Hallam, 2009). When Törnroos et al. (2006) used hierarchical linear models in the Nordic countries in PISA they found that self-concept was a stronger predictor to students' achievement in mathematics than internal motivation, instrumental motivation and anxiety in mathematics. This result differed from average results in all OECD countries. In OECD students' self-concept was not as strong a predictor to students' performance in mathematics as in the Nordic countries.

Anxiety in mathematics

Anxiety in mathematics has been defined in different ways: a feeling of tension, apprehension or fear that interferes with mathematics performance (Richardson & Shuinn, 1972; Ashcraft, 2002); or a state of discomfort, which occurs in situations involving mathematics (Trujillo & Hadfield, 1999). The first definition focuses on the impact of anxiety on cognitive outcomes, while the latter definition highlights the impact on self-esteem.

Aschcraft (2002) summarizes the extensive literature on personal and educational consequences of anxiety in mathematics. One unfortunate consequence is that people with anxiety in mathematics have a tendency to avoid mathematics. They take fewer and easier courses and when they take mathematics courses they receive lower grades. Students with anxiety in mathematics also seem to adopt negative attitudes and negative self-concept. One explanation to why people with high anxiety in mathematics end up with lower grades is their avoidance behaviour. They are exposed to less mathematics in school and learn less of what they are exposed to (Fennema, 1989).

Researchers have found three variables affecting mathematics anxiety: environmental, personality and intellectual. Environmental factors contain classroom issues, parental pressure and the perception of mathematics as a severe set of rules. Personality refers to reluctance to ask questions in class and self-esteem; intellectual include a mismatch of learning styles and self-doubt (Hadfield & McNeil, 1994).

In the OECD model anxiety has stronger negative effect on students' performance than in the Nordic countries (Törnroos et al., 2006). It was also shown that students in the Nordic countries had the least anxiety towards mathematics (OECD, 2004).

Different activities impact on self-regulated learning skills

The strong relation between self-regulated learning skills and performance helps researchers identify some weaknesses in schools in Sweden (OECD, 2004). One important question to consider is how teachers can help students to develop their self-regulated learning skills. In Törnroos et al. (2006) it is suggested that students

> with negative attitudes should be guided in their encounters with mathematics so that they can see the fascination and importance of mathematics in our world. The encounters should give these students feelings of success in performing mathematical tasks and thus give them confidence in their abilities and potential to learn mathematics. (Törnroos et al., 2006 p100)

Other researchers have shown how different teaching approaches influence student's self-regulated learning skills (interest, view of the subject's importance, self-perception, and attribution) (Boaler, 2002). Students who were expected to cram for examinations describe their attitudes in passive and negative terms. Those who were invited to contribute with ideas and methods describe their attitude in active and positive terms that are inconsistent with the identities they had previously developed in their lives. Samuelsson (2008) showed that working together with peers helped students to develop a greater interest than traditional teaching and independent work did. In order to progress in this aspect, it seems important that students have the opportunity to discuss mathematical issues with their peers.

Researchers have also shown that students' self-concept is affected significantly more if they work traditionally or with problem-solving activities. One interpretation Samuelsson (2008) made was that students became aware of their knowledge more than they did when working independently. In both the traditional and peer collaboration groups, they were provided with feedback from teachers and peers. These results support the results of Boaler's (1999) study which found that a strong predictor of a positive self-concept in mathematics is a group climate where students interact with each other and feel support from teachers and peers.

The present study

In this study, a split-plot factorial design with time as within-subject factor and ability groups as a between-subject factor was used in order investigate the development of self-regulated learning skills in lower secondary school. Self-regulated learning skills in mathematics, internal and instrumental motivation, self-concept and anxiety (OECD, 2004), were used as dependent variables.

To answer the second aim, which was to find out to what extent the four factors related to self-regulated learning skills predict learning outcomes in mathematics grades, self-regulated learning skills were correlated and regressed to grades in mathematics.

