PUPILS' ATTITUDES TOWARD MATHEMATICS: COMPARATIVE RESEARCH BETWEEN ESTONIAN AND FINNISH PRACTICE SCHOOLS

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Abstract

In initial teacher education we have put a lot of effort into improving student teachers' readiness to support learners' motivation and use diverse teaching methods. The objective of this paper is to research the motivation to learn mathematics and mental arithmetic among primary school pupils in student teachers' practice schools. In Estonia, the problem is that most pupils don't like science studies, and most university students prefer social sciences. Mental arithmetic strategies and arithmetic skills used by pupils are important in mathematics, as well as in everyday life. Teachers' skills in teaching mathematics are poor and there is a little variability.
A survey was conducted in April and May 2006 among the 1st to 3rd form pupils of 7 student teachers' practice schools in Estonia. Research results were then compared to the results of research conducted simultaneously in Finland, and also among 1st to 3rd form pupils in practice school. The present article focuses on pupils' attitudes toward mathematics and mental arithmetic. The main results of the research show that the attitude toward mathematics among pupils is positive. The comparison showed that Finnish pupils' attitudes are more positive toward mathematics than Estonian pupils' and boys have a more positive attitude than girls. In teaching methodologies and teacher training, the emphasis has to be put on the problems girls are having. This is because girls are the ones who don't like mathematics and mental arithmetic.
Key words: *learning motivation, mental arithmetic, teaching mathematics.*

Introduction

International research is done between countries in order to get comparative material about pupils' knowledge and learning interests. As shown by the 2006 *Pisa survey*, the knowledge level among both Estonian and Finnish pupils is very high (Assessing Scientific, Reading and Mathematical Literacy, 2006). At the same time, much research emphasizes that pupils in Estonian schools are experiencing stress, and their motivation to learn is low (Ruus et al., 2007). Another problem is the uneven interest toward different subject areas. Estonian pupils' interest in studying the natural sciences and exact sciences in a university setting has decreased remarkably (Kõrghariduse riiklik koolitustellimus, 2008). At a time when the social sciences are gaining popularity, it is important to acknowledge the necessity of having mathematical and arithmetic skills. Pupils need these skills in everyday life. For a pupil in elementary school, it is important to be able to count, to fix the location in a row of numbers, to have mental arithmetic skills, to know how to tell time and do calculations with time, to be able to do different activities involving measurements, and to be able to do monetary

calculations. To be able to do these functions, a pupil needs mathematical and mental arithmetic skills because the facilities that aid in doing these tasks may not be available in everyday life. Generally, these kinds of abilities help develop logical thinking and form the basis for future studies.

Features that influence motivation to study of mathematics

What may support a pupil's motivation to study mathematics and to pay attention to it in the learning process? As with learning every other subject, mathematics also has to be connected to a pupil's everyday life. In this case, a pupil who is active in the learning process will create knowledge that is also significant for him or her in everyday life (Heuvel-Panhuizen, 1996). Pupils have to come to the conclusion that mathematics exercises are not only in textbooks, but there are also a vast number of them in the classroom, in the school at large, on the way home, and at home; they are part of our everyday lives. Every task and problem we encounter in our lives contains some urgency of calculation and the need to solve a problem (Kaasik, 1997).

Pupils' attitudes toward a subject are very important. Prior to going to school and for the first few years in school, pupils are very interested in studying, because they have a natural interest in learning about their environment. External environmental factors affect a child's attitude toward different activities, but so do parents and teachers. Internal motivation works more efficiently than external; therefore, teachers have to plan, find, and create situations and tasks that are connected to the pupils' needs for attention (Lindgren & Suter, 1994, p.496). Every child has his or her own strengths and weaknesses. They wish to behave according to their parents' expectations, and they expect praise and recognition (Burnett & Jarvis, 2006, p.26-28; Lindenfield, 2003, p.131).

Getting negative feedback, a child becomes afraid of failure and avoids taking excessive risks during his or her studies (Burnett & Jarvis, 2006, p.26-28). Negative self-esteem is not natural – it forms through bad experiences. Unfortunately, children experience this in everyday situations, and at early ages. From the learning perspective, it is important to support pupils and their motivation, so that children do not associate negative experiences with learning and hold back on their studies. Negative self-esteem makes a child insecure about his or her eventual successes (Lindenfield, 2003, p.124). Based on previous research, it is evident that children who dread mathematics and fail at it have parents who also had problems in mathematics studies. Therefore, the parents are the cause of fear and insecurity in their children (Ernest 1988; Sikka, 1997, p.129-138).

