LATVIAN MATHEMATICS TEACHERS' BELIEFS ON EFFECTIVE TEACHING

Abstract

The article aims to present findings of a study on the profile of traditional/constructivist beliefs of mathematics teachers in Latvia connected with effective teaching. For this purpose, data acquired within the framework of the project "Nordic-Baltic comparative research in mathematics education" (NorBa) were analyzed. The sample included 390 teachers of mathematics from different regions of Latvia, 96 of whom worked at schools of ethnic minorities, and 165 of whom were teachers from bigger towns. Latvian mathematics teachers' beliefs about effective teaching tended towards constructivism, though in response to many questions traditional standpoints still remained. The results demonstrate statistically significant differences between teachers of different social and demographical groups. Teachers from general education schools were found to have different beliefs from schools with a large percentage of students from ethnic minorities, and teachers from bigger towns were found to have different beliefs from teachers working in small towns or the countryside. The outcomes of this study may be used for the development and improvement of courses in mathematics teacher education.

Key words: teachers, beliefs, teaching of mathematics, constructivist beliefs, traditional beliefs

Introduction

Analysis of the educational experience of many countries shows that due to liberalization of economics and the development of democratic society, illustrative explanatory models of learning have been replaced by the models focused on learners' activity (ISEC, 2008). This spread of ideas based around holistic education has led to new understandings that teachers should be facilitators of learning. In this frame, learning is viewed as an organic, natural process and not a product that can be turned out on demand (Education, 2000; Forbes, 1996; Roger, 1983). Furthermore, teachers require autonomy to design and implement learning environments that are appropriate to the needs of their particular students (Education, 2000).

Globalization, density of information, gender balance in families, and women's emancipation are essential factors that characterize processes that concern the whole world, including Latvia. Therefore, new demands have been set for the sphere of education that brought out a need for reforms in education. In 2006 and 2008 new standards in basic (ISCED[1] level 1) and secondary (ISCED level 2) education were introduced in Latvian system of education. These reforms changed the philosophy of Latvian education system by introducing the fundamental principles of holism and constructivism: goals were set to provide learners with basic knowledge and skills needed for their public and personal life, to form the basis of learners' further education, facilitate their harmonious development and responsible attitude towards oneself, family, society, surrounding environment, and country (Latvian National Standards, 2006, 2008).

[1] ISCED - International Standard Classification of Education

Holism stands on the assumption that the universe is an integrated whole in which everything is connected (Schubert, 1986; Flake, 1993; UNESCO-APNIEVE, 2002). In turn, education (including education in Latvia proceeding from the goals stated above) may be described as holistic when it exemplifies the following characteristics (Miller, 1991):

• Holistic education nurtures the broad development of the students and focuses on their intellectual, emotional, social, physical, creative or intuitive, aesthetic and spiritual potentials;

• It promotes the importance of relationships at all levels within a learning community in which the educator and student work together in an open and collaborative relationship;

• There is an emphasis on life experience and learning beyond the confines of the classroom and the formal educational environment towards education as growth, discovery and a broadening of horizons.

Constructivist theory of learning is based on the principles that knowledge is formed and not transmitted, learning is an active process that depends on the way learner assumes responsibility for his/her learning, and finally, learning takes place by relating the prior knowledge to new information (Piaget, 1973).

The necessity to introduce the constructivist approach in education of Latvia has been determined by the advancing of new aspects of *self-expression* and *creativity* in Latvian system of education. In compliance with the *National Standard of Basic Education* in Latvia (2006), learners must be provided with an opportunity of gaining the experience in creative action, a constant possibility to seek and find solutions to practical problems, to reveal common regularities. Constructivist approach is the best one for provision of those in the process of learning.

Before the introduction of constructivist approaches in education in Latvia around 2006, the system of education here faced the demand of efficient instruction for ethnic minority learners in the Latvian language or bilingual education based on constructivism. In Latvia bilingual education is more often used in ethnic minority schools. Instruction in schools with general education programme is only in the Latvian language. Bilingual education in Latvia is manifested in both teaching different academic subjects in different languages in one education establishment for the same group of learners and using two languages in explicating the content of an academic subject in the same class if the language of instruction is not the native language of the learners.

Mortimore and colleagues (1988) have singled out 12 factors of influence in bilingual education. The role of teachers in bilingual education is defined as follows: 1) teachers run the lesson with appropriate methodology getting learners involved in decision making, following their knowledge development and supervising their language acquisition; 2) teachers use methods to facilitate up-to-date and harmonious ways of learning; and 3) teachers use in their work cooperative methods and group work which encourages cooperation among learners (Tikunoff, 1983; Garc'a et al., 1988). These factors are in compliance with constructivist and holistic approaches in the process of learning. It may be assumed that their existence in bilingual education in Latvia could potentially affect both teachers' beliefs on approaches to teaching and their practical actions in class.