In this study all schools followed the national curriculum. All classes were taught in the traditional way. This means that the teacher explained methods and procedures from the chalk board at the start of the lessons, and the students then practiced with textbook questions. There was no ability grouping in the selected schools. Research on the effects of ability grouping in school is not always consistent. Oakes (1985) as well as Hallam and Deathe (2002) found that for students in low-ability groups self-concept becomes more negative as they progress through school. Ireson et al. (2001) found that self-concept in mathematics and science was unaffected by setting. It appears, therefore, that the effects of ability grouping may vary from one subject to another and that different facets of self-concept are sensitive to different aspects of ability grouping in school as a whole and in specific subjects.

Method

Participants

A total of 219 students attending 10 different classes in ten different schools in mathematics were included in the study. They were all between 13 and 14 years old when they started in lower secondary school, 108 female students and 111 male students, and they were 15–16 years old when they left lower secondary school. Their schools mainly recruit students from a part of Sweden with average socio-economic status. Their performances on standardised national tests in 5th grade in language and mathematics were representative for Swedish students according to the National Agency of Education. Thus, there were 10 groups of mathematic students attending a new school at grade 7 in mid-August 2006. Age in month, gender, and previous performance on national test in language and mathematics were similar across classes for each class. Pre-testing (arithmetic and self-regulated learning skills test) was performed during the first two weeks in school. This testing was performed by the class teacher. The first post-test was performed after three terms, in 8th grade in January 2008. The second post-test was performed during the last two weeks in grade 9 in June 2009 (see figure 1). Post-testing was also performed by the class teacher. The arithmetic test showed what ability group each student would be assigned to in the analyses. Maximum score on the arithmetic test was 30 points. Approximately 30 % were assigned to the low ability (LA) group, they scored between 1 and 14 points on the

Table 1. *Type of test and number of participants*

Test	August 2006 Arithmetic test, Self-regulated test	January 2008 Self-regulated test	June 2009 Self-regulated test
LA	65	58	52
AA	85	78	78
HA	69	68	68
n	219	204	198

test. Approximately thirty percent were assigned to the high ability (HA) group, they scored between 24 and 30 points and the rest were assigned to the average ability (AA) group.

The arithmetic test

The tests employed in this study were developed by six teachers in mathematics and three teacher educators. The teacher educators are all involved in textbook writing in mathematics and also are part of the committee working on the national mathematics tests in Sweden. One test covering arithmetic ability, calculation, and conceptual understanding was developed. The calculation items required the student to perform addition, subtraction, multiplication and division:

$$19+9=, \frac{450}{9}=, 1-\frac{1}{3}=, 2.1+0.7=, 13.1+0.01=, 10-0.3=, 21\cdot 10=,$$

$$10\cdot 2.45=, \frac{420}{10}=, \frac{141}{6}=, 567+273=, 5\cdot 6.4=5\cdot 9.6=$$

The conceptual understanding items required the student to solve problems related to knowledge about the position system and the magnitude of numbers. For instance:

- Draw a line under the largest number 1.49 1.499 1.5 1.099
- Your number is 123.45. Exchange the hundreds and the tenth. What is your new number?
- What numbers should be in the squares [ ]?

a)	10	20	30	[ ]	[ ]
b)	8.4	8.6	8.8	[ ]	[ ]
c)	14.34	14.32	14.30	[ ]	[ ]

The self-regulated learning skills questionnaire

Self-regulated learning skills were assessed with a questionnaire originally designed and used in PISA 2003 (OECD, 2004). However, in this study a ten-point scale was employed (don't agree = 1 to totally agree = 10) instead of a six-point scale used in the PISA study. The first four statements in the questionnaire were related to *internal motivation*, that is, (a) I enjoy reading about mathematics, (b) I look forward to my mathematics lessons, (c) I do mathematics because I enjoy it, and (d) I am interested in the things I learn in mathematics. Another four statements in the questionnaire were employed to measure *instrumental motivation*. These statements were as follows: (a) Making an effort in mathematics is worth it because it will help me in the work that I want to do later, (b) Learning mathematics is important because it will help me with the subject that I will study further on in school, (c) Mathematics is an important subject for me because I need it for what I want to study later on, and (d) I will learn many things in mathematics that will help me get a job. *Self-concept* was measured by 5 different statements: (a) I am good at mathematics, (b) I get good grades, (c) I learn mathematics quickly, (d) I have always believed that mathematics is one of my best subjects, and (e) In my mathematics class, I understand even the most difficult work. Finally, the last five statements focused on *anxiety* about mathematics: (a) I often worry that it will be difficult for me in mathematics classes, (b) I get very tense when I have to do mathematics homework, (c) I get nervous doing mathematics problems, (d) I feel helpless when doing mathematics problems, and (e) I worry that I will get poor grades in mathematics.

