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Globalization has led to a large number of cross-cultural studies in different areas, especially in education and psychology. Researchers have to use multiple-language versions of tests and questionnaires and to involve individuals from different languages and cultures. The question of measurement of cross-cultural differences comes to the fore.

This paper aims to measure lower secondary school mathematics teachers' beliefs in Estonia, Latvia and Russia. It will consider thier perspectives on teaching in general and teaching of mathematics and to analyse the structure of these beliefs. About 25% of school students in Latvia and 19% in Estonia attend Russian-language schools. The paper presents results from a cross-cultural comparison of beliefs teachers from Russian-language schools in Latvia and Estonia and Russian teachers.

For this purpose, data acquired within the framework of the project "Nordic-Baltic comparative research in mathematics education" (NorBa) were analyzed. Additionally, semi-structural interviews were conducted to verify the answers of Russian teachers.

The results indicate that differences between the teachers of mathematics in Russia, Latvia and Estonia were statistically significant on all the scales analyzed. Moreover, the teachers from the Russian-language schools in Estonia and Latvia were in most dimensions somewhere between the Russian teachers and the teachers from Estonian and Latvian-language schools.

JEL Classification: Z

Key words: beliefs, cross-cultural measurement, mathematics teachers

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1. Introduction

The TIMSS and PISA surveys documented the differences in the levels of mathematical performance among Russian, Latvian, and Estonian school students. With the highest TIMSS scores, Russian students showed considerably lower PISA performance than their Latvian and, especially, Estonian counterparts. We can presuppose that teachers' beliefs about teaching displayed through their classroom practices differ across these countries, too.

Beliefs reflect how mathematics, its teaching and learning, is conceptualised by teachers. Thompson states that what a teacher considers to be desirable goals of their 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).

In the context of this study, 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 in general and on their beliefs about the nature of mathematics teaching. It is assumed that what one believes influences what one does — beliefs act as a teacher's pedagogical predispositions. Therefore, beliefs are factors shaping a teacher's decisions, for example, the goals that should be accomplished and what the effective learning of mathematics should look like (Schoenfeld, 1998).

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 teachers' beliefs can provide important information regarding the scope of possible classroom practices and teachers' 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 teachers' beliefs may inform pre-service and in-service teacher education or curricular reforms. However, only a few studies have compared teacher beliefs across countries (e.g., Andrews & Hatch, 2000; Andrews, 2007; Felbrich, Kaiser, & Schmotz, 2012).

The aim of this paper is to measure lower secondary school mathematics teachers' beliefs in Estonia, Latvia and Russia concerning teaching in general and teaching of mathematics and to

analyse the structure of these beliefs. The paper will focus on comparing the beliefs of Russian teachers with the teachers from Russian-language schools in Latvia and Estonia. About 25% of school students in Latvia and 19% in Estonia attend Russian-language schools.

We chose to compare the teachers from Russia, Estonia and Latvia for a number of reasons. First, all these countries have a large proportion of teachers who earned their degrees in Soviet times and have been keeping to the traditions of the past. Second, some of the current trends in the development of educational systems are common for these countries: the attractiveness of the teaching profession is in decline; low wages and poor career opportunities make the best teachers of mathematics and students of teacher training colleges look for non-school jobs. Third, natural sciences and mathematics used to prevail in the Soviet curricula, but later they ceded the spotlight to other fields of science. Teachers who did not quit the profession have had to adapt to less motivated students, to the new curricula, to the increasing cuts in hours of mathematics, etc.

Mathematics education systems in Russia, Latvia and Estonia had a common history from the 1950s to 1991 — 20 years before the data were collected in Latvia and Estonia. As older teachers would have had their education from that era, we expect that teacher age might have an effect on their educational beliefs. On the other hand, even before 1991, teachers with Estonian or Latvian as a mother tongue usually received their teacher education in local universities that accepted the local language as medium. On the other hand, Russian speaking teachers in these countries often had their teacher education in the Russian speaking universities in Leningrad (now St. Petersburg) or Pskov. Based on this background, we expect to see differences not only across the countries, but also within the Baltic countries according to their linguistic groups. The teachers from Russian-language schools in these countries are likely to be more similar to the Russian teachers than the teachers who teach in Latvian- and Estonian-language schools.