Recent major changes in the Latvian system of education concern mathematics. From 2008 to 2013, a European Union structural fund project "Elaboration of the content of learning and teacher further education in subjects of natural sciences, mathematics and technologies" was conducted to promote change in

mathematics education in Latvia and to secure the sustainability of the initiated reforms at the basic education stage (grades 7-9, the age of learners from 13 to 15). One of the project goals is raising the professional qualification of mathematics teachers in work with modernized learning content. Each teacher working in grades 7-9 has an opportunity within the project to participate in professional learning courses, informative seminars, public lectures, master classes and consultations. Hence, teachers have an opportunity to improve their skills in evaluating learners' research activities and working with information technology.

The present article is focused on mathematic teachers of grades 7-9 and their beliefs on effective teaching. Effective teaching may be defined as teaching that is adequate for accomplishing a set goal to produce the intended or expected result (Smith, 1995). Hence, teachers' beliefs on effective teaching may differ according to the goal set by the teacher in the process of learning and the expected results.

The Latvian National standards (2006) state that mathematics has a dual purpose in allowing learners the opportunity to acquire skills in mathematics, e.g., execute operations with real numbers but also *to acquire skills of investigating and solving practical tasks and to foster the development of thinking.* This definition gives a new role for the teacher in the process of learning that is aligned with a holistic philosophy and constructivist learning approach. Yet, what happens in reality? Is it sufficient to change the education paradigm in educational policy by providing teachers with professional learning courses and support materials to change mathematics teachers' beliefs on effective teaching? These questions formed the background of the study into Latvian teachers' beliefs.

To answer the above questions, the notion of beliefs is used in the present article. In this context, beliefs are considered as an individual's subjective knowledge of a certain object or concern for knowledge of which there may not necessarily be any tenable basis in objective considerations (Pehkonen, 1994). There is a correspondence between teachers' beliefs and changes teachers undergo (Lerman, 2001). This means that teachers' beliefs seriously affect what and in what way teachers provide to their learners (Perrin-Glorian, Deblois, & Robert, 2008).

Hence, the aim of the present article is to study the profile of traditional/constructivist beliefs of mathematics teachers in Latvia in relation to effective teaching. In this way important information can be provided on the role of a teacher in the process of learning and the correspondence of teacher's beliefs to education reforms.

Theoretical framework

The present article is concerned with "teachers' beliefs". This term is usually used to refer to teachers' educational beliefs (Borg, 2001). From the whole range of teachers' beliefs we will analyze just those on effective teaching.

Beliefs about the nature of teaching and learning which, for instance, are the focus of OECD's (Organization for Economic Cooperation and Development) Teaching and Learning International Survey (TALIS) (OECD, 2009) include "direct transmission beliefs about learning and instruction" and "constructivist beliefs about learning and instruction". Teachers with transmission and constructivist beliefs hold different views on the role of a teacher and learner, teaching and learning strategies, and assessment and curriculum.

The **direct transmission view** of student learning implies that a teacher's role is to communicate knowledge in a clear and structured way, to explain correct

solutions, to give learners clear and resolvable problems, and to ensure peace and concentration in the classroom. The term ‘traditional beliefs’ is used in the present article to express this notion (OECD, 2009, p. 92). The **constructivist view** focuses on students as active participants in the process of acquiring knowledge. Teachers holding this view emphasize facilitating learners’ inquiry. They prefer giving learners a chance to develop problem solutions on their own, and allow learners to play an active role in instructional activities. The term ‘constructivist beliefs’ is used in the present article to express this notion.

TALIS results (OECD, 2009) showed that in most countries endorsement of constructivist beliefs is stronger than that of traditional beliefs. Teachers in Australia, South Korea, northwestern Europe and Scandinavia show a stronger preference for a constructivist view than teachers in Malaysia, South America and southern Europe. Teachers in eastern European countries lie in between.

As mentioned above, the present article focuses on *mathematic* teachers’ beliefs on effective teaching. In other words, in the present research, teachers’ beliefs on effective teaching are concerned with effective teaching of just one subject, i.e. mathematics. Hence, the present article is focused on teachers’ beliefs on effective *mathematics* teaching.

Three sets of belief (on effective *mathematics* teaching) orientations were identified in the case study examining the links between teachers’ practices, beliefs and knowledge and the performance of learners in the development of numeracy (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997): **connectionist** - beliefs based around both valuing pupils' methods and teaching strategies with an emphasis on establishing connections within mathematics; **transmission** - beliefs based around the primacy of teaching and a view of mathematics as a collection of separate routines and procedures; **discovery** - beliefs clustered around the primacy of learning and a view of mathematics as being discovered by pupils. In this study it was noted that these orientations were "ideal types": none of the teachers did, or was ever likely to, fit exactly within the framework of beliefs of any of the three orientations; many combined several characteristics of two or more orientations.

Yet in the present research we proceed from two kinds of beliefs on learning (direct transmission views and constructivist views) used in the general context so that mathematics teachers’ approach to teaching potentially could be compared to that of other subject teachers.

Mathematics teachers’ theoretical beliefs have been studied by Brown and Rose (1995). They conducted an interview study with 10 elementary school teachers of mathematics in order to determine their theoretical framework. Teachers’ replies showed a varied range of theories of teaching and learning mathematics. Teachers also admitted that *their theoretical views influenced their instructional behaviour*.

