Comparing mathematics teachers' beliefs about good teaching: the cases of Estonia, Latvia and Finland

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The article presents results from a cross-cultural NorBa project *Mathematics teachers' educational beliefs*. We report on Estonian, Latvian and Finnish lower secondary mathematics teachers' espoused beliefs about good teaching. A principal component analyses identified a two-component structure of teachers' beliefs about good teaching: (1) Reasoning and conceptual understanding and (2) Mastery of skills and facts. Cross-cultural differences were identified in both of these dimensions. Latvian teachers indicated the strongest agreement with reasoning and conceptual understanding, Estonian teachers with mastery of skills and facts, while Finnish teachers scored lowest on both dimensions. Moreover, we analysed the amount of teachers with different profiles with regard to these two dimensions. The results suggest both common conceptual core of teachers' beliefs on mathematics teaching and certain cultural influence on the profile of these beliefs.

Beliefs reflect in which way mathematics, its teaching and learning is conceptualised by teachers. Thompson (1992, p. 135) 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.

Raymond (1997) suggests that mathematics beliefs stem from prior school experiences, including experiences as a mathematics student, the influence of prior teachers and of teacher training programs, and prior teaching practice. But personal experiences are not the only influence

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on beliefs; the person's own society, the consequences of the person's reflection and contemplation, as well as reactions to the beliefs of others are also important influences (Schlöglmann & Kepler, 2006). A detailed account of the nature of beliefs can be found, for instance in Fang (1996), Leder, Pehkonen & Törner (2002) and Pajares (1992). Despite the prevalence of research into beliefs, there is still considerable debate about the definition and characteristics of beliefs (see Furinghetti & Pehkonen, 2002). In the context of this study the beliefs are understood broadly as conceptions, views and personal ideologies that shape teaching practice. More specifically, we focus on mathematics teachers' beliefs about good teaching. It is assumed, that what one believes influences what one does – beliefs act as the teacher's pedagogical predispositions. So, beliefs are factors shaping the teacher's decisions, for example, about what goals should be accomplished and what should the effective learning of mathematics look like (Schoenfeld, 1998). 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 to hold idiosyncratic and implicit theories throughout their careers. Understanding teachers' decisions requires understanding not only what knowledge they possess, but also how they decide what knowledge to invoke, when, and how. Those decisions are reflections of teacher implicit theories, reflections of what the teacher believes to be important and plausible (Speer, 2005).

This study targets exclusively the teachers' openly acknowledged explicit or espoused beliefs (what is said) designating what teachers think about the impact of teaching in general, as well as their understanding of how children learn, being aware of the potential inconsistency between the espoused beliefs, less conscious implicit beliefs and beliefs in action or enacted beliefs demonstrated in the consistent behaviour (McMullen et al., 2006).

Belief research in mathematics education focuses primarily on how teachers view the nature of mathematics, its learning and teaching, and teaching in general (Dionne, 1984; Ernest, 1991; Liljedahl, Rösken & Rolka, 2007; Törner, 1998). Currently it is widely assumed that teachers' beliefs about the nature of teaching and learning include both "direct transmission beliefs about learning and instruction" or, so called, "traditional beliefs" and "constructivist beliefs about learning and instruction" (OECD, 2009). The teaching approach of direct transmission implies that the teacher communicates knowledge in a clear and structured way, explains correct solutions, gives learners clear and resolvable problems and ensures peace and concentration in the classroom, while in constructivist classroom students are perceived as active participants in acquisition of knowledge, students' own inquiry is stressed developing problem

solutions (OECD, 2009; Underhill, 1988). However, recently some voices, challenging any dichotomisation in educational studies, and especially in international comparative research, have appeared, suggesting the complementary view on the interrelated nature on teacher-centred vs student-centred classrooms, real world vs abstract tasks, telling vs not-telling, speaking vs listening, where choices are seen more dependent on purpose and context of situation therefore leading to more sophisticated pedagogies (Andrews & Sayers, 2013; Clarke, 2006).