Learning should support pupils' motivation to participate actively in the learning process. For the purpose of motivation and gaining interest in studying, tasks must be varied and diversified, important to a pupil, challenging for a pupil, have different constructions and substance, and have goals that are concrete and achievable within a relatively short time. Representatives of cognitive learning theories (Piaget, Gagne, Kohlberg et al.) point out the importance of mental development stages when planning learning tasks. Piaget (1968) sets apart four main phases in a child's mental development: sensomotoric, the period of pre-operations, the period of concrete operations (7 to 12 years), and the period of formal operations (11 to 12 years). In the period of concrete operations (in elementary school), the ability to think systematically develops only concerning concrete objects and activities. A child comes to rank and classify objects based on some features, and he thinks about compounds and parts at the same time. A child is on his way to logical thinking. A pupil's pattern of mental development and correspondingly chosen tasks have decisive importance in teaching mathematics.

Teacher education has a great influence in preparing student teachers to use diverse teaching methods and support learners' motivation. Teachers' competences have been the core question in Estonian education policy in recent years. In the Teachers' Standard the teachers' competences are described in eight areas and the readiness to support pupils' motivation is highlighted (Õpetaja V, 2005).

Mental arithmetic

There are different skills in mathematics that a pupil has to acquire and balance during the study process. Emanating from everyday situations, mental arithmetic is important in the era of technology.

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Many American and Japanese studies confirm that pupils consider mental arithmetic to be very important. Pupils who participated in these studies consider mental arithmetic to be more important than written arithmetic because it is possible to use these skills in everyday life (McIntosh & Reys, 1997). Thompson (1999) claims calculation by heart to be no different from mental arithmetic. Many countries do not use the concept of mental arithmetic at all, for example, in the Netherlands "work in your head" and "work with your head" mean the same thing. Schipper (2001) pays a great deal of attention to reaching results by counting. He says that if children do not understand counting completely and haven't structured it for themselves, it is not possible to use other strategies for finding solutions. There have been studies conducted across the world regarding how pupils use calculation strategies. Jordan, Hanisch and Kaplan (2003) conclude that children who have problems with calculation use calculation strategies observably less than pupils who do not have such problems.

Ashcraft and Kirkin (2001) and Faust (1994) in the University of Cleveland have studied pupils' fears of mental arithmetic. They conclude that difficulties in relation to mental arithmetic exercises come up among fearful pupils mostly when adding two-digit numbers and where a problem deals with crossing over decimals. Even if the pupil calculated correctly, the time he or she used was three times longer than that of a pupil who is not frightened of mathematics and mental arithmetic. (Ashcraft & Kirk, 2001).

Hutton and Towse (2001) from London University have studied 8 to 11-year-old pupils who have problems with short-term memory. They concluded that pupils succeed better in tasks where only short-term memory is needed. Pupils dealt well with ranking numbers from smaller to bigger, but problems occurred when ranking numbers from bigger to smaller.

The more everyday life is involved in learning, the better a pupil realizes the necessity of learning. The attitudes and support of parents and teachers are essential. In order to make acquiring mental arithmetic skills more interesting and more diversified for a pupil, the teacher's attitudes and teaching methods he or she uses in the classroom play an important role.

Methodology of Research

Problems in the research

Based on PISA international research results, both Estonian and Finnish pupils have relatively high achievements in mathematics (Assessing Scientific, Reading and Mathematical Literacy, 2006 – is this a title? No way of telling. It is given as such – in italics – in bibliography.). Despite these results, current Estonian youth do not wish to study science. The tendency to study humanities and social sciences is increasing exponentially. The results of national exams at the end of secondary school confirm this (Riigieksamite esialgsed tulemused, 2008). Previous research shows that already elementary school pupils are afraid of learning mathematics and they fail to understand the teacher's instructions (Sikka, 1997, p.137). Thus, it is important to find out how motivated pupils in elementary school are when it comes to studying mathematics and mental arithmetic.