Data analyses

The first question (to compare the development of self-regulated learning skills in mathematics through lower secondary school across subgroups of children) was answered with of a split-plot factorial design with group (low ability – LA, average ability – AA, high ability – HA) as a between-subject factor and time (lower secondary school) as a within-subject factor. There were a total of four dependent variables in the study. Measures related to self-regulated learning skills such as internal and instrumental motivation, self-concept, and anxiety were used as dependent variables.

To be able to answer the second question, to what extent the four factors related to self-regulated learning skills predict learning outcomes in mathematics grades, Pearson's product moment correlation test and a multiple regression analyses were carried out. These analyses made it possible to estimate the relationship between self-regulated learning skills and grade in mathematics individually as well as between multiple independent variables and grade in mathematics. Each of the factors of *internal motivation*, *instrumental motivation*, *self-concept* and *anxiety* was used as an independent variable in the regression equations. The dependent one was grade in mathematics. The data analyses were made in two steps. (a) Pearson's product moment correlation test, and (b) students' self-regulated learning skills were regressed to their grades mathematics. A reliability test (Cronbach α) was carried out on each factor, internal motivation (α = .94) instrumental motivation (α = .90), self-concept (α = .94) and anxiety (α = .85).

Results

The first aim of this study was to compare three different groups' (LA, AA, HA) development of self-regulated learning skills in mathematics through lower secondary school. The primary data, therefore, come from changes in internal motivation, instrumental motivation, self concept and anxiety for mathematics, between pre- and post-tests.

Means and standard deviations for internal motivation, instrumental motivation, self-concept and anxiety are shown in table 2. The main issue of interest is the extent to which the three groups, low achievers, average achievers and high achievers, have made differential progress on these performance measures.

Table 2. *Means and standard deviation for the test levels on internal motivation, instrumental motivation, self-concept and anxiety*

	Group		
	LA (52)	AA (78)	HA (68)
Internal motivation			
t1	5.27 (2.21)	5.99 (2.24)	5.93 (2.23)
t2	4.86 (2.19)	5.10 (2.54)	5.53 (2.32)
t3	4.66 (1.93)	4.75 (2.49)	5.69 (2.40)
Instrumental motivation			
t1	7.56 (1.90)	7.72 (1.89)	7.77 (1.53)
t2	7.41 (1.95)	6.90 (1.74)	7.90 (1.50)
t3	4.18 (2.23)	4.00 (2.12)	2.05 (0.97)
Self–concept			
t1	4.47 (1.89)	5.35 (2.00)	7.19 (1.74)
t2	4.00 (1.83)	4.61 (2.14)	7.52 (1.66)
t3	3.95 (1.83)	4.54 (2.21)	6.99 (1.95)
Anxiety			
t1	5.05 (1.86)	4.29 (1.64)	2.77 (1.53)
t2	5.24 (1.60)	4.01 (2.12)	2.28 (1.23)
t3	4.43 (2.03)	4.22 (2.17)	2.39 (1.19)

Notes. Maximum scores = 10. Pre-test, t1, and post-tests, t2 and t3.

To assess the development of three different groups in mathematics, a total of four analyses of variance (ANOVA) with group as a between-subject factor and time as a within-subject factor were performed. Dependent variables were different aspects of self-regulated learning skills.

Development of self-regulated learning skills

An ANOVA with total scores of internal motivation as dependent measures revealed a significant main effect for time, $F(1,196) = 17.76$, $p < .001$, suggesting that interest and enjoyment in mathematics were declined across teaching groups. There were also a main effect of group, $F(1,196) = 3.62$, $p < .03$. No interaction between group and time, $F(2,196) = 2.54$, $p > .05$ was found.

