Baltic-Nordic Comparative Study on Mathematics Teachers' Beliefs and practices

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The article describes some aspects of the cross-cultural NorBa project "Mathematics teachers' educational beliefs".[1] *The aims of the study, its theoretical background as well as the development of the questionnaire are discussed. Some preliminary results on Estonian and Latvian mathematics teachers' beliefs and their comparison are presented. Knowledge of teachers' beliefs may reveal the specificity of teaching approaches and thus contribute to teachers' education or curricular reforms.*

Key words*: teachers' beliefs, comparative study, constructivist approach, non-constructivist approach.*

Introduction

Recently, teachers' beliefs have been a popular research topic in mathematics didactics. Beliefs reflect in which way mathematics and its teaching and learning are conceptualised by teachers. A.G. Thompson states that "what a teacher considers to be desirable goals of the mathematics program, his or her own role in teaching, the students' role, appropriate classroom activities, desirable instructional approaches and emphases, legitimate mathematical procedures, and acceptable outcomes of instruction are all part of the teacher's conceptions of mathematics teaching" (Thompson, 1992, p. 135). One commonly recognised finding is that beliefs are culturally informed and exert a different impact on classroom practice. However, only a few studies compare teachers' beliefs across countries (e.g., Andrews, Hatch, 2000).

The investigation reported here is part of a larger study incorporating surveys of teachers of mathematics in five countries: Estonia, Finland, Latvia, Lithuania, and Norway. The objectives of this study were: 1) to construct an instrument that can, in cross-culturally valid ways, measure the aspects of teachers' beliefs concerning job satisfaction, teaching, school mathematics

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and mathematics didactics, and 2) to use the instrument for an explorative study of mathematics teachers' beliefs in Baltic and Scandinavian countries.

In this paper, **we aim** to describe the theoretical background of the study and discuss the structure of the questionnaire – the main instrument of the survey. Also, some preliminary results related to Estonian and Latvian mathematics teachers' beliefs and their comparison are presented.

Teachers' beliefs

A detailed account of the nature of beliefs can be found, for instance, in Pajares (1992), Fang (1996), Leder, Pehkonen and Törner (2002), etc. Despite the prevalence of research into beliefs, there is still a considerable debate as to the definition and characteristics of beliefs. In the context of this study, the beliefs are understood broadly as the conceptions, views, personal ideologies and values that shape the teaching practice. It is assumed that what one's beliefs influence what one does – beliefs act as a teacher's pedagogical predispositions. So, beliefs are the factors that shape a teacher's decisions as regards, for example, the apropriate teaching routines, the goals that should be accomplished and what should the learning of mathematics look like. The research suggests that many teachers begin their careers with previously constructed and possibly subconscious theories about teaching (Powell, 1992). Furthermore, as Clark (1988) suggests, teachers continue holding idiosyncratic and implicit theories throughout their careers. Understanding teachers' decisions requires understanding not only what knowledge they possess, but also how they decide the knowledge to invoke, when, and how. These decisions are reflections of a teacher's implicit theories, reflections of what teacher believes to be important and plausible (Speer, 2005).

Research findings often take the form of categorizations of beliefs. Belief research in mathematics education focus primarily on how teachers view the nature of mathematics, teaching in general and particularly in mathematics, and learning (Dionne, 1984; Ernest, 1991; Liljedahl et al., 2007).

Teachers' beliefs concerning mathematics, its teaching and learning reflect a teacher's priorities for the practices of mathematics classrooms and play a significant role in shaping teachers' characteristic patterns of instructional behaviour (Thompson, 1992).

At the same time, the implementation of teacher's beliefs in practice is influenced by a rich context: school climate, pupils' abilities, etc. This makes the relationship between teachers' beliefs and their teaching practice not linear; related studies often report inconsistencies between teachers' beliefs and their actions (Chen, 2008; Skott, 2009).