2. Theoretical framework of the study: teachers' beliefs — what are they about?

Despite the prevalence of research into beliefs, there is still considerable debate about the definition and characteristics of beliefs (see Furinghetti & Pehkonen, 2002). Although broadly discussed and discrepantly defined, beliefs can be viewed as a fundamental concept understood as the regulating system of the knowledge structure (Pehkonen & Törner, 1995). Beliefs occupy the transition zone between the cognitive and the affective, bearing features of both. They represent a rather stable subjective (experience-based), implicit knowledge of an individual about mathematics and its teaching/learning. In this paper, we are going to apply the term in quite a broad sense, understanding beliefs *as conceptions, views and personal ideology that teachers hold in their practice.*

Research 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 (Raymond, 1997). 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 a teacher believes to be important and plausible (Speer, 2005).

Noddings emphasized the role that research of teachers' views and beliefs concerning mathematics and the way it is taught plays a large role in understanding mathematical behavior of teachers and students (Noddings, 1990). Beliefs research is especially important to change working practices when innovations affect accepted standards, programs or requirements to teaching techniques. Pajares (1992) attempted to synthesize research in this field and to "clean up a messy construct". He summarized the existing studies on teachers' beliefs (not only in mathematics) and came to the conclusion that there are no specific beliefs; teachers' beliefs are indissolubly interconnected. In their professional practices, teachers rely upon a whole system of views which, in turn, are based on deeply-rooted beliefs. That is why beliefs research requires that we do not classify or differentiate between beliefs but try to extract the common teacher-specific understanding of mathematical education (Pajares, 1992).

However, later researchers identified different categories of beliefs: regarding mathematics as a science, or mathematics as a school subject, or the role of the teacher in teaching, or the role of students (Törner, 1998). It has been put forward lately that teachers' beliefs about the essence of mathematics, about teaching mathematics, and about teaching in general may be investigated in isolation (Liljedahl, Rösken, & Rolka, 2007).

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 a teacher communicates knowledge in a clear and structured way, explains correct solutions, gives learners clear and resolvable problems and ensure peace and concentration in the classroom; while in a constructivist classroom, students are perceived as active participants in the acquisition of knowledge, and students' own inquiry is stressed in developing problem solutions (Underhill, 1988; OECD, 2009). This model was used in the presented research to evaluate teachers' beliefs and the perceptions about good teaching (Table 1).

Table 1. Two approaches to mathematics teaching

Traditional approach	**Constructivist approach**
The learning process is built around the basic skills	The learning process is built around the concept as a whole
Strict adherence to fixed curriculum is highly valued	Pursuit of student questioning is highly valued
Student is a "blank slate" to be filled with information provided by the teacher	Student is a thinker with emerging theories about the world
The teacher is normally didactic when transmitting knowledge to students	The teacher works interactively, mediating the environment for students for efficient learning
Teacher seeks the correct answer to validate student learning	The teacher is trying to understand the student's point of view in order to understand student's present conceptions for use in subsequent lessons
Students usually work individually	Students usually work in groups
Knowledge is assessed through tests, apart	Assessment of knowledge is regarded as an

from the learning process	integral part of the learning process and is performed through monitoring of students, their work and projects

Brooks & Brooks, 1993

Teachers with a constructive approach can be characterized by their perception of a student as an active participant in the process of gaining knowledge. This kind of teacher gives students the opportunity to figure out solutions to problems by themselves. According to Beswick (2007), constructivism is the most effective medium to achieve the greatest results by students. Traditionalist teachers believe that their main role is to present the material — clearly, precisely and structurally — to explain correct solutions to tasks and to maintain the necessary level of concentration in the classroom. 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; Törner, 1998; Liljedahl, Rösken & Rolka, 2007).

Thompson and her co-authors introduced the concept of "orientation in teaching mathematics" and defined conceptually-oriented teachers who are primarily focused on a system of ideas, styles of thinking, and methods of their development; and calculationally-oriented teachers who give more attention to numbers, calculation procedures, and numerical results (Thompson et al., 1994).

One of the popular approaches to the classification of teachers' beliefs on teaching mathematics has been created by Dionne and Ernest who differentiated between traditional, formalist and constructivist (based on the view that knowledge is constructed by students) perspectives (Dionne, 1984; Ernest, 1991). Speaking differently, this classification can be represented as the toolbox, system and process aspect of teaching math. 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. This perception is close to traditionalist teaching beliefs. The "system aspect" stresses rigorous proof, logic, exact definitions and a precise use of the mathematical language; mathematics is understood as a system. In the "process aspect", mathematics is considered a constructive process in which relations among different notions play an important role. This perception sees learning as a process of knowledge construction with the paramount focus on development of thinking processes and creative steps in mathematical activity. This perception is close to constructivism. This model is used in Module 4 of the NorBA questionnaire.

