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Research Insights
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TEACHERS' ATTITUDES BOUT TEACHING AND LEARNING MATHEMATICS

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Abstract. The aim of the research is to determine the attitudes of teachers about different concepts of learning and teaching mathematics in the lower grades of primary school. In accordance with the goal, three research tasks were set in which we wanted to determine the attitudes of teachers towards the traditional and constructive concept of teaching and learning mathematics and possible differences in these attitudes in regard to the degree of education and work experience. The research sample consisted of 161 primary school teachers in Serbia. A scale of attitudes was used as an instrument, which contained 16 items (9 items referred to traditionalist beliefs, and 7 to constructivist beliefs). The results of the research indicate that teachers understand and act in accordance with the requirements of the constructivist concept of modern teaching, but at the same time they determine certain elements of traditional teaching as acceptable and desirable. When it comes to these attitudes, we found that there is no statistically significant difference in regard to the education and work experience of teachers globally, but there is significant difference when it comes to individual items. In some further research, the application of a qualitative methodology should examine how teachers understand and determine the items about which they have expressed their views.

Keywords: primary teachers; mathematics teaching; beliefs and attitudes; traditional and constructivist concept of teaching

Introduction

Teachers' beliefs about teaching and learning are of great importance in determining the role of teachers in teaching and directly affect many aspects of their professional work and teaching practice (Aljaberi & Gheith 2018; Cross 2009; Kopas-Vukašinović, Mihajlović & Cekić-Jovanović 2020; Philipp 2007; Purnomo 2017; Stipek et al. 2001; Yang & Leung 2015). They influence and guide teachers in their decision-making and in the selection and implementation of teaching strategies, and represent an important component in the design and planning of learning

(Aljaberi & Gheith 2018; Perry, Howard & Tracey 1999). Teachers' beliefs about teaching and learning mathematics relate to their perception of desirable ways of teaching and learning, such as mental images of typical teaching activities in the classroom and determining appropriate and typical learning activities in mathematics (Yang & Leung 2015). Also, some research suggests that teachers ' beliefs about mathematics, mathematics teaching and learning can be linked to the students' achievement in mathematics and their understanding of mathematical contents (Carter & Norwood 1997; Staub & Stern 2002; Šapkova 2014).

In the literature, generally, two opposing conceptions can be singled out that refer to teachers' beliefs about teaching and learning mathematics: traditional and constructivist (Aljaberi & Gheith 2018; Aypay 2011; Chan & Elliott 2004). According to the traditional view, teaching mathematics is defined as a process of knowledge transfer in which students passively receive knowledge from teachers in a clear, organized and systematic way, while from a constructivist point of view, teaching is defined as a process of encouraging independent construction of students' knowledge (Chan & Elliott 2004; Voss et al. 2013; Yang & Leung 2015). A teacher with an orientation towards the traditional point of view is focused on acquiring factual knowledge and mastering routines and calculation procedures (Staub & Stern 2002). Constructivist conceptions imply that the student and his needs are put in the first place, and emphasize the importance of applying teaching procedures that put the student in focus, namely, into the center of the learning process (Šapkova 2014).

Similarly, Perry, Howard & Tracey (1999) discuss a model of teachers' beliefs that is based on two factors, which describe teachers' beliefs about mathematics, mathematics teaching, and mathematics learning, and correspond to the aforementioned views. These factors are called *transmission* and *child-centeredness*. According to them, *the transmission approach* represents the traditional view of mathematics as a static discipline that is taught and learned through the transmission of mathematical skills and knowledge from teacher to student. Mathematics is seen as a rigid system of externally dictated rules in relation to standards of accuracy, speed and memorization. *The child-centeredness approach* implies that students are actively involved in teaching mathematics and constructing their own understanding, while facing learning experiences based on existing knowledge.