The implementation of teachers' beliefs into the practice is influenced by the rich context: pedagogical traditions in the country, school culture, background of the students, etc. This makes the relationship between teachers' beliefs and their teaching practice not linear; research often reports inconsistencies between teachers' espoused beliefs and their actions (Chen, 2008; Raymond, 1997; Skott, 2009; Wilson & Cooney, 2002). It is important to distinguish between two different levels of those contextual factors: namely the global and the local level. Global context means the overall cultural milieu in the country, pedagogical traditions and official educational policy at the state level. The influence of global factors to teachers' beliefs has been described in several international studies (see e.g. OECD, 2009).

Another level of context is the local microculture in the school, which is reflected in the school rules and norms, but also in the way teachers collaborate. Within this microculture, the teacher is an important actor and may potentially have a large influence on its development over time. The importance of school microculture has been found repeatedly in intervention studies (Bobis et al., 2005; Lloyd, 2002).

Assuming that teaching depends on the global cultural context and that beliefs are culturally informed requires international comparative studies of teachers' beliefs. Cross-cultural differences in teacher beliefs can provide important information regarding the scope of possible classroom practice and teacher inclination to different teaching approaches. As such, beliefs held by mathematics teachers in different countries provide an interesting window through which to study mathematics teaching in those countries. Moreover, knowledge of teacher beliefs may inform pre-service and in-service teacher education or curricular reforms. However, few studies compare teacher beliefs across countries (Andrews, 2007; Andrews & Hatch, 2000; Felbrich, Kaiser & Schmotz, 2012; Pepin, 1999). The studies on the ways mathematics teaching is enacted in different European countries (e.g. Andrews, 2009; Andrews & Sayers, 2013; Kaiser, 2002) indicate both to the common core of practice in these countries and also to some variations (e.g. Andrews & Sayers, 2013) depending on the cultural context in respective countries.

The cultural context of the study

The cultural context for this investigation is three neighbouring countries – Finland, Estonia and Latvia with different cultural, historical, and educational backgrounds.

The Finnish educational system has received international recognition in recent years. A study of Finnish elementary and secondary teachers' beliefs identified two types of mathematics teachers, traditional and innovative teachers. The traditional teacher emphasises basic teaching techniques and extensive drill, while the innovative teacher emphasises student thinking and deeper learning (Kupari, 1996). In the field of mathematics and science education the national LUMA-project (1996–2002) aiming to enhance the learning of mathematics and sciences is likely to have had an influence on teachers (Ahtee, Lavonen, Parviainen & Pehkonen, 2007). Moreover, the national ethos of the time was inspired by the rise of Nokia, generating a vision of Finland as a high-tech economy. As a surprise for Finns, Finland scored to the top in PISA achievement scores in 2000 and later. However, Finnish students' performance in TIMSS (Mullis, Martin, Foy & Arora, 2012) has been less impressive. Although Finland is well above average in TIMSS and among the top ten performing countries, the results are clearly behind those of the top performing countries. Finland was also characterised by less favourable results on the affective measures. Finnish students lack interest and enjoyment in mathematics, they have below average self-efficacy, and low level of control strategies. As a more positive finding, levels of anxiety were low. The study also revealed that gender differences favouring males in the domain of affect were larger in Finland than in OECD on average (OECD, 2004).

Since regaining their independences in 1991 Estonia and Latvia have gone through many changes that have also affected the educational system. While natural sciences and mathematics had been emphasised in the Soviet curriculum and in the society at large (Stoloff, 1989), the focus has since then shifted towards other topics. Also the attractiveness of teacher profession has fallen considerably. The results of TALIS (*Teaching and learning international survey*) 2008 showed that Estonian teachers' self-efficacy and satisfaction with their work are considerably lower by international comparison (Loogma, Keskküla & Roosipõld, 2010). According to the recent studies (ESF, 2007), during the last 10 years, the status of the teaching profession has decreased both in Estonia and Latvia. High salaries and career opportunities have tempted students and educated mathematics teachers to the private sector instead of schools. Those remaining in the profession had to adapt to less motivated students (Bebriša, Ieviņa & Krastiņa, 2007) and to a series of new curricula, each with fewer hours for teaching mathematics than the previous one.