To improve teacher education we need feedback from student teachers' everyday practice. The schools in which student teachers pass their first teaching experience have great influence on their teaching style and the methods they use. In Estonia and Finland student teachers' practice spent passed in special practice schools. In Finland these schools are university schools, in Estonia independent practice schools. The quality of teaching in these schools should be high, since the teachers who work there are highly educated. Still we need to research how the learning process in these schools influences pupils' motivation.

Sample

Two groups of pupils participated in the research: 1st to 3rd form pupils from 7 Estonian student teachers' practice schools (n=157) and from the practice school (n=130) of Turku University (Normaalikoulu), making a total of 287 pupils (Table 1).

Table 1. Pupils that participated in the research by form and country.

Form	Estonians	Finnish	Total
Form 1	47	56	103
Form 2	39	37	76
Form 3	71	37	108
Total	157	130	287

The sample is sufficient to get feedback about the quality of student teachers' practice and plan future developments to improve their teaching skills.

Method and data analysis

This is quantitative research. The questionnaire was circulated among pupils from April to May 2006. To gather data, a questionnaire consisting of three parts was delivered, in which the third part focused on the motivation to learn mathematics and mental arithmetic. The results concerning the motivation to study mathematics and work with mental arithmetic are observed in this article. The pupils evaluated their own interest and readiness to learn mathematics and mental arithmetic. The questionnaire was based on the Likert type scale from 1 (I dislike) to 4 (I like very much).

The 1st form pupils were interviewed and 2nd and 3rd form pupils filled in questionnaires in writing. The results of the Estonian research were compared with the results of the Finnish research.

The results were processed through the SPSS program. First, to describe Estonian and Finnish pupils' motivation to learn mathematics and mental arithmetic, the mean and standard derivation were found. To control items significantly different between the groups, t-test was conducted.

In order to determine the relationship between the motivation to learn mathematics and mental arithmetic and groups (boys-girls; Estonian-Finnish, 1st-2nd- 3rd form), Pearson correlation analyses were carried out.

Results of Research

Motivation to learn mathematics

It became evident from the research that Finnish children like to learn mathematics more (M=3.16, SD= 0.80) than Estonians (M=2.85, SD=0.81) (Table 2).

Table 2. Motivation of Estonian and Finnish pupils to study mathematics.

Nation	N	Mean	Std
Estonians	157	2.85	0.81
Finnish	130	3.16	0.80
Total	287	2.99	0.82

The attitude of Finnish pupils toward mathematics differs significantly from the attitude of the Estonian pupils (t= -3.3, df=285, p=0.001).

Comparing the difference of the sexes' attitude toward mathematics (Table 3), it appears that boys are more motivated to learn mathematics (M=3.10, SD=0.82) than girls (M=2.87, SD=0.80).

Table 3. Difference of the sexes to learn mathematics.

Sex	N	Mean	Std
Boys	151	3.10	0.82
Girls	136	2.87	0.80

Boys have a more positive attitude toward mathematics than girls and the difference is statistically significant (t=2.42, df=285, p=0.016).

Interesting findings appear comparing pupils' motivation to learn mathematics by sex, forms and nationalities (Table 4). According to the results Estonian girls (M=3.00, SD=0.61) and Finnish girls (M=3.17, SD=0.71) of the 1st form are highly motivated to study mathematics. Overall the 1st form pupils have a positive attitude toward mathematics (M=3.10, SD=0.75).

Table 4. Motivation to study mathematics by sex, nationalities and forms.

Nation	Sex	N	Mean	Std
		1st form		
Estonians	Boys	30	2.77	0.86
	Girls	17	3.00	0.61
Finnish	Boys	27	3.44	0.58
	Girls	29	3.17	0.71
Total		103	3.10	0.75
		2nd form		
Estonians	Boys	19	3.21	0.79
	Girls	20	2.65	0.88
Finnish	Boys	16	3.19	0.83
	Girls	21	2.62	0.80
Total		76	2.89	0.86
		3rd form		
Estonians	Boys	39	2.92	0.87
	Girls	32	2.66	0.70
Finnish	Boys	20	3.30	0.80
	Girls	17	3.18	0.95
Total		108	2.95	0.85

The pupils of the 2nd form evaluate their motivation to learn mathematics the lowest (M=2.89, SD=0.86). It is interesting that among the 2nd form pupils there are differences between sexes, but not between nationalities. Second form boys in Finland (M=3.19, SD=0.83) and in Estonia (M=3.21, SD=0.79) are much more highly motivated to study mathematics than girls in Finland (M=2.62, SD=0.80) and in Estonia (M=2.65, SD=0.88):

Bigger differences appear between the Estonian and Finnish pupils concerning the motivation to learn mathematics in the 3rd form. Finnish girls (M=3.18, SD=0.95) are much more highly motivated than Estonian girls (M=2.66, SD=0.70). In this sample the motivation to study mathematics is the lowest among Estonian 3rd form girls. A constant positive attitude among boys is noticeable.