The main problems arising from traditional teaching practice are that most of the acquired knowledge is not permanent, is incomplete and learned without understanding, students learn for assessment, not for life, and fail to use later acquired knowledge and skills in life (Onen, Altundag & Mustafaoglu 2017). The emphasis is on memorizing facts and on the ability to follow predefined rules, execute procedures, and apply formulas. The role of the teacher in a traditional classroom is to "provide clear, step-by-step demonstrations of each procedure, restate steps in response to students questions, provide adequate opportunities for students to practice the procedures, and offer specific support when necessary", and it is up to students to "learn by listening to teachers' demonstrations, attending carefully to their modeling actions, and practicing the steps in the procedures until they can complete them without substantial effort" (Smith 1996, 390 – 391). Teaching procedures that dominate traditional classes can "stifle" the thinking process of students, which interferes with their perception of the logical construction of mathematics (Aljaberi & Gheith 2018). Pavlović Babić and Baucal (2010) believe that one of the main reasons why students from Serbia achieve less results of the PISA testing is the fact that teaching and learning in Serbian schools are still focused on acquiring academic knowledge, while traditional lectures are still the most widespread form of teaching and learning. Stipek et al. (2001) in their research found that teachers who have traditional beliefs apply traditional teaching practice.

On the other hand, constructivism provides opportunities to solve most of the problems brought about by traditional teaching. According to constructivism, learning is an internal process that occurs in the mind of an individual. The individual constructs the elements he or she learns through establishing relationships with previously learned and existing knowledge (Onen, Altundag & Mustafaoglu 2017). For the knowledge construction process, the important role is the experience and active participation of the individual in the learning process (Aypay 2011). Mathematics teaching, which relies on a constructive approach, helps students develop mathematical thinking skills in a different form, especially metacognitive abilities (Aljaberi & Gheith 2018).

This duality of factors is not something new and many authors describe it in different ways. Stipek & Byler (1997) in their study, which examined educators' beliefs about appropriate education for younger children, also singled out two factors, which are similar to the above, and called them: *basic skills* and *child-centered* beliefs. The first factor refers to teachers' beliefs about the effectiveness of formal teaching that is oriented towards teaching basic skills, while the second refers to the belief that the teacher should primarily encourage children's self-initiative, provide them with sufficient opportunities for open-ended activities and enable them to explore specific materials and interact with each other. Lubinski et al. (1994) in their research, in which they analyzed the decisions of teachers during teaching, describe the mentioned factors as opposite ends of the continuum of beliefs. The questionnaire designed and used by Perry, Howard & Tracey (1999) to examine teachers' beliefs reflected the two separate factors already mentioned: *transmission or child-centerness.* Unlike them, Purnomo (2017), in a questionnaire used to examine the beliefs of Indonesian primary school teachers about the nature of mathematics, mathematics teaching and assessment, views traditionalist and constructivist beliefs, not as separate factors, but as two opposite ends of one factor. In our research, we consider these factors as separate, and not as the extremes of one factor. While constructing the instrument used in our research, we took care that it can be applied not only for examining beliefs towards traditional, i.e. constructivist elements of teaching mathematics of current teachers, but also of future teachers, in order to make improvements of the existing study programs of the faculties that educate this staff. The instrument is based on theoretical assumptions and concepts of traditional and constructivist teaching and on the results of previous research presented in this paper. We believe in the contribution of this research to the improvement of teaching practice, because there have not been any researches done in this context in primary schools in Serbia.

Research methodology

The aim of the research was to determine the attitudes of teachers about different concepts of learning and teaching mathematics in the lower grades of primary school. Based on the goal of the research, the following research tasks were defined:

1. To determine the attitudes of teachers towards the traditional and constructivist concept of teaching and learning mathematics.

2. To determine the statistical significance of differences between teachers' attitudes about given items, in regard to the degree of education.

3. To determine the statistical significance of differences between teachers' attitudes about given items, in regard to years of work experience.

The research was conducted during the year 2018/2019 and included the sample of 161 primary teachers from Serbia. Structure of the sample, according to degree of education and years of work experience is given in Table 1.

Table 1. Structure of the sample in regard to the degree of education and years of work experience

	Degree of education		Years of work experience		
	College	B.A.	0-12	13-24	25 –
f	52	109	47	49	65
%	32.3%	67.7%	29.2%	30.4%	40.4%

The instrument used was a *Traditional and Constructivist Teachers' Beliefs Scale* (TCB) which contained 16 six-point Likert-type items. TCB consisted of two subscales: 9 items *Traditional Teachers' Beliefs* (TB) and 7 items *Constructivist Teachers' Beliefs Scale* (CB). TCB was developed by the authors and the items were constructed in accordance with some previous studies (Perry, Howard & Tracey 1999; Šapkova 2014; Voss et al. 2013) and literature. We decided to apply a six-point scale to avoid the possibility of respondents expressing a neutral attitude. Higher grades indicated a more positive attitude towards the claim.