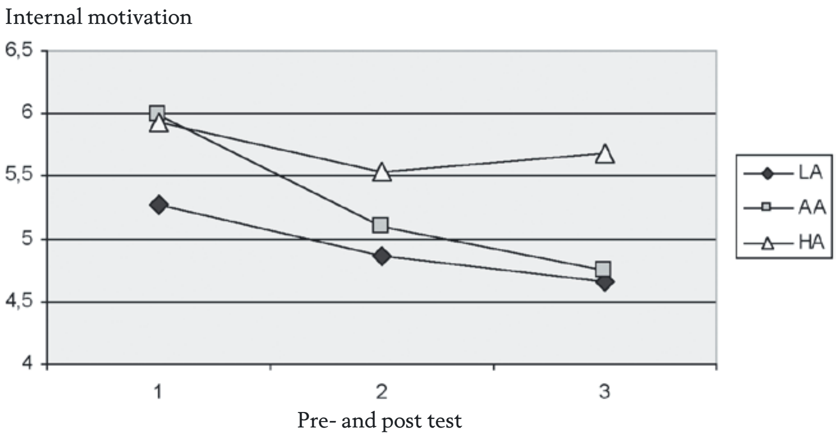
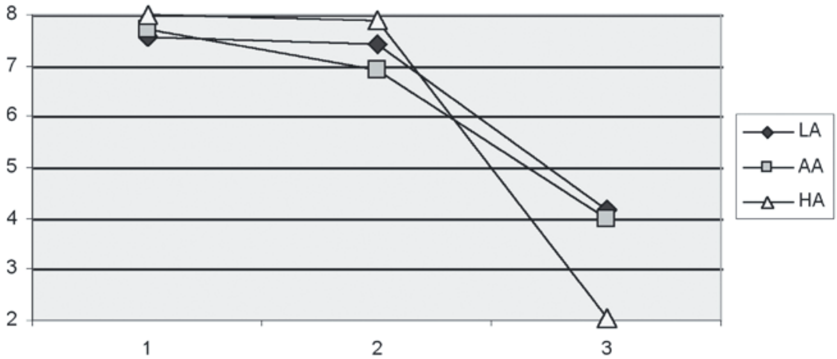


Figure 1. *Progress in internal motivation*

These findings suggest that there was no general effect of the variation in subgroups, and that change in interest and enjoyment for mathematics was similar across different ability groups.

Two additional ANOVA's were performed with instrumental motivation and self-concept, respectively. For instrumental motivation, $F(1,196) = 498.3$, $p < .001$, as well as for self-concepts, $F(1,196) = 12.3$, $p < .001$, there was a main effect of time signifying that both instrumental motivation ability and self-concept were declined across sub-groups. There were also a main effect of group for self-concept, $F(2,196) = 62.4$, $p < .001$, which indicates that at least one group differs according to self-concept. There were no main effects of group, $F(2,196) = 2.51$, $p > .05$, when measuring instrumental motivation. Finally, there was no interaction between group and time for self-concept, $F(2,196) = 2.46$, $p > .05$, but there was for instrumental motivation, $F(2,196) = 17.27$, $p < .001$. Interaction is explained by differences between the high ability group and the average ability group as well as the low ability group. The greater negative change on instrumental motivation in the high ability group than in the average and the low ability group is illustrated in figure 2.

Instrumental motivation



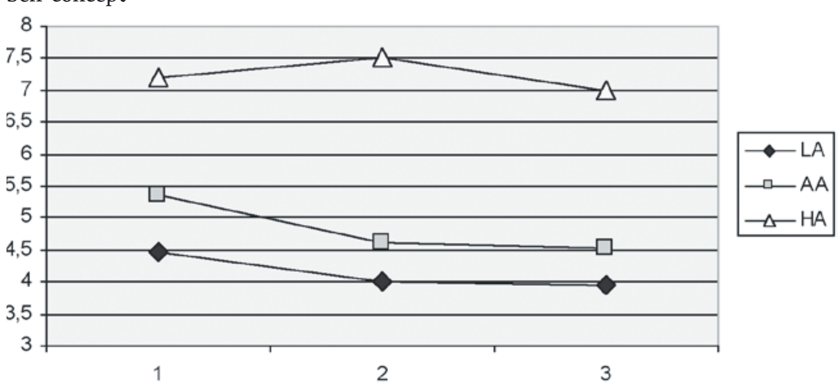
Pre- and post test

Figure 2. *Progress in instrumental motivation*

These findings suggest that there was no general effect of the variation in subgroups, and that change in self-concept in mathematics was similar across different ability groups (see figure 3). Thus, students with high mathematics ability in the beginning of lower secondary school tend to progress on a similar level across year with respect to self-concept when average and low ability students are likely to decline. But still there were no significant differences.