In Estonia, there was also a concern of the mathematics education researchers that teaching was too much based on drill and practice-methods and although students' achievement was good, students' self-confidence in learning mathematics and valuing of mathematics were low (Lepik, 2005).

The international TALIS-study indicated Estonia to be one of the countries with strongest support for constructivist teaching beliefs (Loogma, Ruus, Talts & Poom-Valickis, 2009). In Estonia the correlation coefficient between traditional and constructivist teaching beliefs was statistically non-significant indicating that although Estonian teachers believed more in a constructivist way of teaching they did not directly contrast this view to the direct transformation of knowledge, and could therefore believe in the combination of these two views.

Although the teachers' beliefs in Latvia are oriented towards constructivism, both primary and secondary teachers put the teacher in the center of educational experience when reporting on their classroom practice. Whilst both primary and secondary teachers in their beliefs and practice support the similar hierarchy of constructivist elements, primary teachers are more attuned to reporting the implementation of elements of constructivism in their classrooms than secondary teachers (Pipere, 2005). In 2006 and 2008 new standards in basic and secondary education were introduced in Latvia. These reforms as well as the ESF project (*Elaboration of the content of learning and teacher further education in the subjects of natural sciences, mathematics and technologies*) (2008–2013) changed the philosophy of the Latvian education system by introducing the fundamental principles of holism and constructivism (ISEC, 2008).

The three countries have similar school systems in several aspects. Pupils start schooling at the age of six or seven, and compulsory school lasts nine years in each country. In compulsory school, pupils most often study in mixed-ability groups as there is no setting. According to the PISA 2009 results Finnish school mathematics proves to be among the best (average score = 541). Estonian pupils scored significantly higher (average score = 512) and Latvians lower (average score = 482) than the OECD average of 496 (OECD, 2010).

The investigation reported here is part of a larger study (NorBa study) incorporating a survey of mathematics teachers in Estonia, Latvia and Finland (see Hannula et al., 2012). The objectives of the NorBa study are to construct an instrument that can, in cross-culturally valid ways, measure aspects of teachers' job satisfaction, beliefs about teaching, school mathematics and mathematics didactics, and to use the instrument for an explorative study of mathematics teachers' belief structures in Baltic and Scandinavian countries and comparison of possible cross-cultural differences.

In this paper we aim to describe Estonian, Latvian and Finnish teachers' beliefs concerning good teaching and to analyse the structure of these beliefs. According to the different degrees of agreement with ideas regarding components of good teaching typical belief profiles are also derived and described.

Methods

Participants

Data were collected from the 7–9th grade mathematics teachers in Estonia ($n = 333$), Latvia ($n = 390$) and Finland ($n = 92$). Thus the overall sample size is 815 teachers. The age of Estonian teachers ranged from 25 to 77 ($m = 47$), length of service of these teachers ranged from 1 to 59 years ($m = 22$). The age of Latvian teachers ranged from 25 to 66 years ($m = 46$) and their length of service ranged from 1 to 44 years ($m = 23$). The age of Finnish teachers ranged from 25 to 61 years ($m = 42$), and length of service ranged from 1 to 35 years ($m = 14$).

The data collection has been completed in the fall and winter 2010/2011. However, the number of responses was low in Finland and additional data was collected during the spring semester 2012. Data were collected differently in each country because of the need to choose the best way to raise the response rate considering the current situation with teachers' over-involvement in different empirical studies observed by researchers. Informative e-mails were sent to schools inviting teachers to participate in the survey. In Latvia, teachers who accepted the invitation received the surveys with the necessary instructions, filled them in and sent them back to the appointed e-mail address. In Latvia, the response rate was about 95 %. In Estonia, head-teachers from the schools who accepted the invitation received the paper-based surveys with the necessary instructions and distributed them among the teachers. Teachers filled them in and sent them back. The respondents' identity and records were kept confidential. The response rate was about 85 %. In Finland we approached the teachers through principals of a representative sample of Finnish-speaking schools ($n = 35$). When principals were willing, we sent surveys to the schools to be filled together with a response envelope. As we do not know the actual number of mathematics teachers in these schools, we can only estimate the response rate based on the number of students in these schools. In the first round we received 49 responses and the response rate was approximately 30 %. As the number of responses was too low, we collected additional data the following year using again a representative sample of Finnish schools ($n = 79$). This time we used an

electronic survey and searched the e-mail addressed to send invitations directly to the teachers. Unfortunately, the response rate was even poorer, approximately 15 %.