Erickson (1993) also concluded that teachers’ ideal beliefs had a strong influence on their teaching practice. However, obstacles to full implementation of their ideals included lack of time for preparation and lack of collaboration among peers; size of the classroom; availability of technology, materials, and financing; non-supportive administration and parents; need for lengthened class periods; and personal opportunity for growth.

In Latvia, the beliefs of Latvian teachers of mathematics have been studied within the framework of project “Nordic-Baltic comparative research in mathematics education” (NorBa) that makes use of the quantitative questionnaire created by the researchers participating in the project (Lepik & Pipere, 2011). The first results were related to the beliefs of Latvian teachers of mathematics on *efficient teaching*

(Šapkova, 2011). The teachers were offered a description of two teachers with competing approaches in teaching. One of them poses the teacher as a facilitator of student learning who provides opportunities and resources for students to discover or construct knowledge for themselves (constructivist approach); the other describes the teacher's role as one who explains knowledge in a structured manner (Ravitz, Becker, & Wong, 2000). It must be noted that though the majority of teachers realize that a constructivist approach in teaching provides learners with more knowledge and useful skills, often teachers do not feel comfortable themselves when conducting classes with the constructivist approach.

The present article reflects the Latvian mathematics teachers' beliefs on *effective teaching* specifically investigating the following research questions:

1) What view of effective teaching is more popular with Latvian mathematics teachers?

2) What statistically significant differences, if any, appear in beliefs of teachers of various socio-demographical groups on effective teaching?

Method

Instrument

The present study is a part of an international comparative research of project NorBa.

The questionnaire is divided into 8 parts. One part is qualitative, 7 parts are quantitative and, except for part A, are evaluated by 4 or 5 point Likert scale from fully agree to fully disagree. The parts of the questionnaire are as follows: A. Socio-demographical information; B. Teachers' general satisfaction with their work as a teacher; C. Teachers' beliefs about two teaching approaches; D. Teachers' beliefs on effective teaching; E. Teachers' beliefs on effective teaching and learning of mathematics; F. Teachers' own use of text-books; G. Teachers' own classroom practice.

According to the aim of the present paper and research questions, only the results obtained from the part D (teachers' beliefs on efficient teaching) of this questionnaire will be analyzed here. Part D consists of 16 Likert-type questions, 8 from which are based on TALIS Teacher Questionnaire: *Teaching Practices, Beliefs and Attitudes Module* (OECD, 2009), while the remaining 8 questions are adapted from various teacher surveys available in research literature, for example, *Teaching, Learning, and Computing: 1998 National Survey in US* (Ravitz, Becker, & Wong, 2000).

Before the analysis, answers obtained from the items D2, D3, D4, D16 that are the characteristics of the traditional approach were re-coded. After re-coding it became obvious that teachers with strong constructivist beliefs on effective teaching provided 4 or 5 point replies according to Likert scale, while those with strong traditional beliefs provided 2 or 1 point replies. For example, for items D2, D3, D4, D16 "1" stands for "fully agree" and "5" for "fully disagree" with one of the above mentioned traditional approach. At the same time for the rest of items that represent the characteristics of the constructivist approach "1" stands for "fully disagree" and "5" for "fully agree" with one of constructivist approaches.

Sample and procedure

The sample of mathematics teachers in grades 7-9 included 390 mathematics teachers from different regions in Latvia. From all participants, 377 were female, 294 worked in schools of general education, and 165 of them lived in big towns (see Table 1).

Table 1. Distribution of teacher sample and the investigated population in socio-demographical subgroups

Characteristics		**Frequency N (%)**	**Investigated population frequency (%)**	**P value***
Region of Latvia	Riga and its region Latgale Vidzeme Kurzeme Zemgale	151 (38.7%) 95 (24.4%) 62 (15.9%) 48 (12.3%) 34 (8.7%)	36% 18% 14% 16% 16%	0.241
Gender	Female Male	377 (96.7%) 13 (3.3%)	94% 6%	0.157
Education programme	General Ethnic minorities	294 (75.4%) 96 (24.6%)	68% 32%	0.157
Urbanization	Bigger town Small town or countryside	165 (42.3%) 225 (57.7%)	40% 60%	0.157
Age	20-29 30-39 40-49 50-59 60+	11(2.8%) 62 (15.9%) 171 (43.8%) 127 (32.6%) 19 (4.9%)	No data	
Education	Secondary Bachelor's degree Master's degree Doctoral degree	4 (1%) 198 (50.2%) 186 (47.7%) 1 (0.3%)	No data	
Teaching experience in years	0-5 6-10 11-15 16-20 21-25 26-30 30-35 36-40 41+	12 (3.1%) 21 (5.4%) 43 (11.0%) 67 (17.2%) 77 (19.7%) 92 (23.6%) 44 (11.3%) 28 (7.2%) 6 (1.5%)	No data	

***** Sample and investigated population differences were assessed with Chi-square tests

The sample consisted of teachers of diverse age (from 25 to 74, the average age was 47, the dominant age group from 40 to 49 years of age), different education (the majority of respondents hold a bachelor or Master's degree) and varying duration of teaching experience (from 1 to 51 years, on average 23 years, the biggest group from 26 to 30 years of teaching experience).