There are hardly any teachers who base their practices on only one of the conceptions described above; every teacher includes and integrates elements of both approaches in teaching. Nevertheless, Staub and Stern conducted a quasi-experimental study to find out that teaching with a more pronounced constructivist orientation was associated with better students' performance than teaching with a more pronounced instructional orientation (Staub & Stern, 2002).

To introduce innovative teaching practices, teachers' beliefs should be reshaped both in teacher education universities and in advanced training programs. Being rather stable psychological states, beliefs have been proven to gradually change under certain conditions (Törner, 1998; Kaasila et al., 2006; Kislenko & Lepmann, 2011).

As it was mentioned before, only a few studies compare teacher beliefs across countries (e.g., Andrews & Hatch, 2000; Andrews, 2007; Felbrich, Kaiser, & Schmotz, 2012). One of the earliest major research projects relating to teachers' beliefs was TALIS (Teaching and Learning International Survey, OECD, 2009). But TALIS was designed to collect information about teachers as a professional group and does not focus on teachers of mathematics. Mathematics teachers were the specific focus of cross-cultural research TEDS-M studying teacher education systems and assessing the quality of education provided for future teachers of mathematics in primary and secondary schools. To assess the characteristics of in-service teachers and conduct a comparative study of mathematics teachers' beliefs, we did our own survey using the NorBA (Nordic-Baltic Comparative Research in Mathematics Education)[6] questionnaire.

NorBA is a comparative study of mathematics education originally aimed to target the Nordic and Baltic countries (Finland, Sweden, Norway, Estonia, Latvia, Lithuania). The participants of this study developed a questionnaire designed to explore lower-secondary teachers' beliefs regarding mathematics teaching and learning (Lepik & Pipere, 2011). The principal difference between this questionnaire and the one used in the TEDS-M is that the former is focused on teaching practices (investigates beliefs directly associated with teaching), while the latter is about studying beliefs regarding the nature of mathematics and the process of its teaching.

[6] Official website of Nordic-Baltic Comparative Research in Mathematics Education (NorBA) http://norbal.wordpress.com/2011/09/29/hello-world/.

3. Method

3.1. Instrument

The NorBa project was launched relatively recently. In 2010, a group of researchers from Estonia, Latvia and Finland developed a questionnaire to measure various aspects of mathematics teachers' beliefs in cross-culturally valid ways. The main part of the NorBa questionnaire includes five modules: 1) general information (social and demographic characteristics of teachers: age, education, years of experience, type of settlement where they are teaching, number of students in a class, etc.); 2) school climate (items assessing job satisfaction, relationship with colleagues and school administrators); 3) general beliefs about teaching (two pools of items reflecting two learning approaches, constructivism and traditionalism); 4) conceptions of good teaching of mathematics; 5) teachers' perceptions of their own classroom practices (items on how often teachers use specific types of activities with students in the class).

Each module consists of a series of statements, for which respondents specify their level of agreement or disagreement measured using five- or four-point Likert scales. Therefore, the questionnaire reveals how teachers evaluate their own beliefs; however, the accumulated research on teachers' beliefs has led the academic community to agree that the results of such questionnaires may be used as characteristics of beliefs.

The very first version of the questionnaire was developed in English and later translated into the languages of the participating countries, including Russian (for Russian-speaking teachers of Latvia and Estonia). The survey was conducted in Latvia and Estonia from 2010–2011 (Lepik & Pipere, 2011; Lepik, Pipere, & Hannula, 2013).

To conduct successful research on the sample of teachers in Russia, a Russian version of the NorBa questionnaire was modified with the developers' approval by paraphrasing some of the items to make them sound as smooth as possible in Russian, keeping the same meaning as the original items in English. The survey of Russian teachers was conducted in spring 2013.

As this paper is designed to explore mathematics teachers' beliefs, we are going to analyze the results using questionnaire modules 3 and 4.

3.2. Sample and procedure

In Latvia, 390 teachers were surveyed, including 95 teachers teaching in Russian language schools (Russian-speaking teachers). The respondents were aged between 25 and 66 (the average age was 47); the average number of years of experience was 23; the prevailing age range was from 40 to 49. The Latvian sample was selected to be representative of the general population of mathematics teachers (Sapkova 2011).

In Estonia, 332 teachers from 15 regions were surveyed, including 92 teachers teaching in Russian language schools (Russian-speaking teachers). The respondents were aged between 25 and 77 (average age was 47); the average number of years of experience was 23.