Instrument

For the NorBa project a seven-module questionnaire was devised to describe the teachers' overall job satisfaction, their beliefs about teaching and learning in general and in mathematics in particular, as well as perceptions of teachers' classroom practices. The questionnaire module about teachers' general beliefs on teaching and learning consisting of 16 Likert-type items (see table 1) served as the main instrument for the investigation reported in this paper. The module consisted of items related to *transmission of knowledge* (4 items), *comprehension and transference* (4 items), *independent discovery* (3 items), *connection with real life* (2 items), and *self-regulated learning* (3 items) adapted from the TALIS (Teacher questionnaire: teaching practices, beliefs and attitudes module, OECD, 2001), Indicators of Engaged Learning (Jones, Valdez, Nowakowski & Rasmussen, 1995), UCLES/CLES (University/constructivist learning environment survey, Taylor, Fraser & Fisher, 1997), CTI (Constructivist teaching inventory, Greer, Hudson & Wiersma, 1999) and ESTEEM (Expert science teaching educational evaluation model, Burry-Stock, 1995).

This study exploited so called "joint-development-concurrent" model (Dujykes & Rokkan, 1954; Osborn, 2004) when the research was planned jointly by researchers from different cultures and conducted more or less simultaneously in these cultures.

The cross-national team from Estonia, Finland and Latvia devised the questionnaire in English. Then it was adequately translated into the languages of the participating countries (Finnish, Estonian, Latvian, Russian). In addition to English and their respective mother tongue, each team member was fluent in at least one additional language of the research, which was a highly valuable asset in the translation phase. In conformity with the goals of this study, the adaptation of the questionnaire included the techniques for ensuring linguistic, functional, and cultural equivalence (Peña, 2007). To satisfy the standard of linguistic equivalence, a back translation by bilingual language experts was used to make the translation as similar to the original as possible. Besides, the research problem was salient to all cultures involved (Osborn, 2004). Functional equivalence was ensured by using "decentering" together with back-translation approach, when at the piloting stage in local cultures and final language revision stage the items were checked for representativity in a linguistically familiar way in the target languages (Peña, 2007).

Cultural equivalence was determined in relation to functional equivalence, mainly focusing on the way teachers of different cultural and linguistic groups view the underlying meaning of an item during the piloting of the questionnaire. All types of equivalences used in this adaptation process were coordinated on three levels: level of bilingual translators, level of individual teachers during the piloting stage in each country and level of researchers discussing the production of instrument on several face-to-face meetings and by e-mails.

A piloting of the questionnaire was carried out in three participating countries in the spring of 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. The theoretical background, development and structure of entire questionnaire are described more thoroughly in our previous paper (Lepik & Pipere, 2011).

Results

Comparing Estonian, Latvian and Finnish teachers' responses

Teachers' responses revealed the following similarities and differences in their general beliefs about good teaching (table 1). According to the country averages teachers agreed with 11 items and stayed neutral towards 5 items. Teachers in all countries indicated a strong support for constructivist ideas, while, at the same time, their preferences for traditional ideas were split into three equal groups (accepting/neutral/denying).

In general, agreement was strongest toward the constructivist-oriented statements that emphasize students' own inquiry and discoveries, practical and cross-disciplinary problems, conceptual understanding, and teacher's role as a facilitator (70–99 % of Finnish, Estonian and Latvian teachers agreed with those statements).

At the same time differences in Estonian, Latvian and Finnish teachers' responses appeared to be statistically significant in the case of 12 items related both to constructivist and traditional ideas. Estonian teachers agree less with using inquiry and emphasize more facts and quiet classrooms than teachers in the other countries. In Latvia one third of the teachers deviate from the general trend of the three countries as they de-emphasize reasoning processes and background knowledge. Finnish teachers focus much less on formulas and procedures, Latvian teachers more often relate mathematics to the daily life of students and use group work more often, and Estonian teachers emphasize non-routine problems slightly more compared to teachers in the other two countries.