The sample was designed using a proportional stratification approach. As it is shown in Table 1, there are no statistically significant differences between the sample and the investigated population. Therefore, this sample represents all teachers in

grades 7-9 in Latvia. The focus on mathematics teachers in grades 7-9 is justified by the essential changes that have taken place in mathematics basic education in Latvia.

The data collecting process took place in October – December 2010 at several stages: 1) Informative e-mails were sent to schools all over Latvia inviting mathematics teachers to participate in the survey; 2) Teachers who wished to participate in the survey filled in applications electronically and sent them to a specially appointed e-mail address; 3) The registered participants obtained a code and received the questionnaires with the necessary instructions; 4) Respondents filled in questionnaires electronically and sent them to the appointed e-mail address.

Participation in the survey was voluntary, respondents' identity and records of the research were kept confidential. The participants of the survey were rewarded by certificates of participation in the project.

The fact that teacher participation in the survey was voluntary could have affected the results of the survey. We may assume that there is a probability of bias on the side of constructivism because more active teachers chose to participate in the survey.

Data analysis

The following methods of statistical analysis were used for data processing: Kolmogorov-Smirnov test to assess the distribution of data, Descriptive Statistics, Frequencies, Correlational analysis, Principal Component analysis, Mann-Whitney criterion, Kruskall-Wallace criterion as well as Cronbach Alpha to assess the reliability of extracted factors.

Main results

According to Kolmogorov-Smirnov criterion, the data on all items significantly differed from normal distribution, therefore the statistical analysis of differences in items was conducted using non-parametrical criterions of data analysis.

Teachers' beliefs on effective teaching

To acquire the independent components from the items of part D of the questionnaire, data on the items of surveys module ***Teachers' beliefs on effective teaching*** were included in the factor analysis. KMO value (0.764) suggested that data were valid for factor analysis. The Principal Component Analysis with Varimax rotation and Kaiser normalization located 5 factors with the eigenvalue greater than 1 (See Table 2).

Table 2. The results of factor analysis for the module ***Teachers' beliefs on effective teaching***

	Factors	**Items**	**Cronbach Alpha**
Factor 1	Comprehension and transference of knowledge	D5, D9, D10, D12, D13	0.65
Factor 2	Independent discoveries	D6, D7, D8	0.63

Factor 3	Traditional approach	D2, D3, D4, D16	0.66
Factor 4	Relatedness to the real life	D1, D15	0.32
Factor 5	Self-regulated teaching	D10, D11, D14	0.46

For all 15 statements, factor weight on one of four factors was above 0.5 with the only exception for item D10 (0.338).

Cronbach Alpha values show that reliability level for factors 4 and 5 is low, therefore for further analysis only the results related to factors 1, 2, 3 will be used.

Comprehension and transference of knowledge

Teachers' replies about effective teaching in the sphere of students' comprehension and transference of knowledge are summarized in Table 3.

Table 3. Descriptive statistics on Latvian mathematics teachers' beliefs of effective teaching in the sphere of students' comprehension and transference of knowledge

Items on Factor 1 (Comprehension and transference of knowledge)	**Mean± Std. Deviation**	**Scores 1 or 2 (%)**	**Score 3 (%)**	**Scores 4 or 5 (%)**
D5 My role as a teacher is to facilitate learners' own inquiry.	4.70±0.56	1.00	0.80	98.2
D9 In order to facilitate learners' conceptual understanding the teacher should vary methods accordingly (according to the situation).	4.66±0.59	0.80	3.30	95.9
D10 Learners should engage in collaboration in small groups explaining newly developing ideas and listening to other learners' ideas.	4.27±0.61	2.60	12.8	84.6
D12 Most activities require use of previous knowledge and skills in new ways.	4.04±0.77	2.10	21.6	76.3
D13 Teacher should emphasize the use of knowledge and skills obtained in other disciplines to solve problems and address issues.	4.47±0.70	1.10	8.50	90.5
Average	4.43±0.65	1.50	9.40	89.1

Correlation analysis among five **Comprehension and transference of knowledge** items revealed the statistically significant correlations among them ($p<0.01$). The strongest correlation occurred between the items D13 and D12 ($r=0.33$, $p<0.01$) (See Table 4).