A fourth ANOVA with anxiety as dependent measure revealed a significant main effect for time, $F(1,196) = 6.96$, $p < .01$. The results also showed that there were no main effects of group, $F(2,196) = 43.34$, $p < .001$. Finally, there was no interaction between group and time for anxiety, $F(2,196) = 1.49$, $p > .05$, which indicates that students' anxiety in

Self-concept



Pre- and post test

Figure 3. *Progress in self-concept*

mathematics changed in a similar way across different ability groups. Thus, high ability students seem to have lower anxiety in mathematics (figure 4) than students with average ability or low ability in mathematics across time.

Anxiety

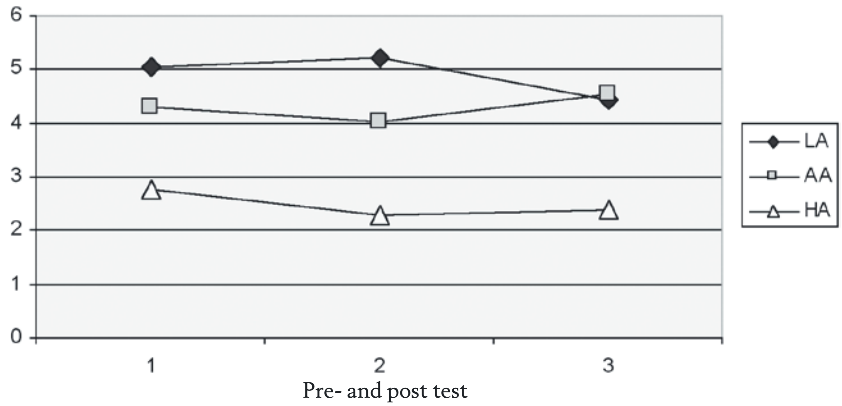


Figure 4. *Progress in anxiety*

The result indicates that internal motivation, instrumental motivation as well as self-concept decline across year in lower secondary school. Thereby the following question, to what extent the four factors related to self-regulated learning skills predict learning outcomes in mathematics grades, remains still more interesting.

Self-regulated learning skills relation to achievement in mathematics

The statistical analyses concerned the relationship between self-regulated learning skills and grades. Analyzed individually, all four factors were strongly related to students' grades. Pearson's product moment correlation test showed that all skills, interest and enjoyment of mathematics (r = .40, p < .01), instrumental motivation (r = -.52, p < .01), self-concept (r = .64, p < .01), and anxiety (r = -.54, p < .01) correlated with grades. Interest and enjoyment as well as self-concept correlated positively.

In the next step a regression model was specified with mathematics grade as the dependent variable and self-regulated learning skills as the independent variable. All standardized regression coefficients for the equation are shown in table 3.

As expected, self-regulated learning skill predicted grade. The multiple regression coefficient was significant, r = .69, F (4,193) = 42.89, p < .001. This

Table 3. *Regressing self-regulated learning skills on grades in mathematics*

Self-regulated learning skills	Standardized coefficient	*t*-value
Internal motivation	-.02	-.32 ns
Instrumental motivation	-.17	-.72 ns
Self-concept	.52	6.36*
Anxiety	-.11	-.46 ns

Notes. * $p < .01$

implies that there is a relationship between self-regulated learning skills and grades when students finish lower secondary school in Sweden. The regression model shows that self-concept is strongly related to mathematics grades. Internal motivation, instrumental motivation and anxiety had no statistical significant relation to grade in the regression model.

Discussion

In this study the development of self-regulated learning skills in lower secondary school as well as the relations between self-regulated learning skills and mathematics achievement in lower secondary school in Sweden were examined. The first aim of the study was to compare development in self-regulated learning skills across subgroups of students with different mathematics ability in arithmetic at the beginning of lower secondary school. Discussions of sorting students according to their achievement level could lead to assimilation effects that enhance student motivation in higher tracks and undermine it in lower ones. In this study all students have been taught in mixed ability groups. The results, therefore, tell us something about how self-regulated learning skills are developed for different ability groups in a traditional learning context in Sweden.