Table 1. *Teachers' average responses (means and standard deviations) by countries and the statistical significance of cross-country differences*

Items (Factor)	Lat	Est	Fin	U*
	M (SD)	M (SD)	M (SD)	
The students' real-life problems and future life serve as a meaningful context for the development of their knowledge (F1)	3.9 (.95)	4.2 (.80)	4.2 (.65)	.000*
Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly (F2)	3.5 (1.04)	3.2 (.94)	2.9 (.99)	.000*
How much students learn depends on how much background knowledge they have – that is why teaching facts is so necessary (F2)	3.1 (1.02)	3.5 (.87)	3.2 (.97)	.000*
Effective/good teachers demonstrate the correct way to solve a problem (F2)	3.0 (1.11)	2.9 (1.04)	2.9 (.93)	.000*
My role as a teacher is to facilitate students' own inquiry (F1)	4.7 (.56)	4.2 (.81)	4.2 (.70)	.000*
Students learn best by finding solutions to problems on their own (F1)	4.1 (.88)	4.2 (.80)	4.2 (.76)	.363
Students should work on practical problems themselves before the teacher shows them how they are solved (F1)	4.5 (.74)	4.5 (.71)	4.0 (.77)	.000*
Teacher should direct students in a way that allows them to make their own discoveries (F1)	4.7 (.59)	4.5 (.64)	4.4 (.62)	.000*
In order to facilitate student's conceptual understanding the teacher should vary methods accordingly (according to the situation) (F1)	4.7 (.61)	4.6 (.58)	4.6 (.64)	.071
Students should engage in collaboration in small groups explaining newly developing ideas and listening to other students' ideas (F1)	4.3 (.80)	4.3 (.79)	3.7 (.92)	.000*
Thinking and reasoning processes are more important than specific curriculum content (F1)	3.9 (.82)	3.9 (.89)	4.0 (.77)	.215
Most activities require the use of previous knowledge and skills in new ways (F1)	4.0 (.77)	4.0 (.83)	4.1 (.65)	.954
Teacher should emphasize the use of knowledge and skills obtained in other disciplines to solve problems and address issues (F1)	4.5 (.70)	4.5 (.61)	3.9 (.87)	.000*
Students and their teachers create the assessment criteria and/or tools together (F1)	3.3 (.99)	3.0 (1.04)	2.7 (.91)	.000*
Assessment should include practical problems, projects and investigations (F1)	3.8 (.93)	4.0 (.95)	3.5 (.95)	.000*
A quiet classroom is generally needed for effective learning (F2)	3.3 (.98)	3.9 (.92)	3.0 (1.05)	.000*

Note. *Significance is calculated using Monte Carlo Sig. (2-tailed); 99 % confidence interval

Principal component analyses

The 16 items of the questionnaire were subject to a Principal Component Analysis (PCA) with Varimax rotation. Analyses were at first

performed on a joint sample of teachers. The number of factors extracted was determined by eigenvalues and scree diagrams. Based on these criteria it was decided to explore solutions of four, three and two factors. The best solution with most obviously interpretable factors was found in two-component structure. The two-component solution explained a total of 32 % of the variance.

The first factor (F1, see table 1) was labelled *Reasoning and conceptual understanding* ($\alpha = .73$). Twelve items comprising this factor represent a perspective on (mathematics) teaching which emphasizes the students' active and meaningful participation in learning process: students' discoveries and inquiry on problems and real life applications, working in small groups; aiming at conceptual understanding.

The second factor (F2, see table 1) was labelled *Mastery of skills and facts* ($\alpha = .58$). The four items of this factor emphasise (mathematics) teaching as concerned with the formal teaching of skills and fluency through practice of routine procedures; the teaching is first and foremost the direct transmission of knowledge from the teacher to the pupil.