In the Russian Federation, the sample consisted of 1,096 secondary school mathematics teachers in Krasnoyarsk region, which accounted for 40% of the mathematics teachers' population in the region. A special analysis showed that the Russian sample may be considered representative of the regional mathematics teachers' population (the sample was compared to the population by types of settlement and types of educational institution, with differences between the sample and the population being under 3% for all the criteria). The average age of the Russian teachers was 46 years, while the average experience was 20 years. About 40% of teachers in the region were over 50 and only 12% under 30. People of retirement age accounted for 18% of teachers.

About 25% of school students in Latvia and 19% in Estonia go to Russian-language schools. The Latvian subsample of Russian-speaking teachers consisted of 95 people (25% of the sample), while the Estonian subsample included 92 respondents (28% of the sample).

The Latvian and Estonian teachers received emails describing the survey and inviting them to participate in the study. Those who replied positively received a questionnaire, filled it out, and sent it back to the survey staff. The Russian teachers followed the same procedure, except that they were provided access to an e-questionnaire to fill it out online. Teachers of all the three countries were reassured that all the information collected by the survey would be kept in strict confidence and would be only available to the researchers.

3.3. Verification of cross-cultural comparability of the survey data and the construction of scales

Ensuring the comparability of results obtained in different cultures and languages is one of the most important issues in cross-cultural research. It is not sufficient to assume that an instrument

developed in a certain culture, based on specific cultural values and conceptions, measures the same construct in another culture. In fact, in the literature it is emphasized that constructs, especially psychological ones, are likely to involve culture-specific attributes and meanings (Cooper & Denner, 1998). For instance, constructs such as attitudes, classroom climate, or even social-economic status are likely to differ in different countries, cultures and languages (Ercikan & Lyons-Thomas, 2013). Linguistic equivalence is one aspect of measurement comparability that is addressed most often, but the psychological equivalence of constructs is another very important issue requires attention.

To make the analysis of equivalence for our data, we have combined two approaches: IRT-modeling (including DIF) and factor analysis (EFA and CFA). According to both approaches, all samples revealed a two-factor structure for module 3. The analysis confirmed the theoretical hypotheses of the questionnaire's developers. Each scale was found out to be uni-dimensional (i.e., measuring only one construct), all items had satisfactory psychometric characteristics and fit the measurement model. Thus, module 3 consists of two scales that can be interpreted as traditionalism (4 items) and constructivism (11 items). The reliability was 0.67 for the constructivism scale and 0.61 for the traditionalism scale (we used the Pearson Reliability index which Item Response Theory utilizes as an alternative to the classic reliability coefficient).

Differential Item Functioning (DIF) analysis was conducted to demonstrate the cross-cultural measurement invariance of the constructs (Wang, 2008). Multiple group confirmatory factor analysis (CFA) also was used to verify the cross-cultural equivalence of the measurement models in the three countries (Byrne, 2011). The results showed that some of the items were understood differently by teachers in different countries. However, the number of such items was rather small — the rest of the items were proved to be equivalent. That being said, the constructivism and traditionalism scales may be regarded as partially equivalent for the participating countries.

In order to measure the level of constructivism and traditionalism in the participants' beliefs, we used the Partial Credit Model. This enabled us to get estimates of the parameters on the interval scale with precision characteristics specified. The interval scale made it possible to compare the measurement results obtained for partially differing sets of items and, hence, to take into consideration the partial non-equivalence of the scales.

To evaluate teachers' beliefs about the most efficient mathematics teaching approach, we developed three scales for module 4 of the NorBA questionnaire, "Conceptions of good teaching of mathematics", using methods similar to those described above in respect to the constructivism

and traditionalism scales. Thus, module 4 is represented by the following scales: 1) "Process aspect": 10 items, reliability: 0.8; 2) "Toolbox aspect": 5 items, reliability: 0.65; 3) "System aspect": 6 items, reliability: 0.72. The teachers' estimates on these scales were obtained using Partial Credit Model again.

A detailed description of the analysis is out of our focus and presented in another paper (Kardanova et al., 2014).

All participants' estimates were converted into a 100-point scale (T-scores scale) with the mean value of 50 and standard deviation of 10 for convenience of comparison and interpretation. Therefore, each teacher is characterized through five scores on a 100-point scale showing the level of constructivism and traditionalism in their general beliefs and the level on the process, toolbox and system scales (beliefs about teaching math).