Table 4. Intercorrelations of the teachers' beliefs on effective teaching (Spearman's correlation) (N=390)

	d1	d2	D3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15
d2	-0.03														
d3	**-0.14****	**037****													
d4	0.09	**0.45****	**0.26****												
d5	0.04	0.07	**0.11***	0.01											
d6	**0.14****	**0.13***	0.03	**0.25****	**0.23****										
d7	0.05	0.09	0.10	**0.10***	**0.21****	**0.36****									
d8	0.09	**0.11***	0.04	**0.16****	**0.26****	**0.24****	**0.39****								
d9	**0.14****	**0.11***	**0.12***	**0.12***	**0.22****	**0.14****	**0.18****	**0.26****							
d10	**0.16****	0.10	0.05	0.08	**0.16****	**0.24****	**0.25****	**0.28****	**0.33****						
d11	**0.11***	-0.02	0.10	**0.13***	**0.13****	**0.15****	**0.16****	**0.18****	**0.11***	**0.16****					
d12	0.08	0.04	0.08	0.01	**0.16****	**0.09**	**0.19****	**0.19****	**0.15****	**0.19****	**0.19****				
d13	**0.19****	0.01	-0.03	0.05	**0.32****	**0,20****	**0.15****	**0.25****	**0.31****	**0.21****	**0.13***	**0.33****			
d14	0.02	-0.01	**0.19****	-0.03	**0.19****	**0.13***	**0.22****	**0.21****	0.09	**0.21****	**0.24****	**0.10***	**0.14****		
d15	**0.20****	-0.02	**-0.15****	**0.11***	0.07	**0.21****	**0.15****	**0.20****	**0.12***	**0.30****	**0.17****	0.10	**0.16****	**0.16****	
d16	0.01	**0.33****	**0.31****	**0.30****	0.06	0.03	0.02	0.08	0.09	**0.11***	**0.13****	0.04	0.07	0.05	-0.02

**p<0.01; *p<0.05

Besides, items of **Comprehension and transference of knowledge** correlated (p<0.01; p<0.05) with all other items except those of the factor **Traditional approach** and item D1 (Learners' real-life problems and future life serve as a meaningful context for the development of their knowledge) and D15 (Assessment ought to be based on practical tasks, projects, and investigations); however some exceptions occurred here as well (see below).

Independent discoveries

Teachers' replies about effective teaching in the sphere of students' independent discoveries are summarized in Table 5.

Table 5. Descriptive statistics on Latvian mathematics teachers' beliefs on effective teaching in the sphere of students' independent discoveries

Items on Factor 2 (Independent discoveries)	**Mean± Std. Deviation**	**Scores 1 or 2 (%)**	**Scores 3 (%)**	**Scores 4 or 5 (%)**
D6 Learners learn best by finding solutions to problems on their own.	4.07±0.88	5.40	18.0	76.6
D7 Learners should work on practical problems themselves before the teacher shows them how they are solved.	4.48±0.74	1.80	8.50	89.7
D8 Teacher should direct learners in a way that allows them to make their own discoveries.	4.67±0.59	0.80	3.10	95.8

Average	4.41 ±0.74	2.70	9.90	87.4

Analysis of correlations among all items of **Independent discoveries** revealed the statistically significant correlations among them ($p<0.01$). The strongest correlation was observed between the items D6 and D7 ($r=0.36$, $p<0.01$) (See Table 4).

Besides, items D6, D7, and D8 correlated ($p<0.01$; $p<0.05$) also with all other items, except for items of **Traditional approach** and item D1 (The learners' real-life problems and future life serve as a meaningful context for the development of their knowledge); however some exceptions occurred here as well (see below).

Traditional approach

Results of the descriptive statistics are summarized in Table 6.

Table 6. Descriptive statistics on Latvian mathematics teachers' beliefs on effective teaching in the sphere of traditional approach

Items on Factor 3 (Traditional approach)	**Mean± Std. Deviation**	**Scores 1 or 2 (%)**	**Score 3 (%)**	**Scores 4 or 5 (%)**
D2 Instruction should be built around problems with clear, correct answers, and around ideas that most learners can grasp quickly.	2.55±1.04	46.4	34.8	18.8
D3 How much learners learn depends on how much background knowledge they have – that is why teaching facts is so necessary.	2.87±1.02	37.5	33.6	29.0
D4 Good teachers demonstrate the correct way to solve a problem	3.04±1.11	32.2	32.4	35.5
D16 A quiet classroom is generally needed for efficient learning.	2.67±0.98	43.6	35.6	20.8
Average	2.78 ±1.04	39.9	34.1	26.0

Analysis of correlations among all items of **Traditional approach** revealed the statistically significant correlations ($p<0.01$) among them. The strongest correlation occurred between the items D2 and D4 ($r=0.45$, $p<0.01$) (See Table 4).

Item D16 (after recoding: a quiet classroom is not needed for effective learning) correlated with D10 and D11 that indicates that mathematics teachers considered that group work developed learners' thinking abilities and was not compatible with total silence in class.

Item D2 (after recoding: instruction should not be built around problems with clear, correct answers) and D4 (after recoding: effective teachers do not demonstrate the correct way to solve a problem) correlated ($p<0.05$) with items D6, D8, and D9 indicating that Latvian mathematics teachers in the given sample believed that teaching should not be built around problems with clear, correct, and demonstrated answers and ideas that most learners can grasp quickly, but around learners' independent solutions, discoveries, varying corresponding methods according to the situation.