Development of self-regulated learning skills in mathematics

Students with low ability in arithmetics in the beginning of lower secondary school estimate their self-regulated learning skills more negative than average and high ability students. The results show that there are significant differences across groups with respect to interest and enjoyment in mathematics, self-concept in mathematics and anxiety in mathematics. Students who begin lower secondary school with low scores in the above mentioned aspects of self-regulated learning skills continue to score low, average ability students score on an average level and high ability students score highest across year. The development of interest and enjoyment in mathematics, self-concept in mathematics and anxiety in mathematics was similar in each ability group. No interaction effects across groups were significant in the study. A positive interpretation is that the Swedish education system gives students with different ability in mathematics the same opportunity to develop their self-regulated learning skills in lower secondary school. Swedish schools seem to develop students' self-regulated learning skills in the wrong direction in lower secondary school. The results indicate that students' development in interest and enjoyment in mathematics, self-concept and anxiety do not progress in a positive but rather a negative, way (cf. Pajares & Cheong, 2003; Chapman, Tumner & Prochnow, 2000.) This pattern of results contradicts previous findings reported by Ireson et al. (2001) who argue that self-concept is unaffected by setting. The results of my study indicate that self-concept, interest and enjoyment and anxiety develop but in an unconstructive way for all ability groups. One interpretation to the differences could be found in Pajares' and Cheong's (2003) study. They argue that less personalised instruction and perception of increased pressure in lower secondary school have a negative impact on for instance students' self-concept in mathematics. Maybe Swedish students experience less personalised instruction and increased pressure during lower secondary school. When a student starts lower secondary school at the age of thirteen previously confident children experience an increasing awareness of peers and their relative ability, they become more realistic about task demands, and more sensitive to social comparison (e g Harters, 1998; 1999). In the beginning of lower secondary school Swedish students could have a tendency to overestimate their competences in mathematics. If Swedish students overestimate their mathematics performance in the beginning of lower secondary school they will not reach their full potential. Several studies showed that overestimation of one's potential can lead to poor preparation and lower performance (Vancouver & Kendall, 2006).

Self-regulated learning skills and achievement in mathematics

In discussions about the effect of mathematics teaching in schools, cognitive outcomes receive a lot of the attention. This study highlights the importance to also take affective factors into account in discussions about the results of mathematics teaching and learning. It is widely reported that students' self-regulated learning skills have a strong relation to achievement in mathematics (Törnroos et al., 2006; OECD, 2004). The strong correlation between affective factors and achievement in mathematics helps us to identify some weaknesses in the Swedish education system. The results show that students with low interest and enjoyment in mathematics (e g Törnroos et al., 2006), with low self-concept (e g Dermitzaki, Leondari & Goudas, 2009; Iresson & Hallam, 2009) and high anxiety (eg Richardson & Shuinn, 1972; Ashcraft, 2002) receive lower grades. These results are coherent with earlier research on the relation between affective factors and performance in mathematics. The correlation for instrumental motivation was certainly unexpected. In the regression model there was no relation to grades but instrumental motivation itself was negatively correlated to grades. One explanation could be that students with high grades and good results in mathematics do not see knowledge in mathematics as important in their future studies or working life. The students answered the questionnaire after they had received their results on national tests and after they had chosen study program in higher secondary school. Sweden will have a great problem if students with high grades in mathematics do not see the subject as an important competence in their future life. Too many students with great mathematics ability will choose to study programs with low demands on their mathematics knowledge. Another interpretation is that too high instrumental motivation in mathematics could be experienced as unreasonable demands which Samuelsson and Granström (2007), as well as Artelt (2005) found were counter-productive to students learning.

One important question to consider is how teachers can help students to develop their self-regulated learning skills. Törnroos et al. (2006) proposed that teachers should help students to see the fascination and importance of mathematics in our world. More explicitly, this study also draws attention to knowledge of the importance of mathematics in different subjects as economics, engineering as well as in different professions. Thus, the teacher of mathematics plays a critical role in encouraging students to sustain positive attitudes. How a teacher views mathematics and the learning of it affects students' view about themselves as mathematics learners. When norms allow students to be comfortable in doing mathematics and sharing their ideas with others, they see themselves as capable of understanding (Boaler, 1999; Samuelsson, 2008). Further research is needed on how to develop self-regulated learning skills in mathematics in a positive way.