Table 2. Traditional and Constructivist Teachers' Beliefs Scale items

Item codes	Items
T1	Right answers are much more important than the ways in which you get them.
T2	Students should be given mathematical problems that have only one method of solving.
T3	A key factor in learning mathematics is memorizing procedures and rules.
T4	Students should rely solely on the teacher when learning maths.
T5	Students learn mathematics by repeating algorithms several times and solving similar problems.
T6	The dominant role of the teacher in the teaching of mathematics is to make his presentations and explanations a source of knowledge.
T7	It is the teacher who asks the questions, and the students are the ones who answer.
T8	Teachers should give complex tasks only to the most capable students.
T9	Student assessment should be based solely on giving correct answers.
C1	The role of the teacher is to encourage students to create mathematical knowledge through their own thinking efforts.
C2	The teacher should encourage students to ask questions in maths classes.
C3	The role of the teacher is to help students to research and discover mathematical ideas independently.
C4	Mathematics teaching should include a large number of different teaching aids, models and materials.
C5	The main role of the teacher is to be the organizer and associate of the students in the teaching process.
C6	The teacher should connect the contents of teaching mathematics with the contents of other subjects.
C7	The teacher should involve the whole class in the discussion.

The Statistical analyses were conducted using the Statistical package for the Social Sciences (SPSS 23.0), and Monte Carlo PCA for Parallel Analysis. In order to explore underlying factor structure of the scale Principal Component Analysis (PCA) was performed. To detect the number of factors Kaiser's criterion, Scree test (Catell 1966) and parallel analysis (Horn 1965) were used. Oblimin rotation was performed after extracting the factors. The reliability and internal consistency for TCB scale and subscales TB and CB were assessed using Cronbach's alpha coefficient. The Cronbach alpha indicated good and acceptable reliability for both, TCB in general (α=0.763) and TB and CB subscales (Table 3).

Table 3. Cronbach's α and average inter-item correlation coefficients

	Scale	Cronbach's α	Average inter-item correlation
1	TB	0.832	0.358
2	CB	0.722	0.277

Dimensionality of the scale was explored using the PCA with direct oblimin rotation. Prior to performing PCA, factorability was assessed by inspection of correlation matrix and Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity (BTS) tests as a measure of sampling adequacy. Inspection of the correlation matrix revealed the presence of many coefficients above of 0.3. The KMO value was 0.784, exceeding the recommended value of 0.60 and BTS was statistically significant ($p<0.001$), supporting the factorability of the correlation matrix. PCA revealed the presence of four components with eigenvalues exceeding 1, explaining 24.6%, 17.4%, 7.2% and 6.6% of the variance. In order to determine the number of factors to retain we used Kaiser's criterion, Scree test (Catell 1966), parallel analysis (Horn 1965) and factor interpretation. Using the Catell's scree test and the results of Parallel Analysis, we decided to retain two factors for further research. The two-factor solution explained a total of 42.1% of the variance (Factor 1 contributing 24.6%, Factor 2 contributing 17.4%). In order to aid the interpretation of these two factors, direct oblimin rotation was performed. The rotated solution revealed the presence of a simple structure with both factors showing strong loadings (>0.3) and all variables loading substantially on only one component. There was a weak negative correlation between the two factors ($r=-0.037$). The obtained results of this analysis support the use of two separate TB and CB subcales which is in line with some previous research (Perry, Howard & Tracey 1999).

Table 4. Pattern and structure matrix for PCA with oblimin rotation of two-factor solution TCB items

Item	Pattern coefficients		Structure coefficients		Communalities
	Factor 1	Factor 2	Factor 1	Factor 2	
T3	**0.769**	0.088	**0.765**	0.059	0.593
T2	**0.726**	-0.331	**0.738**	-0.358	0.654
T6	**0.669**	0.052	**0.667**	0.027	0.448
T1	**0.654**	0.141	**0.649**	0.117	0.441
T5	**0.634**	0.042	**0.633**	0.019	0.402
T9	**0.622**	-0.062	**0.624**	-0.085	0.393
T4	**0.615**	-0.118	**0.619**	-0.141	0.398
T7	**0.603**	-0.137	**0.608**	-0.159	0.388
T8	**0.541**	0.167	**0.535**	0.146	0.314
C6	-0.001	**0.719**	-0.028	**0.719**	0.517
C2	-0.088	**0.689**	-0.114	**0.692**	0.487
C1	-0.057	**0.609**	-0.079	**0.611**	0.377
C7	-0.088	**0.593**	-0.110	**0.597**	0.364
C4	0.164	**0.578**	-0.027	**0.573**	0.354
C3	-0.006	**0.572**	0.143	**0.572**	0.328
C5	0.070	**0.519**	0.050	**0.517**	0.272