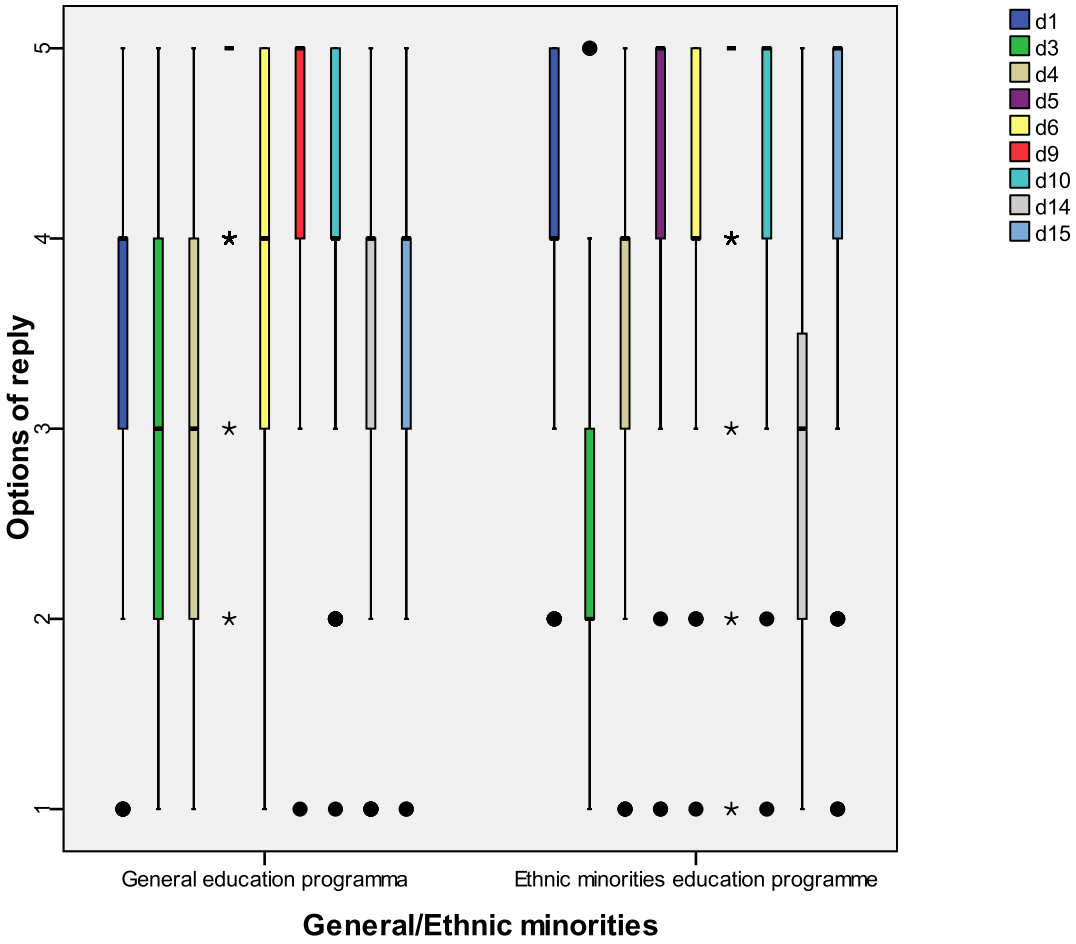
Finally, item D3 (after recoding: teaching facts is not so necessary) correlated with item D14 (learners and their teachers create the assessment criteria together) ($p<0.01$) and D9 and D5 ($p<0.05$) suggesting that teachers believed that teaching facts did not always give an opportunity to encourage learners' independent cognition,

cooperation of learners and teachers in creating assessment criteria together, neither did it encourage teachers to vary their teaching methods according to the situation.

Teachers' beliefs on effective teaching: socio-demographical differences

To determine the statistical socio-demographical differences in teachers' beliefs on effective teaching Mann-Whitney criterion and Kruskall-Wallace criterion were used.

Using Mann-Whitney criterion there were found differences in beliefs on effective teaching of the teachers from general education schools and teachers from schools for ethnic minorities (items D1, D3, D4, D5, D6, D9, D14 and D15 $p<0.01$) and in beliefs of teachers in bigger towns and teachers in small towns or countryside (items D3, D5, D7, D11, D14, D16, $p<0.01$) (see Figure 1 and Figure 2)[2].