3.4 *Verification of the Russian teachers' responses*

It appears that the Russian teachers have the highest results on the constructivist scale and this result is rather unexpected. Because of this, we have checked the validity of the scale in the Russian context. In our sample, there is a big share of older teachers. Older teachers might expose a larger "social desirability" in their answers because at their age some of them are afraid of getting fired or punished otherwise if they keep to the "old ways". Thus, we decided to conduct an additional verification analysis of the Russian teachers' responses. To do this, semi-structured interviews were conducted with 12 teachers from Russia from 5 different schools (regular schools and schools with advanced subject learning). The sample was formed in such a way so to cover all the different combinations of the constructivist and traditional levels. Table 2 presents the main characteristics of the interview sample: their age, level of traditionalism and constructivism — high, medium or low (the method of establishing the thresholds will be described in the next section).

Table 2. Characteristics of the interview respondents

Name	Constructivism level	Traditionalism level	Age
Respondent 1	High	High	55
Respondent 2	Low	Medium	61
Respondent 3	Low	Medium	54

Name	Constructivism level	Traditionalism level	Age
Respondent 4	Medium	Medium	24
Respondent 5	High	High	n
Respondent 6	High	High	51
Respondent 7	Medium	Medium	50
Respondent 8	Medium	High	58
Respondent 9	Medium	Medium	27
Respondent 10	Medium	Low	42
Respondent 11	High	Low	53
Respondent 12	High	Low	58

It was assumed that teachers with a higher levels of constructivism put more emphasis on constructing self-knowledge and group work; their lessons are more interactive, students feel free to ask questions. While a traditionalist teacher pays attention to assimilation of the curriculum through training and skills development and discipline in the classroom. But it should be kept in mind that a teacher potentially uses the both traditional and constructivist approaches.

The analysis of the interviews showed that, indeed, the teachers with a higher level of constructivism consider the student an active participant in the learning process. Here are some examples from their interviews: “I love kids’ reasoning”; “Every lesson a pupil should make a small discovery”; “A teacher is a coordinator who only directs the learning”.

For teachers with high levels of constructivism, the connection with the real life plays an important role: “an ideal teacher shows how mathematics is associated with life”, “I have a discussion ‘Why do we need math?’”, “I give examples from other subjects”.

A constructivist teacher is not afraid to admit that he does not know something. To the question, “Have you ever been in a situation when you didn’t know the answer to student’s question?’ only the teachers with high levels of traditionalism and low levels of constructivism answered that they have never been in such situations.

Teachers who have a higher level of traditionalism than constructivism focused on discipline: “A child may have some *minimal* communication. But not noisy”; “It is necessary to bring homework to the irreproachability”. These teachers pay attention to the curriculum and educational standards: “I make sure that the base-level is achieved, the standard is learned”, “I

make a list of things ‘the children must know’ and then look at whether there are all these points”.

To conclude, we can assume that we can trust the results of the measurement of teachers’ beliefs. And the scales of constructivism and traditionalism are valid for the Russian context.

4. Results

The results from the analysis are presented to highlight the major findings. Firstly, the general beliefs about teaching will be described. We begin with descriptive statistics of all the examined variables and the cross-cultural comparisons of these measurements. Secondly, the beliefs about good teaching/learning of mathematics will be presented using the same structure. The third part of our analysis focuses on the analysis of correlations between the identified variables.

4.1. Teachers’ general beliefs about teaching

Table 3 provides information about the distribution of teachers across the groups with different levels on constructivism and traditionalism scales in percentages. The percentages are given for all five cultural groups: teachers from Latvia who teach in Latvian language (Lat_Lat) and in Russian language (Lat_Rus); the same for Estonian teachers (Est_Est are the teachers who teach in Estonian, Est_Rus teach in Russian) and for teachers from Russia (Rus_Rus). So, the first part of an abbreviation in the column “Country” signifies a country, while the second part is the instruction language at school.

We divided teachers into several groups by their levels of constructivism and traditionalism. Threshold values for establishing groups were determined based on the quartiles values. If teachers’ value of constructivism or traditionalism is within the first quartile, then their level of constructivism or traditionalism is considered to be low. If teachers’ constructivism value is higher than the third quartile, then their level of constructivism is considered to be high. If their value of constructivism or traditionalism is within quartile range, then their level of the corresponding scale is considered to be medium. The thresholds were set to a 100-point scale (T-scores scale). The 100-point scale thresholds are 43 and 56 for both constructivism and traditionalism scale and 43 and 56 for traditionalism scale. The borders are included in low and high groups. By using these thresholds we can divide teachers into groups with low, medium or high levels of traditionalism or constructivism.