Results and Discussions

With the first research task, we wanted to determine the attitudes of teachers towards the traditional (T) and constructivist (C) concept of teaching and learning mathematics. Table 5 shows the arithmetic means and standard deviations for each of the estimated items in the instrument.

Table 5. Descriptive statistics of TCB items

Item	M	SD
T1	2.83	1.65
T2	2.31	1.39
T3	3.10	1.43
T4	2.58	1.39
T5	3.28	1.46
T6	3.71	1.68
T7	2.41	1.46
T8	3.13	1.52
T9	3.17	1.52
C1	5.56	0.61
C2	5,67	0.57
C3	5.49	0.75
C4	5.25	0.82
C5	5.38	0.84
C6	5.44	0.97
C7	5.50	0.73

The possible range of results on the TB scale is from 9 to 54, and on the CT scale is from 7 to 42. The range of scores obtained on the first scale ranges from 10 to 54, with an arithmetic mean of 26.86 (SD=8.92), and on the second from 28 to 42, with an arithmetic mean of 38.22 (SD=3.31). The arithmetic mean for TB items is 3.00 (SD=1.57) and for CB items is 5.46 (SD=0.78). Based on the obtained results, we can conclude that the surveyed teachers express a more positive attitude towards C beliefs, which is in line with the results of the presented studies (Purnomo 2017). Such research results are expected, given that the outcomes of university education and professional development of teachers include their ability to develop students' cognitive abilities, creativity, initiative and cooperation, all with the aim of their readiness to transfer acquired, applicable knowledge in new learning situations. These conclusions are confirmed by the results presented in Table 6, which indicate a higher degree of agreement with the group of items that identify the C concept (Md=6.00) compared to the T concept of teaching and learning (Md=3.00). The characteristic of this data is that three-quarters of the respondents evaluate C items with an estimate of 5.00 and 6.00.

Table 6. TB and CB subscales quartile distribution

	Percentiles		
Scale	25^{th}	50^{th}	75^{th}
TB	2.00	3.00	4.00
CB	5.00	6.00	6.00

Nevertheless, we cannot say that teachers' attitudes towards T and C beliefs are mutually exclusive. When it comes to T beliefs, teachers express a negative attitude towards T1, T2, T4, T7, but they express a positive attitude towards items T3, T5, T6, T8 and T9. Items T6 and T5 have the highest values. Teachers express a positive attitude towards the claim that the dominant role of teachers in teaching mathematics is that their presentations and explanations are a source of knowledge, as well as when it comes to the claim that students learn mathematics by repeating algorithms and solving similar tasks. As much as it seemed that such attitudes of teachers imply that they advocate the T concept of teaching, we must accept the fact that the definitions of these items can be interpreted in different ways and in different contexts. While researchers interpret item T5 in the context of actualizing repetition as the basis of learning, without reflection, understanding and logical connection, teachers as practitioners most often view repetition in unity with reflection, understanding and logical connection. When it comes to item T6, it can also be interpreted in different contexts, from the fact that teachers' explanations are inevitable and must be useful to students in mastering the teaching content, to the assumption that teachers' presentations and explanations imply verbalization of teaching and giving knowledge in the finished form. In this case, too, there are different contexts in which it is possible to see this claim and which represent two extremes. Therefore, it is necessary to interpret teachers' attitudes about the given items carefully, with a certain amount of restraint, bearing in mind their different understanding. Other items according to which teachers express positive attitudes are T9, T8 and T3. It is interesting to consider the item T9. It is clear that in addition to the correct answers, teachers also evaluate the student's activity in class and the above-mentioned abilities, but the correct answer implies assessment as an incentive, so that this item can be seen as part of the C concept.