References

Aschcraft, M. H. (2002). Math anxiety: personal, educational, and cognitive consequences. *American Psychological Society*, 11, 181–185.

Bandura, A. (1997). *Self-efficacy in changing societies*. New York: Cambridge University Press.

Bandura, A. (2001). Social cognitive theory: an agent perspective. *Annual Review of Psychology*, 52, 1–26.
Bong, M. & Clark, R. E. (1999). Comparsion between self-concept and self-efficacy in academic motivation research. *Educational Psychology Review*, 15, 1–40.
Byrne, B. M. & Shavelson, R. J. (1986). On the structure of adolescent selfconcept. *Journal of Adolescent Psychology*, 78, 474–481.
Chapman, J. W., Tunmer, W. E. & Prochnow, J. E. (2000). Early reading-related skills and performance, reading self-concept, and the development of academic self-concept. *Journal of Educational Psychology*, 92, 703–708.
Csikszentmihalyi, M. & Schiefele, U. (1993). Die Qualität des Erlebens und der Prozess des Lernens [The quality of experience and the process of learning]. *Zeitschrift für Pädagogik*, 39, 207–221.
Dermitzaki, I., Leondari, A. & Goudas, M. (2009). Relations between young students' strategic behaviours, domain-specific self-concept, and performance in a problem-solving situation. *Learning and Instruction*, 19, 144–157.
Fredricks, J. A. & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: growth trajectories in two male-sex-typed domains. *Developmental Psychology*, 38, 516–533.
Harter, S. (1998). The development of self-representation. In W. Damon (Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: social, emotional, and personality development* (5th ed., pp. 553–617). New York: Wiley.
Harter, S. (1999). *The construction of the self: a developmental perspective.* New York: Guildford Press.
Hidi, S. & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: a critical issue for the 21st century. *Review of Educational Research*, 70, 151–179.
Hidi, S. & Ainley, M. (2002). Interest and adolescence. In F. Pajares & T. Urdan (Eds.), *Academic motivation of adolescents* (pp. 247–275). Greenwich: Information Age.
Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41, 111–127.
Ireson, J. & Hallam, S. (2001). *Ability grouping in education*. London: Sage.
Ireson, J. & Hallam, S. (2009). Academic self-concepts in adolescence: relations with achievement and ability grouping in schools. *Learning and Instruction*, 19, 201–213.
Krapp, A. (2000). Interest and human development during adolescence: an educational-psychological approach. In J. Heckhausen (Ed.), *Motivational psychology of human development* (pp. 109–128). London: Elsevier.

Köller, O., Baumert, J. & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*, 32, 448–470.

Oakes, J. (1985). *Keeping track: how schools structure inequality*. New Haven: Yale University Press.

OECD (2004). *Learning for tomorrows' world. First results from PISA 2003.* Paris: Author.

Pajares, F. & Cheong, Y. F. (2003). Achievement goal orientations in writing. *International Journal of Educational Research*, 39, 437–455.

Richardson, F. C. & Shuinn, R. M. (1972). The mathematics anxiety rating scale. *Journal of Counseling Psychology*, 19, 551–554.

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

Schraw, G. & Lehman, S. (2001). Situational interest: a review of the literature and directions for future research. *Educational Psychology Review*, 13, 23–52.

Stipek, D. (1998). *Motivation to learn*. Needham Heights: Allyn and Bacon.

Trujillo, K. M. & Hadfield, O. D. (1999). Tracing the roots of mathematical anxiety through in-depth interviews with pre-service elementary teachers. *College Students Journal*, 33, 219–233.

Törnroos, J. et al., (2006). Affective factors and their relation to the mathematical literacy performance of students in the Nordic countries. In J. Mejding & A. Roe (Eds.), *Northern lights on PISA 2003 – a reflection from the Nordic countries* (pp. 87–101). Copenhagen: Nordic Councils of Ministers.

Watt, H. M. G. (2004). Development of adolescence' self-perceptions, values, and task perceptions according to gender and domain in 7th through 11th grade in Australian students. *Child Development*, 75, 1556–1574.

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