Table 3. The ratio of teachers with low, medium and high scores on the scales from module 3

%	Constructivism			Traditionalism		
	Low	Medium	High	Low	Medium	High
Lat_Lat	23	62	15	22	47	31
Lat_Rus	20	58	22	19	47	34
Est_Est	19	73	9	35	43	22
Est_Rus	16	68	15	37	41	22
Rus_Rus	20	44	36	25	50	24

A high level of constructivism is typical for 36% of the Russian teachers. This share is the largest for all cultural groups. Russian teachers are followed by the Russian-language school teachers from Latvia (22%), while the other three groups have from 9-15% in the "high group". The teachers in Estonian-language schools have the smallest share of teachers with a high level of constructivism (9%) and the largest share of teachers with a medium level (73%). They are followed by the teachers of Russian-language schools from Estonia (68%). Teachers from Latvia also have more than a half of all teachers in the middle group for both Latvian-speaking and Russian-speaking schools.

Thus, Russian teachers of mathematics demonstrated higher scores on the constructivism scale than the teachers in the other four groups. The teachers from the Estonian-language schools have less constructivist beliefs than teachers in other groups (according to their self-report).

For the traditionalism scale, Russian teachers have the largest share (50%) in the "medium group" and the other half of Russian teachers is divided equally between high and low groups. Latvian teachers (both from Latvian-language and Russian-language schools) have more teachers in a high group and less in a low group than teachers from other cultural groups. On the contrary, Estonian teachers (both from Estonian-language and Russian-language schools) have more teachers in a low group and less in a high group than teachers from other cultural groups.

4.2. Teachers' beliefs about good teaching/learning of mathematics

Table 4 provides descriptive statistics for the toolbox, process and system scales on the 100-point scales. For each scale the descriptive statistics were calculated for each cultural group.

Table 4. Descriptive statistics across the scales from module 4

Scale	Country	N	Minimum	Maximum	Mean	Standard deviation
Process aspect	Lat_Lat	295	21.7	70.2	45.8	8.0
	Est_Est	241	29.2	70.2	45.9	7.1
	Lat _Rus	95	10.5	81.2	48.1	9.7
	Est_ Rus	91	32.4	70.2	50.6	8.4
	Rus_Rus	1,096	24.0	81.2	52.0	10.5
System aspect	Lat_Lat	295	23.2	78.0	44.5	8.5
	Est_Est	241	27.7	68.0	45.5	7.7
	Lat _Rus	95	29.6	78.0	47.3	8.7
	Est_Rus	91	29.6	78.0	50.7	8.7
	Rus_Rus	1,096	10.7	77.9	52.6	10.0
Toolbox aspect	Lat_Lat	295	15.8	70.3	45.1	9.0
	Est_Est	241	24.6	90.3	49.0	9.3
	Lat _Rus	95	27.9	70.3	47.2	8.7
	Est_ Rus	91	27.9	78.2	49.7	9.3
	Rus_Rus	1,096	20.7	90.3	51.8	9.9

A statistical evaluation of differences between the teachers from different cultural groups for the three scales was performed using single-factor analysis of variance (ANOVA). As a result, we revealed significant differences on all the scales: Process ($F(4; 1{,}804) = 38.84$, $p < 0.001$, partial $eta^2=.09$); Toolbox ($F(4; 1{,}803) = 30.88$, $p < 0.001$, partial $eta^2=.07$), System ($F(4; 1{,}803) = 62.68$, $p < 0.001$, partial $eta^2=.12$).

The Russian teachers demonstrated the highest mean values on all the scales, while Latvian-language school teachers had the lowest . The results of pairwise comparison using Tukey HSD method are shown in Tables 5–7.

Table 5. Pairwise comparison for Process scales from module 4

Process scale	Lat_Lat	Lat_Rus	Est_Est	Est_Rus	Rus_Rus
Lat_Lat		Yes (p=.04)	No (p=.99)	Yes (p=.00)	Yes (p=.00)
Lat_Rus			No (p=.31)	No (p=.37)	Yes (p=.01)

Est_Est				Yes (p=.01)	Yes (p=.00)
Est_Rus					No (p=.65)
Rus_Rus					

In Tables 5–7 the word “yes” means that there are significant differences between two cultural groups and the word “no” means that the means are statistically the same.

Thus, there are no differences between the teachers from Estonian-language schools and both groups from Latvia; also, the means for the Process scale are the same for the teachers from Russian-language schools in Estonia and Latvia and Russian teachers.