Questionnaire development

To implement a cross-cultural research project, the researchers needed an instrument that can, in cross-culturally valid ways, measure different aspects of teachers' mathematics-related beliefs. A seven-module questionnaire was devised to explore the aspects of teachers' views of mathematics teaching and their classroom behaviour. These modules describe (1) general information, (2) teachers' overall job satisfaction, (3) their general pedagogical approach (conceptions of teaching

and learning in general), (4) their conceptions of good teaching / learning of mathematics, and (5) teachers' perceptions of their own classroom practices.

A piloting of the questionnaire was carried out in three participating countries (Estonia, Finland, Latvia) in spring 2010; the total number of respondents was around 60. The questionnaire was revised in the light of teachers' responses and reliability calculations. Several items were removed or rephrased.

Teachers' overall job satisfaction

A teacher's satisfaction with his or her work can have strong implications for the students' learning: it may influence the quality and stability of instruction given to students (Perie, Baker, & Whitener, 1997). Teachers' overall job satisfaction was measured using 13 Likert-type items, for example, *I look forward to each teaching day, Physical surroundings in my school are unsatisfactory,* or *In our school, staff members are recognized for a job well done.*

The given module consists of eight components related to colleagues (2 items), working conditions (2 items), responsibility (2 items), work itself (2 items), recognition (2 items), perceived administrative support (1 item), satisfaction with teaching career (1 item) and coping with job-related stress (1 item). During the elaboration of items, the following instruments were used for the general guidance and as a source of items: three items were adapted from Teacher Burnout Scale (TBS, Seidman & Zager, 1987), four items were adapted from the questionnaire of US teachers' job satisfaction by Perie, Baker, and Whitener (1997), and six items were borrowed from the Teacher Job Satisfaction Questionnaire (TJSQ, Lester, 1987) based on the Hertzberg two-factor theory. Both the authors of THSQ and TBS report the good reliability and validity indices for the original instruments. The components of Pay, Advancement, Security and Attitudes toward students (from the THSQ and TBS) were omitted in the new module as less relevant to the aims of the study or overlapping with the items of other modules.

Teachers' general pedagogical approach

The general pedagogical approach was measured in two ways: 1) by providing a description of two fictional teachers' teaching (non-constructivist A, constructivist B) and asking to rate the preference for these teaching approaches for four specific learning goals, for example: *Which type of class discussion would be more comfortable having in class?* Teachers had to respond using a 5-point scale: Definitely A; Tend toward A; Cannot decide; Tend toward B; Definitely B, and 2) sixteen Likert-type items of certain teaching approaches identified as typical of constructivist (or non-constructivist) teaching philosophy, for example: *A teacher should direct students in a way that allows them to make their own discoveries,* or *Effective / good teachers demonstrate a correct way to solve a problem*. Teachers had to respond using a 5-point scale (1 – fully disagree… 5 – fully agree).

Teachers' general pedagogical approach: specific learning goals

Two different approaches to teaching, provided by fictional teachers, described the regular situation in the class:

Approach A:
Ms. Hill was leading her class in an animated way, asking questions that students could answer quickly based on the reading they had done the day before. After this review, Ms. Hill taught the class new material, again using questions to keep students attentive and listening to what she was saying.

Approach B:
Mr. Jones' class was also having a discussion, but many of the questions came from students themselves. Although Mr. Jones could clarify students' questions and suggest where the students could find relevant information, he couldn't really answer most of the questions himself.

The description of these teaching approaches and the subsequent four questions dealing with specific learning goals (see Table 1) was borrowed from the US National Survey on *Teaching, Learning and Computing* (TLC-1998) described by Ravitz, Becker, and Wong (2000).