The reliability level of this factor is relatively low, at the same time this construct stayed stable throughout all tested factor-models. The poorer reliability may be due to the small number of items in this construct. Although the reliability of this factor was not satisfactory, our view remains that it is a well-defined construct and it can be used for reducing data complexity. However, results of consecutive analyses need to be interpreted with care.

It is interesting that constructs described by factors 1 and 2 appeared as independent components and not as opposite extremes of one scale. So, in the case of an individual teacher they both may exist in parallel. For example, a teacher who emphasizes reasoning and conceptual understanding in her teaching may value highly also practicing of routine procedures.

Cross-cultural comparison of factor models

Principal component analyses were performed also on sub-samples of each participating country. Factor models for the joint sample and three national cohorts proved to be almost identical.

So, it seems that conceptions of good teaching held across national educational systems in Estonia, Latvia and Finland have similar structures. However, the second factor proves to be most reliable in the Latvian sample ($\alpha = .66$) while in Finland this dimension has low reliability ($\alpha = .40$). Despite the concerns regarding reliability, we decided to use derived factors to compare teachers' beliefs in our countries. Mean scores were calculated for each teacher (in Finnish, Estonian and Latvian sample)

on both factors. Differences in national perspectives were explored by means of *t*-test. Country averages for factor scores are presented in table 2 and distribution of teachers in each subsample by factor score values in table 3.

Table 2. *Comparison of factor score averages by countries*

Factor	Estonia		Latvia		Finland		
	Mean	SD	Mean	SD	Mean	SD	Sig
Reasoning and conceptual understanding	4.1	.42	4.2	.40	4.0	.44	.000*
Mastery of skills and facts	3.4	.61	3.2	.74	3.0	.59	.000*

Table 3. *Distribution of teachers by factor score values*

Values of factor score	F1			F2		
	Est (%)	Lat (%)	Fin (%)	Est (%)	Lat (%)	Fin (%)
Disagree ($F \leq 2.5$)	1	1	1	11	22	25
Neutral ($2.5 < F \leq 3.5$)	6	4	15	56	47	62
Agree ($F > 3.5$)	93	95	84	34	32	13

All country scores proved to differ significantly ($p = .000$) by all possible pairs of countries in case of both factors. As can be seen from tables 2 and 3, a teaching approach stressing reasoning and conceptual understanding (F1) is generally supported by the teachers in all three countries. The support is strongest in Latvia where 95% of teachers agree or strongly agree with statements reflecting this approach and only 0.5% disagree. The amount of supporters is lowest in Finland where still 84% of the teachers are in favour of and only 1% opposes this approach. In all three countries teachers tend to stay neutral towards mastery of skills and facts approach (F2). The strongest support to this approach appears to be among the Estonian teachers, only 11% of them disagree with it. Yet in Finland 25% and in Latvia 22% of teachers disagree with this approach. Only in Finland the amount of teachers supporting mastery of skills and facts approach is lower than of those who disagree with this approach.

Belief profiles

According to the factor model derived above, teachers' beliefs about good teaching can be described using a two-component structure. In case of the individual teachers these two components – reasoning and

conceptual understanding, and mastery of skills and facts may exist in parallel. And in spite of significant differences in teachers' beliefs between the three countries under consideration, there are teachers in each of the countries with a similar combination of agreement with those two components. Thus, according to the different degrees of agreement with ideas regarding these two factors, typical belief profiles could be derived. These belief profiles describe different models of teachers' conceptions of good mathematics teaching.

Table 4. *Percentage of teachers in nine different belief profiles*

Reasoning and conceptual understanding	Mastery of skills and facts		
	Disagree (%)	Neutral (%)	Agree (%)
Disagree, neutral	*Oppositionist* Lat: 1 Est: 0 Fin: 3 Total: 1	*Anti-constructivist* Lat: 2 Est: 5 Fin: 11 Total: 4	*Radical traditionalist* Lat: 2 Est: 2 Fin: 2 Total: 2
Agree	*Anti-traditionalist* Lat: 15 Est: 10 Fin: 17 Total: 13	*Modest compromise* Lat: 37 Est: 42 Fin: 47 Total: 40	*Traditionalist* Lat: 24 Est: 26 Fin: 10 Total: 24
Fully agree	*Radical constructivist* Lat: 6 Est: 1 Fin: 4 Total: 4	*Constructivist* Lat: 8 Est: 9 Fin: 4 Total: 8	*Reconsiliation of polarities* Lat: 5 Est: 5 Fin: 1 Total: 5