Table 6. Pairwise comparison for Toolbox scales from module 4

Toolbox scale	Lat_Lat	Lat_Rus	Est_Est	Est_Rus	Rus_Rus
Lat_Lat		No (p=.34)	Yes (p=.00)	Yes (p=.00)	Yes (p=.00)
Lat_Rus			No (p=.56)	No (p=.98)	Yes (p=.00)
Est_Est				No (p=.98)	Yes (p=.00)
Est_Rus					Yes (p=.04)
Rus_Rus					

For the Toolbox scale there are no differences between the two groups of the teachers from Latvia. Both groups from Estonia and the teachers of the Russian-language schools from Latvia have the same levels on the Toolbox scale. Between the other language groups, pairwise comparison shows significant differences.

Table 7. Pairwise comparison for the System scales from module 4

System scale	Lat_Lat	Lat_Rus	Est_Est	Est_Rus	Rus_Rus
Lat_Lat		Yes (p=.04)	No (p=.51)	Yes (p=.00)	Yes (p=.00)
Lat_Rus			No (p=.53)	Yes (p=.04)	Yes (p=.00)
Est_Est				Yes (p=.00)	Yes (p=.00)
Est_Rus					No (p=.34)
Rus_Rus					

There are no differences between the two language groups from Latvia and the teachers from Estonian-language schools. But it should be mentioned that Latvian-speaking teachers and Russian speaking Latvian teachers differ significantly. Also, there are no differences between the teachers of the Russian-language schools from Estonia and Russian teachers for the System scale.

For two out of three scales there are no significant differences between the Russian teachers and the teachers of the Russian-language schools from Estonia. They are much closer to each other rather than with the Latvian teachers.

4.3. Correlation analysis

The correlations between the two scales of general teaching beliefs — traditionalism and constructivism — were weak and negative for all the subsamples (Rus_Lat: r = –0.19; Est_Est: r = 0.08; Rus_Est: r = –0.09 and Rus_Rus: r = –0.05), except among the teachers from the Latvian-language schools, where the weak negative correlation was statistically significant (r = –0.17, p< 0.01).

Zero correlations between the scales demonstrate that any teacher may be both a constructivist and traditionalist at the same time. This is why it is impossible to classify them rigidly into one of the two categories.

The following analysis explored the hypothesized relationship between general beliefs and mathematics-related beliefs. Theoretically, the "process aspect" in mathematics teaching beliefs should correlate with the constructivism and the "toolbox aspect" with the traditionalism beliefs on teaching. This hypothesis was verified through the correlation analysis (Table 8).

Table 8. Correlation analysis of beliefs

Language		constructivism	traditionalism	process	toolbox	system
Lat_Lat	constructivism	1	-.174**	.554**	-.122*	.160**
	traditionalism	-.174**	1	-.173**	.574**	.221**
	process	.554**	-.173**	1	,048	.402**
	toolbox	-.122*	.574**	,048	1	.385**
	system	.160**	.221**	.402**	.385**	1
Rus_Lat	constructivism	1	-,194	.723**	-.240*	.222*
	traditionalism	-,194	1	-,125	.538**	,018
	process	.723**	-,125	1	-,098	.415**
	toolbox	-.240*	.538**	-,098	1	.349**

	system	.222*	,018	.415**	.349**	1
Est_Est	constructivism	1	,082	.479**	.171**	.337**
	traditionalism	,082	1	,026	.481**	.311**
	process	.479**	,026	1	,073	.364**
	toolbox	.171**	.481**	,073	1	.407**
	system	.337**	.311**	.364**	.407**	1
Rus_Est	constructivism	1	-,091	.612**	,028	,201
	traditionalism	-,091	1	,192	.507**	.417**
	process	.612**	,192	1	,150	.352**
	toolbox	,028	.507**	,150	1	.392**
	system	,201	.417**	.352**	.392**	1
Rus_Rus	constructivism	1	-,048	.574**	,054	.264**
	traditionalism	-,048	1	,054	.481**	.272**
	process	.574**	,054	1	.164**	.405**
	toolbox	,054	.481**	.164**	1	.330**
	system	.264**	.272**	.405**	.330**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

We can see statistically significant strong correlations for all the groups between the constructivism scales and the "process aspect" and the traditionalism scales and the "toolbox aspect". These results were expected because the scales had had a very similar nature. Some of the correlations are different for different countries. Both groups of Latvian teachers show a negative correlation between the Constructivism and Toolbox scales, while in Russia and among the teachers from Russian-language school of Estonia, the correlation was almost zero. But for the Estonian-speaking teachers, there was weak but statistically significant positive correlation between the Constructivism and Toolbox scales.