Generally, the Estonian pupils (M=2.82, SD=0.82) and the Finnish pupils (M=2.93, SD=0.83) like mental arithmetic less than learning mathematics generally (Table 5).

Table 5. The attitude of Estonian and Finnish pupils toward mental arithmetic.

Nation	N	Mean	Std
Estonians	157	2.82	0.82
Finnish	130	2.93	0.83
Total	287	2.87	0.83

The attitude of Finnish and Estonian pupils was not statistically significant (t=-1.18, df=285, p=0.239).

The research showed that the boys (M=3.01, SD=0.84) have a more positive attitude toward mental arithmetic than girls (M=2.71, SD=0.79) (Table 6).

Table 6. The attitude of boys and girls toward mental arithmetic.

Sex	N	Mean	Std
Boys	151	3.01	0.84
Girls	136	2.71	0.79

The difference in attitude toward mental arithmetic among boys and girls is statistically significant (t=3.05, df=285, p=0.003).

More concrete findings appear comparing pupils' motivation to learn mental arithmetic by sex, forms and nationalities (Table 7).

The research reveals that boys in 2nd form have a more positive attitude toward mental arithmetic, and Finnish girls have a more positive attitude toward mental arithmetic than Estonian girls. Again the differences appear between the responses of Estonian girls (M=2.35, SD=0.93) and Finnish girls (M=2.71, SD=0.78), attitude the girls of the second form to learn mental arithmetic is low.

Table 7. Motivation to study mental arithmetic by sex, nationalities and forms.

Nation	Sex	N	Mean	Std
		1st form		
Estonians	Boys	30	2.93	0.69
	Girls	17	3.00	0.79
Finnish	Boys	27	3.15	0.82
	Girls	29	3.03	0.42
Total		103	3.03	0.68
		2nd form		
Estonians	Boys	19	3.05	0.85
	Girls	20	2.35	0.93
Finnish	Boys	16	3.19	0.98
	Girls	21	2.71	0.78
Total		76	2.80	0.92

Nation	Sex	N	Mean	Std
		3rd form		
Estonians	Boys	39	2.90	0.88
	Girls	32	2.66	0.70
Finnish	Boys	20	2.95	0.89
	Girls	17	2.41	1.00
Total		108	2.76	0.86

Finnish boys (M=2.95, SD=0.89) and Estonian boys (M=2.90, SD=0.88) are more motivated learn mental arithmetic than girls. The greatest differences appear between the Estonian girls (M=2.66, SD=0.70) and Finnish girls (M=2.41, SD=1.00) concerning the motivation to learn mental arithmetic in 3rd form. In this sample the motivation to study mental arithmetic is lowest among Finnish 3rd form girls.

Generally, comparing the results by forms, motivation to learn mental arithmetic decreases. The biggest difference appears among girls.

Mutual influence between motivation to learn mathematics and mental arithmetic

The pupils' motivation to learn mathematics was more positive than their attitude toward mental arithmetic. In order to find out the correlation between motivation to learn mathematics and mental arithmetic, correlation analyses (Pearson correlation, 2-tailed) were carried out. There is a positive connection between pupils' motivation to learn mathematics and mental arithmetic ($r= 0.56$, $p<0.01$). Correlations are calculated using total ratings of groups: boys-girls, Estonian-Finnish, 1st-2nd-3rd form, or sex, nationality and forms. There are strong relationships between these two items in all groups.

Discussion

Attitude toward mathematics

Pupils' attitude toward mathematics depends on teaching methods and pupils' active participation in the learning process. Creating motivating conditions allows the pupils to have a positive attitude toward mathematics. These results show a decrease in pupils' motivation in the 2nd and 3rd form. Comparing the results of boys and girls, an increase of a more negative attitude among girls is noticeable. The Finnish boys are more highly motivated to study mathematics. The biggest change appears among Estonian girls: in the 1st form Estonian girls more motivated than in the 3rd form.