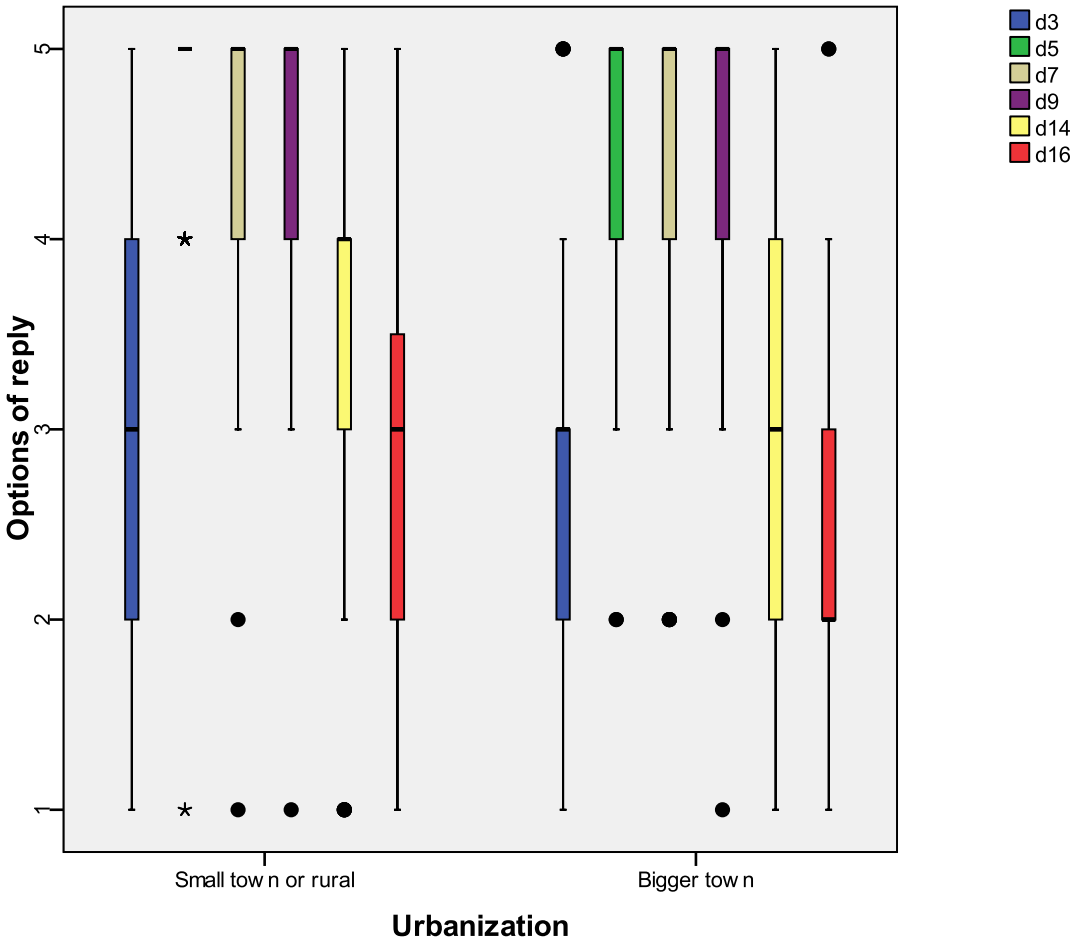


- - outliers; * - extremes

Figure 1. Differences in beliefs on effective teaching of the teachers from general education schools and teachers from schools for ethnic minorities

[2] Figure 1 and Figure 2 are boxplots. Boxplots display the first, second and third quartile as well as the interquartile range and outliers of a data set. The information displayed by the boxplot, and most of its variations, is based on the data's median. For more information see, e.g. McGill, Tukey, & Larsen, 1978.

It appears that in items D3, D5, and D14 teachers of general education programmes were more constructivist oriented, but in items D1, D4, D6, D9, D10, and D15 teachers of ethnic minorities programmes were more constructivist oriented.



• - outliers; * - extremes

Figure 2. Differences in replies of teachers in bigger towns and small towns/countryside about their beliefs on effective teaching

In all items teachers of schools located in small towns and rural settlements were more tended to constructivism than those working in schools situated in bigger towns.

Using Kruskall-Wallace criterion there were found differences in beliefs of teachers from different regions of Latvia (items D3, $p<0.01$ and D11, D14, D15, D16, $p<0.05$), in beliefs of teachers with different ages (D13, $p<0.01$ and D6, D9, D11, $p<0.05$), and in beliefs of teachers with different education level (D14, $p<0.05$).

Mathematics teachers in Latgale were more tended towards traditional teaching in their replies to items D3, D14, and D16, while teachers in Zemgale pointed out their preference for traditional teaching in their replies to items D11 and D15, though this result may be a consequence of uneven distribution of ethnic minority schools and bigger towns across regions.

Constructivist beliefs of teachers grow more distinctly with age.

Only in item D14 (learners and their teachers create the assessment criteria together) teachers holding Bachelor's degree had more distinct constructivist beliefs than their colleagues holding Master's degree. There were no significant differences related to teachers' qualifications on other items.

Discussion

In general, Latvian mathematics teachers' reported beliefs on effective teaching which were more aligned with constructivism than a traditional approach to teaching.

In the factor **Comprehension and transference of knowledge** and **Independent discoveries**, Latvian mathematics teachers had distinctly constructivist beliefs. More than 90% of teachers considered that teacher's role was to encourage learners' independent inquiry, that teachers ought to vary their teaching methods to match the situation, and that teachers should emphasize mathematical knowledge and skills gained in other subjects. Eighty-nine percent of teachers believed that, before showing the correct solution, learners should be given an opportunity to work out their own solutions of practical tasks; 95% of teachers believed that learners need to be encouraged to make discoveries on their own. These conclusions correspond with prior research which showed that the beliefs of Latvian teachers of mathematics on *efficient teaching* are more inclined towards a constructivist approach too (Šapkova, 2011) and that in most countries endorsement of constructivist beliefs is stronger than that of traditional beliefs (OECD, 2009).