The System scale correlates with both Constructivism and Traditionalism for all teacher groups except the Russian-language subsamples from Estonia and Latvia. This curious result could be an indication of a general tendency to agree with whatever the teachers perceive as important rather than indicating any coherent teaching philosophy.

5. Discussion and conclusions

This paper measured the beliefs of mathematics teachers in Estonia, Latvia and Russia concerning teaching in general and teaching mathematics in particular, as well as the analysis of the structure of these beliefs.

More than the half of the teachers in this study received their mathematical education in the Soviet educational system before 1991, when the education system was traditionally oriented. But according to our results, many teachers from all cultural groups have constructivist beliefs. There can be several reasons to explain this. For example, teachers are able to change their beliefs during their practice or teachers have a more adaptable approach to reforms.

In this research, the Estonian or Latvian teachers were divided into two groups in terms of language of instruction: the national language and Russian. Based on this background, the research revealed that differences between the teachers of mathematics in Russia, Latvia and Estonia were statistically significant on all the scales analyzed. Moreover, the teachers from the Russian-language schools in Estonia and Latvia were in most dimensions somewhere between the Russian teachers and the teachers from Estonian and Latvian-language schools. Also, the differences between the teachers inside a country is less than between countries.

A high level of constructivism is typical for teachers in Russia, as compared to the teachers in Latvia and Estonia. At the same time, a considerable percentage of the Russian teachers are traditionalists (74% of Russian teachers have medium or high level of traditionalism), which proves that teaching mathematics as a collection of rules, formulas and procedures is still quite popular in Russia. We can suggest that Russian teachers teach to develop a conceptual understanding of mathematics among learners, at the same time considering the instrumental views of mathematics and focusing on rules and procedures, provided that classes of learners are heterogeneous in their levels of training.

The proportion of teachers with a low and medium level of traditionalist beliefs is higher in Estonia than in Russia and Latvia. At the same time most of the teachers from Estonia (both from Estonian-language and Russian-language schools) demonstrate a medium level of constructivism. We can assume that this approach of compromising conceptions of teachers has led to better the performance of Estonian students in the PISA study.

On the contrary, teachers from Latvia (both from Latvian-language and Russian-language schools) demonstrate a high level of traditionalism in comparing with the teachers from other groups and a medium level of constructivism. We can assume that the Latvian teachers use both approaches at the same time in their practices. These teachers' conceptions of good teaching might combine the understanding of teaching as knowledge construction and as knowledge transfer. Conventional teaching focused on procedures and modern constructivist teaching

methods developing conceptual understanding of the material are seen not as opposed but rather as complementary.

In most of the studied groups, we found the correlations between constructivism and traditionalism to be close to zero. In Latvia, there was a small negative correlation, which was statistically significant only in the larger group of Latvian-language school teachers.

We also found that general teaching beliefs correlate with teachers' conceptions of good teaching of mathematics in all the five teacher groups. Also, the Constructivist teachers tend to see mathematics as a process while the traditionalist teachers believe that teaching mathematics as a set of tools is the best. The correlation between the Constructivism and the Toolbox scales was negative in both Latvian teacher groups, but it was positive in the group of Estonian-language school teachers. Also the correlation between the Traditionalism and the Process scales was negative among Latvian-language school teachers and statistically non-significant in all the other groups. Moreover, in almost all the groups, both a constructivism and traditionalism orientation had a statistically significant positive correlation with a view of mathematics as a system. These results indicate that while relations between some variables are universal across these five teacher groups, there are also relations that are more contextually specific.

The System scale revealed the most substantial differences between the Russian and Baltic teachers who teach in the national language, which confirms the suggestion that the teachers in Russia still follow the traditions of mathematics education with a focus on proofs and the exact use of the mathematical language. It is interesting that teachers from the Estonian-language schools are closer to teachers from the Latvian-language schools while the teachers from the Russian-language schools of Estonia are closer to the Russian teachers.

Thus, our research has shown that different approaches to education reforms used in Russia, Latvia and Estonia resulted in significant differences in mathematics teachers' beliefs about teaching mathematics. The analysis of cross-cultural differences in teachers' beliefs provides essential information about teachers' classroom practices and choice of teaching strategies. This data will help to evaluate more accurately the situation in general education school and to predict its further development, which is especially relevant in the light of education reforms.

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