The reasons that may cause such decrease are: 1) problems in calculation; 2) poor learning methods; or 3) not considering pupil individuality. One problematic area is definitely the preparation of teachers. More attention should be paid to the teachers' psychological knowledge. It is important to acquire knowledge on how pupils think and to support their motivation to learn.

The curriculum of Estonian schools is strongly criticized because it does not show adequate consideration toward the individuality of each pupil. It is necessary to differentiate learning activities so that every pupil's individual potential is considered. Paying more attention to diversity of learning activities requires better planning and the ability to set goals.

To get more objective results and find out the more specific motivations pupils may have for studying mathematics, it would be important to observe pupils over the course of three years, beginning with the 1st form.

Mental arithmetic is important in order to cope with mathematics and everyday life in the future. A readiness to find solutions provides pupils with a positive attitude toward mental arithmetic and an acceptance of it in the learning process.

Comparing the attitudes of Estonian and Finnish pupils toward mental arithmetic, no great differences appeared. Nevertheless, there are differences between the attitudes of boys and girls. The growth of a more negative attitude is noticeable among girls from form to form. In the 1st form Estonian girls and Finnish girls have a positive attitude toward mental arithmetic. It is shocking that the results of 3rd form girls show low motivation to learn mathematics and mental arithmetic.

Learning difficulties and poor learning methods may cause a negative attitude toward mental arithmetic. The difference of attitude may influence the learning habits of boys and girls. In the opinion of the teachers, boys have more learning difficulties, but at the same time it appears that girls have lower learning motivation. Teaching methods should vary according to sex, and girls' problems should receive attention. Specifically, girls do not like mathematics and mental arithmetic.

Previous research has also shown that learning mathematics differs between the sexes (Linnanmäki, 1997, p.283-300; Hyde, Fennema & Lamon 1990, p.139-155). Boys succeed better than girls in mathematics, but for the first years in school, they are weaker than girls in reading. Boys also have an equal level of calculation ability with girls in puberty (McNiece and Jolliffe 1998, p.17-30).

Van der Heijdeni (2004) concluded that girls were somewhat lower achievers than boys in mental arithmetic; girls demonstrated a lower level of automatic mental arithmetic. Girls also demonstrated a lesser degree of consciousness than boys did. The differences in achievement found between boys and girls can be explained by the differences between the gender's approach behaviour. In addition to dealing with intellective factors in mathematics lessons, non-intellective factors, such as self-confidence and failure, should be given a lot of attention as well (Van der Heijden, 2004, p.15).

Conclusions

Pupils' motivation to study mathematics decreases by form. Finnish children have a higher motivation to study mathematics than Estonian children. It is a challenge for teachers to make the learning process interesting in primary school mathematics lessons, where pupils feel the most motivated. It is important to encourage pupils to think about and discuss the necessity of mental arithmetic and its connection to everyday life. Out of the pupils who participated in this research, boys have a more positive attitude than girls. Teachers should think more about the learning motivation of girls. To help pupils become confident, it is important to give them options and be understanding and supportive. It is necessary to offer different options in order to get feedback and recognize the achievements of every child.

Most importantly, teacher preparation and continuing professional development courses should help confront these challenges. Teachers do not generally engage in research of their methods, but teachers' readiness [does this mean "willingness"? or "being prepared?"] to analyze their everyday teaching practices consciously must be emphasized.

Initial teacher education, an important stage in becoming a teacher, has been a focus of attention during the last decade. Criticism has been levelled at the fact that theory appears to be distant from real life. Students do not find connections between theory and teaching practice, and satisfaction is not high amongst either students in the first stages of training or those who have qualified (Korthagen, 2001). Teacher educators are thus seeking solutions to integrate theoretical studies and teaching practice. Teaching practice should be monitored more, the process of student teachers' reflection and the development of practical teaching competences should be more focused. Teaching in practice schools should give the best examples to student teachers. This study shows

that the teaching processes in these schools are not diverse and methodologically rich enough. More awareness of specific aspects of the learning process helps us to develop teaching about teaching. Our school is as effective as our teachers are professional.

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