By fixing three levels of agreement for both components nine possible profiles were constructed (see table 4). The distribution of teachers on the reasoning and conceptual understanding component proved to be extremely uneven: a majority of teachers agreed or fully agreed with these statements. Thus the scale for this component was divided into parts as following: disagree, neutral ($F1 \leq 3.5$); agree ($3.5 < F1 \leq 4.5$); and fully agree ($F1 > 4.5$). The scale describing mastery of skills and facts was divided into three parts as following: disagree ($F2 \leq 2.5$); neutral ($2.5 < F2 \leq 3.5$); and Agree ($F2 > 3.5$). As can be seen from the percentages in table 4, teachers' distribution between these nine constructed profiles

proved to be highly uneven. In the following, some examples of the most expressive profiles are presented.

Modest compromise

The biggest group of teachers represents this profile: 42 % of Estonian teachers, 37 % of Latvian teachers and 47 % of Finnish teachers belong to this group. These teachers compromise both approaches; their views about good teaching include construction of knowledge and accept also transmission of knowledge in combination with it. Staying neutral towards formal training of skills, they are not extremely enthusiastic towards the use of discovery learning, discussions and small group activities.

Radical traditionalists

About 2 % of teachers from all three countries belong to this group. These are the teachers who tend to see the most important goal of mathematics instruction to be formal training of skills. They value teaching through practicing of routines, the teaching is considered first and foremost the direct transmission of knowledge from the teacher to the pupil. These teachers clearly oppose the ideas of inquiry learning, problem solving and group work activities. Covering curriculum content is more important for them than developing students' mathematical reasoning.

Radical constructivists

Only 4 % of all teachers belong to this group, the biggest percentage of this type of teachers is in Latvia (Latvia, 6 %, Finland, 4 %, Estonia, 1 %). This belief profile consists of understanding of good teaching as a fully constructivist activity, teaching in small groups via discoveries and real-life problems. Teachers aim at facilitating conceptual understanding. Formal training of skills is not valued and seemingly instrumental aspects are not stressed by these teachers.

Reconciliation of polarities

Five per cent of all teachers (Estonia, 5 %, Latvia, 5 %, Finland, 1 %) form the group of teachers concurrently believing in both approaches. So most probably they emphasize teaching activities aiming at developing conceptual understanding and at the same time value highly the instrumental part of mathematical knowledge and stress training of routines and learning of facts and skills.

Discussion and conclusions

Teachers' beliefs reflect in which ways teaching and learning are conceptualised in different countries. Principal component analyses carried out in our study yielded two factor structures of such beliefs. These two constructs were interpreted as 1) reasoning and conceptual understanding and 2) mastery of skills and facts. It should be acknowledged that in the context of mathematics teaching and learning none of these constructs should be considered as privileged denigrating the other one (Clarke, 2006). The results demonstrate that so-called traditional teaching that emphasizes routines, and modern, constructivist teaching methods that emphasize pupils' conceptual understanding are not seen by the teachers as two opposites. Rather, these two approaches are seen as complementary alternatives (see Andrews & Sayers, 2013; Clarke, 2006), and in our joint sample we found teachers who disagreed with both as well as teachers who agreed with both.

The quantitative survey data on teachers' beliefs permitted to extract two differently oriented factors that simplified cross-cultural comparison and enabled to obtain the common picture of phenomenon. Subsequent qualitative research in every country could find more circumstantial transitions and profiles of teachers' beliefs. In this study, the teachers' beliefs in Finland, Estonia and Latvia were compared for the first time – especially considering the lack of inclusion of mathematics teachers from the Baltic countries in cross-cultural studies on a European scale, such quantitative and generalizing approach can serve as foundation for further more intricate and penetrating research designs.