Teachers' general pedagogical approach: opinions about good teaching

The given module consists of five components related to the traditional approach (4 items), comprehension and transference (4 items), independent discovery (3 items), connection with real life (2 items), and self-regulated learning (3 items). During the elaboration of items the following instruments were used for the general guidance and as a source of items: eight items were borrowed from the TALIS Teacher Questionnaire **(***Teaching Practices, Beliefs and Attitudes Module,* OECD, 2001), four items were adapted from *Indicators of Engaged Learning* (Jones, Valdez, Nowakowski, Rasmussen, 1995), two items were adapted from the *University / Constructivist Learning Environment Survey* (UCLES / CLES, Taylor et al., 1997), one item was taken from the *Constructivist Teaching Inventory* (CTI, Greer et al., 1999), and one item was taken from the *Expert Science Teaching Educational Evaluation Model* (ESTEEM, Burry-Stock, 1995).

Teachers' conceptions of good teaching / learning of mathematics

The module measuring teachers' conceptions of good teaching / learning of mathematics was constructed using 26 Likert-type statements based on an extensively used approach to mathematical beliefs. Dionne (1984) suggests that mathematical beliefs are composed of three basic components called traditional, formalist and constructivist. Analogically, Ernest (1991) describes three views of mathematics called instrumentalist, Platonist and problem solving. These three notions correspond more or less to each other, and in the relevant literature they are often denoted as the "toolbox aspect", "system aspect" and "process aspect" and are widely used while characterising mathematical beliefs (Liljedahl et al., 2007).

In the "toolbox aspect", mathematics is seen as a set of rules, formulas, skills and procedures. According to this perception, mathematics learning is understood as using rules and formulas, mastering procedural skills.

The "System aspect" stresses a rigorous proof, logic, exact definitions and a precise use of the mathematical language. According to this perception, doing and learning mathematics means writing proofs, using a precise and rigorous language, unified concepts. The formal aspects of mathematics are stressed.

In the "Process aspect", mathematics is considered as a constructive process in which relations among different notions play an important role. This perception stresses the meaningful learning and sees mathematics as a constructive process. According to this perception, doing and learning mathematics means developing thinking processes, building rules and formulas from experience in reality, finding relations among different notations. Here, the mathematical activity involves creative steps, such as inventing and reinventing the mathematics (Liljedahl et al., 2007).

The module was constructed using statements from three aspects described above, for example: *In a math lesson, there should be more emphasis on the practicing phase than on the introductory and explanatory phase* (toolbox aspect); *Working with exact proof forms is an essential objective of mathematics teaching* (system aspect); *Pupils should have an opportunity to independently develop their mathematical understanding and knowledge* (process aspect).

Teachers' perception of their own classroom practices

The teachers' perception of their own classroom practices was measured using two approaches: one module was adopted from the TIMSS study and included seven Likert-type items regarding how often teachers ask their students to engage in certain classroom practices, for example: *Memorize formulas and procedures,* or *Work together in small groups; the* other module about teachers' use of textbooks includes eleven Likert-type items, for example, *The textbook is the primary tool to plan and prepare my lessons* or *The pedagogical strategies I use are often influenced by the instructional approach of the textbook.* Teachers had to respond using a 4-point scale: never – 1; some lessons – 2; about half the lessons – 3; almost every lesson – 4.

The sample and procedure

The data were collected in Estonia and Latvia in the fall and winter 2010 / 2011. In the other participating countries, the survey will be carried out during 2011. The survey focused on mathematics teachers for grades 7–9; 161 schools from Estonia and 97 schools from Latvia were involved (241 teachers from Estonia and 294 teachers from Latvia). The Estonian sample consisted of teachers from 15 regions, the ir age ranged from 25 to 77 (M = 47). The lengh of service of these teachers ranged from 1 to 59 years (M = 22). The majority had the Master's degree or its equivalent.

The Latvian sample represented teachers from five regions of Latvia; 92 teachers were from big cities, and 202 worked in small towns / rural areas. The age ranged from 25 to 66 years (M = 46); the dominant age group was that of 40 to 49 years. The length of service ranged from 1 to 44 years (M = 23). The dominant service group was aged 26 to 30 years. The majority had a bachelor or master degree.