Evidence from the correlation analysis results in this study show that Latvian mathematics teachers' constructivist beliefs may be united in logical cause-consequence groups. Consequently the existence of one constructivist belief directly affects that of another. For example, the following statements were linked: teaching should not be built around problems with clear, correct, and demonstrated answers and ideas that most learners can grasp quickly, but teacher should direct learners in a way that allows them to make their own discoveries, varying corresponding methods according to the situation.

However, it must also be noted that there is a risk that the constructivist beliefs reported by Latvian mathematics teachers will not be practically implemented. This according to Erickson (1993) may be linked, among other things, to a lack of collaboration among mathematics teacher. Lāce (2010) in her doctoral thesis admits that basic school teachers of mathematics in Latvia most often cooperate only in exchanging teaching materials. Common lesson analysis seldom occurs.

In addition, the teachers still have an inclination towards traditional beliefs. More than 40% of Latvian mathematic teachers in the given sample consider that teaching should be based on tasks with clear, correct answers and ideas that most learners can grasp quickly, and a quiet classroom is needed for effective learning process. This may be related to the traditional beliefs of parents on learning process and traditional demands of school administration in auditing teachers' lessons.

Correlation analysis results show that some of the traditional beliefs of teachers are not only dependent on one another to a statistically significant degree but they produce an inverse impact on constructivist beliefs. For instance, it was noted in the present research that traditional beliefs prevent many teachers from using group work in class as it usually disturbs quiet in classroom, disregarding the fact that group work develops learners' thinking skills.

Teachers of general education programmes more than their colleagues in ethnic minority schools prefer the teaching method of demonstration of correct

answers. In turn, ethnic minority school teachers are more tended to teaching facts than their colleagues from general education schools.

Other differences included that general education programme teachers reported that they preferred independent inquiry of learners and cooperation with learners in working out assessment criteria more than their colleagues in ethnic minority schools. At the same time ethnic minority school teachers preferred using teaching methods where learners independently work out their own solutions, when learners' real-life problems serve as a meaningful context for the development of their knowledge and when assessment is based on practical tasks, projects, and investigations.

An unexpected result of the study was that reported constructivist beliefs of teachers grew more distinctly with age. This may be related to economic conditions of the labour market in Latvia, e.g. the desire not to lose a job or after retirement. It also may be conjectured from the findings that the relation between teachers' constructivist beliefs and their age is not directly proportional. This means that teachers' constructivist beliefs do not always grow stronger with their growing age. Hence, in the group from 30 to 39 years of age teachers have a sufficiently high professional level and they are young enough to be ready to change their job, go abroad, thus they feel free in expressing their thoughts.

According to our research results, teachers who worked in rural settlements and small towns reported beliefs which were more aligned towards constructivism. They believed that teaching facts was not so important, learners should be given opportunities to work out their own solutions of practical tasks, and silence in class is not essential. This outcome may be related to small class sizes in small towns and rural settlements. A smaller number of students may allow the implementation of constructivist ideas in teachers' habitual practice more successfully.

Hence, the above mentioned arguments lead to the conclusion that the beliefs expressed by the majority of Latvian teachers of mathematics comply with the education reforms, though at the same time some Latvian teachers still retain traditional beliefs on effective teaching to some degree.

The current research is limited by the data collected which only reflects espoused beliefs. Future research will be undertaken to produce beliefs-in-action analysis and compare this to the espoused beliefs. Further studies will also compare obtained results on the espoused beliefs of Latvian mathematics teachers with espoused beliefs of teachers in Baltic and Nordic countries within the NorBa project.

At present further education courses for mathematics teachers are focusing more on the acquirement of the subject content and less on the development and cultivation of teachers' own personal/individual qualities: sensitivity, creativity, spontaneity, responsibility, compassion, reverence, and a sense of wonder. This may be one of reasons why, despite continuous process of teacher education, some of teachers' beliefs remain traditionalist.

Conclusions

Latvian mathematics teachers' reported beliefs both on effective teaching are more tended towards the constructivist approach than the traditional one. Especially distinct constructivist beliefs are demonstrated by Latvian mathematics teachers in the spheres of comprehension and transference of knowledge and independent discoveries.

There are statistically significant differences in teachers' beliefs on effective teaching between teachers from general education schools and ethnic minorities

schools and between teachers from bigger towns and small towns or countryside. Teachers' beliefs also differ according to regions of Latvia, teachers' age and education. Rural and small town school teachers are more tended in their beliefs towards constructivism. Tendencies are often determined by the replies of general education programme rural or small town school teachers. In some beliefs on effective teaching, ethnic minority school teachers or general education programme teachers are more tended towards constructivist approach. In this study, constructivist beliefs of teachers grow more distinct with age.

To secure positive tendencies in the sustainability of change of teachers' beliefs, the focus ought to be on the improvement of teacher further education courses.

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