Factor models for joint sample and three national cohorts proved to be almost identical. Thus, conceptions of good teaching held across national educational systems in Finland, Estonia and Latvia have a similar structure. This tends to confirm the existence of common core conceptions of mathematics teaching held by teachers from different countries what was shown also by Andrews and Hatch (2000) and Andrews and Sayers (2013). At the same time there are significant differences in the strength these conceptions are held by teachers in the countries under consideration because of the differences in their historical, economical, political background and distinct models of culture (see Andrews, 2010). Such differences in understanding mathematics teaching and learning have been found not only in regard of the frequently studied divide between Western and Eastern countries (Cai, Perry, Wong & Wang, 2009). Previously, for instance Pepin has shown significant cross-cultural differences also in Europe between epistemologies, beliefs and conceptions of mathematics teaching and learning in England, France and Germany (Pepin, 1999).

Such cross-cultural differences in teachers' beliefs can provide important information regarding the scope of possible classroom practice and teachers' inclination to different teaching approaches. Already, TIMSS and PISA studies have shown that the mathematical attainment of Finnish, Latvian and Estonian pupils are different. Therefore, it was relevant to assume that also the teachers' beliefs and classroom behaviour would somehow differ in these countries.

The country comparison carried out in this study indicates that Latvian teachers emphasise the constructivist teaching beliefs more than their colleagues in Finland and Estonia. That could be contingent on the very recent changes in philosophy of educational system specifically related to science and mathematics (ISEC, 2008).

Estonians were the strongest supporters for the traditional beliefs, yet also accepting the constructivist principles. On the overall level, Finland agreed least with both of these approaches. However, a more detailed analysis indicates certain items that Finnish teachers agree with more than their Estonian or Latvian counterparts.

The largest profile of modest compromise between constructivist and so-called traditional beliefs on good teaching envisages the complementary approach of most teachers towards teaching mathematics. Evidently, they are looking for a balance between educational requirements for innovative, discovery-oriented approaches oriented both to pragmatic and humanistic ends (Kascak, Pupala & Petrova, 2011; Partnership for 21st century skills, 2002) and objectivistic epistemology of mathematics as absolute, stable knowledge obtained by routine training, following examples and oriented to subject (Ernest, 1991, 1998; Rowlands, Graham & Berry, 2001). The largest number of these modest teachers comes from Finland, therefore, implicitly indicating the positive impact of balanced beliefs on students' achievements. Similar balanced approach to the constructivist and explicit instruction was found also in other studies with teachers (e.g. Snider & Roehl, 2007). At the same time, teachers are not overly interested in any single approach, though, slight prevalence of constructivist ideology tints the overall mood of teachers.

A very small number of teachers belonging to extreme or radical poles of beliefs might be explained, on one hand, by the teachers' awareness of modern child-centred educational contexts that warn against the predominance of subject-centeredness and instruction based on drill and routine and, on other hand, by the teachers' problems in implementing student-centred methods in diverse classrooms. However, the real distinctions in belief profiles found between countries ask for further in-depth investigation, asking, for instance, do these beliefs really dovetail with educational and other interrelated contexts and systems in a given

country to obtain the best outcomes? It would be interesting to compare if this parallel factors approach works also for the teachers of other subjects, as it is possible that mathematics with its specific history and philosophy as a universal discipline could be an exception in this regard.

Some of the limitations of this study include unequal samples collected in involved countries and low internal reliability for the component of Mastery of skills and facts, especially in the Finnish sample. Despite the application of several equivalence techniques, potential unconformity of teachers' surveys in three respective languages translated from the common English version may serve as some source of bias. Besides, the participation of teachers in this study was voluntary, therefore, it is possible that teachers' with more positive attitude to innovations and new approaches were also more willing to participate.

Due to space constraints, only one module of the NorBa questionnaire was analysed here. Future analyses will explore, for example, the cultural differences in teachers' job satisfaction, their mathematics related beliefs, and their preferred methods of teaching. Further research in a framework of NorBa project will be related to the data collection and analysis in other project countries (Lithuania, Norway and Turkey) in order to extend the scope of relevant cross-cultural comparisons.

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