Initially, the questionnaire had been devised in English and then adequately translated into the languages of participating countries. Back translation was used to make the text as similar to the original as possible. However, we acknowledge that transfer ring the educational vocabulary across different educational systems may create certain inconsistencies.

Results

The analysis of the data has not been completed yet; the following reports on some aspects of the preliminary questionnaire analyses and discusses Estonian and Latvian teachers' general pedagogical approach.

Teachers' general pedagogical approach: specific learning goals

Estonian and Latvian mathematics teachers' responses are summarised in Table 1.

In general, the results in both samples were quite similar. Most Estonian teachers (62%) feel more comfortable using the non-constructivist approach, and the majority of them (58%) believe also that their students prefer the same approach. At the same time, they believe that students gain more knowledge and useful skills from constructivist teaching.

Latvian teachers also feel more comfortable using the non-constructivist approach, although, they are not so unanimous in their approach to student preferences. An almost equal number (about 38%) of teachers believe that their students would prefer either constructivist or non-constructivist type of teaching. While Latvian teachers, similarly as their Estonian colleagues, believe that students would gain more useful skills from the constructivist type of teaching, a larger number (45%) of Latvian teachers believe that their students would gain more knowledge from the non-constructivist type of teaching. Besides, Latvian teachers had more doubts as to their answers on students' preferences than their Estonian counterparts.

Table 1. ***Comparison of teachers' support for non-constructivist (A) or constructivist (B) approach to specific learning goals in Estonia (N = 241) and Latvia (N = 294)***

Questions related to specific learning goals	*Country*	*Average response (mean ± SD)*	*Definitely A Tend toward A (%)*	*Cannot decide (%)*	*Definitely B Tend toward B (%)*
Which type of discussion would you be more comfortable having in class?	EST LAT	2.6 ± 1.1 2.6 ± 1.2	62.0 55.7	12.0 13.3	26.1 31.0
Which type of discussion do you think most students prefer to have?	EST LAT	2.6 ± 1.1 3.0 ± 1.2	57.8 38.2	14.7 23.5	27.6 38.3
From which type of class discussion do you think students gain more knowledge?	EST LAT	3.4 ± 1.2 2.9 ± 1.2	27.5 44.9	15.0 16.7	57.5 38.4
From which type of discussion do you think students gain more useful skills?	EST LAT	3.9 ± 1.1 3.5 ± 1.1	16.7 22.8	9.40 12.9	73.9 64.3

Teachers' general pedagogical approach: Views concerning good teaching

Some results are presented in Table 2. Estonian teachers agree with constructivist statements and tend to stay neutral towards statements describing the traditional perception of teaching. Latvian teachers agree with constructivist statements slightly more than do Estonian teachers, and they stay similarly neutral towards the traditional perception of teaching. The largest differences are observable in three items: Latvian teachers have a more positive perception of the role of teacher as a facilitator of students' own inquiry, and they believe that a quiet classroom and teaching of facts would help effective learning less than do Estonian teachers.

Table 2. ***Comparison of teachers' views about good / effective teaching in Estonia (N = 241) and Latvia (N = 294)***

Statements about good / effective teaching	*Average response (mean ± STD)*	
A. Constructivist perception	**EST**	**LAT**
5. My role as a teacher is to facilitate students' own inquiry.	4.1 ± 0.8	4.8 ± 0.5
8. Teacher should direct students in a way that allows them to make their own discoveries.	4.4 ± 0.6	4.7 ± 0.6
10. Students should engage in collaboration in small groups explaining newly developing ideas and listening to other students' ideas.	4.3 ± 0.8	4.2 ± 0.8
11. Thinking and reasoning processes are more important than specific curriculum content.	3.9 ± 0.9	4.0 ± 0.8
B. Traditional perception		
2. Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.	3.1 ± 0.9	3.5 ± 1.1
3. How much students learn depends on how much of background knowledge they have; that is why teaching facts is so necessary.	3.5 ± 0.9	3.0 ± 1.0
4. Effective / good teachers demonstrate the correct way to solve a problem	2.9 ± 1.0	3.1 ± 1.1
16. A quiet classroom is generally needed for effective learning.	4.1 ± 0.9	3.3 ± 1.0

Discussion and conclusions

Teachers' beliefs reflect in which way teaching and learning are conceptualised in two different countries. Cross-cultural differences in teachers' beliefs can provide important information regarding the scope of a possible classroom practice and teachers' inclination to different teaching approaches. The next step is to compare the teachers' beliefs and their perception of their own classroom practice to focus on the possible contradictions and inconsistencies. Than, finally, the research can be oriented towards a comparison of teachers' beliefs, their classroom practice and the learning achievements of their students. It seems reasonable to assume an interrelation of these three components of the educational process.

The TIMSS and PISA studies have already shown that the mathematical attainements of Latvian and Estonian pupils are different. Therefore, it would be relevant to assume that also the teachers' beliefs

and classroom behaviour would somehow differ in these countries. The preliminary results demonstrate that while both the Estonian and Latvian teachers are quite supportive of constructivism, at the same time they do not negate some elements of traditional teaching. Also, it could be concluded that the answers of Latvian teachers reveal a lower degree of hidden contradictions than those of Estonian teachers, although it is clear that the results show an inconsistency between the views of teachers on different learning goals in both samples. As the previous research on Latvian teachers shows, while believing in the child's central role in the learning process, both primary and secondary teachers place themselves in the centre of educational experience (Pipere, 2005).

The further research in the framework of the NorBa project will be related to data collection in other project countries in order to make a relevant cross-cultural comparison. Also, to be able to make the comparison of belief systems and clustering of teachers according to their beliefs, a collective factor analysis using data from three project countries will be performed.

The knowledge of teachers' beliefs and classroom behaviour may indicate the specificity of teaching approaches and thus contribute to inform teacher education or curricular reforms. In Latvia, the data of this study would be fed into the ESF project (2008–2011) implemented in natural sciences and mathematics education in grades 7–9.

To conclude, as the research shows, the beliefs held by mathematics teachers in different countries can provide an interesting window for studying the teaching of mathematics in these countries.

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BALTIJOS IR ŠIAURĖS ŠALIŲ MATEMATIKOS MOKYTOJŲ NUOSTATŲ LYGINAMOJI STUDIJA

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S a n t r a u k a

Straipsnyje pristatoma tarpkultūrinė lyginamoji studija, kurios pagrindinis tikslas – sukurti instrumentą, patikimai matuojantį Baltijos ir Skandinavijos šalių matematikos mokytojų nuostatas, susijusias su pasitenkinimu darbu, mokymu, matematikos dalyku ir matematikos didaktika. Nuostatos, kurias siekiama tirti, čia suprantamos kaip koncepcijos, požiūriai, asmeninės ideologijos ir vertybės, darančios įtaką matematikos mokymo praktikai. Straipsnyje atskleidžiami lyginamosios studijos teoriniai pagrindai ir aptariama pagrindinio tyrimo instrumento – klausimyno – struktūra. Glaustai pristatomi apklausos, kurioje dalyvavo 241 matematikos mokytojas iš Estijos ir 294 mokytojai iš Latvijos, rezultatai. Konstatuojama, kad Latvijos mokytojai konstruktyvistiniam požiūriui į mokymą(si) pritaria šiek tiek labiau negu Estijos mokytojai. Abiejų šalių mokytojai tradicinio mokymo atžvilgiu yra nusiteikę neutraliai. Daroma prielaida, kad gilesnis matematikos mokytojų nuostatų pažinimas galėtų tapti akstinu reformuojant ugdymo turinį ir mokytojų rengimo sistemas.

Pagrindiniai žodžiai: mokytojų nuostatos, lyginamoji studija, konstruktyvistinis požiūris.

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