When it comes to C beliefs about teaching and learning mathematics, teachers express positive attitudes on all items. This confirms the correctness of our previous interpretations, in relation to items related to traditional teaching. Items C2, C1 and C7 have the highest values. Such attitudes of teachers confirm that they understand and act in accordance with the requirements of the C concept of modern teaching. In such teaching, teachers promote thinking activities and encourage students to discover and conclude independently, with the use of different teaching aids, models and materials. This means that teachers are organizers and collaborators of students in the teaching process, they encourage students to think, ask questions, come to solutions in joint discussions. At the same time, they emphasize the importance of the living word of the teacher, who explains the teaching contents to the students, guides them to possible directions of action and evaluates their achievements. Also, they recognize the repetition of teaching contents as a determinant of the quality of learning.

With the second research task, we wanted to investigate if there are statistically significant differences in teachers' attitudes in regard to the degree of education.

Table 7. Results of Mann-Whitney test

Subscale	Degree of education	Mean Rank	Sum of Ranks	Mann-Whitney test		
				U	Z	Sig.
TB	college	79.61	3821.50	2154.500	-1.006	0.314
	B.A.	72.05	7204.50			
CB	college	77.67	3806.00	2581.000	-0.248	0.804
	B.A.	79.60	8597.00			

The results of the Mann-Whitney test indicate that there is no statistically significant difference in regard to the teachers' educational degree. When it comes to individual items, it was found that there is a statistically significant difference in item T9. Teachers with college degree express a more positive attitude towards the belief that student assessment should be based exclusively on giving correct answers comparing to teachers with B.A. degree ($U=2252.000$, $Z=-2.141$, $p=0.032$). In relation to our previous findings, we can assume that B.A. teachers define grading as a broader category than evaluating correct answers.

With the third research task, we wanted to examine if there are statistically significant differences in teachers' attitudes in regard to the years of work experience.

Table 8. Results of Kruskal-Wallis test

Scale	Years of work experience	Mean Rank	χ^2	df	Sig.
TB	0 – 12	62.93	4.952	2	0.084
	13 – 24	77.22			
	25 –	81.36			
CB	0 – 12	73.19	1.594	2	0.320
	13 – 24	78.09			
	25 –	84.10			

Using the Kruskal-Wallis test, we found that there is no statistically significant difference between teachers' attitudes in regard to the years of work experience. When it comes to individual items, we found that there is a statistically significant difference regarding the item T1 (c(χ^2=7.161, df=2, p=0.028). To determine between which pairs there are statistically significant differences, we used a post-hoc test (Dunn test with Bonferroni correction). The results showed that there is a statistically significant difference in the beliefs of teachers who work 12 years and less and teachers who work 25 years and longer (p=0.038). Thus, teachers who have been working for 25 years and longer express more positive attitudes in relation to the claim that right answers and solutions are much more important than the way in which students get them. This raises the question of the causes of such attitudes of teachers with more work experience. Whether the reason is again in the different interpretations of this item, remains an open question for further research. The fact is that the actions that students apply in solving tasks encourage the development of their thinking potentials, but they do not have to lead to a solution in every situation.

Although in the scientific literature, teachers' attitudes about teaching and learning mathematics can be classified in different ways and categories, in teaching practice it is difficult to say that teachers have only one specific point of view (Yang & Leung 2015). Instead, previous studies have shown that teachers tend to have different views, sometimes contradictory at the same time (Purnomo 2017). Also, this research of ours confirmed the statement that teachers have different points of view, or that they interpret certain items in different ways.

Conclusion

Examination of teachers' beliefs is an important starting step not only for determining the current situation in practice, but also for planning and introducing innovations and changes in the teacher education programs, as well as in teachers' in-service training programs. The results of our research suggest that the teachers surveyed express a more positive attitude towards constructivist beliefs. However, although it has been confirmed that they understand and act in accordance with the requirements of the constructivist concept of modern teaching, at the same time they determine certain elements of traditional teaching as acceptable and desirable. When it comes to their attitudes, we found that there is not statistically significant difference in regard to the education and work experience of teachers in general, but there is significant difference when it comes to individual items. The presented research results have enabled us to concretize the conclusions of this paper, which can be a good starting point for improving pedagogical practice and determining new research issues. We believe that it would be important, by applying a qualitative methodology, to examine how teachers understand and determine the items in relation to which they expressed their views in this research. Based on these results, we could check the reliability of their views, presented in this paper. By complementary consideration of the elements of the traditional and constructivist concept of teaching and learning mathematics, we could concretize clear differences and possible coincidences in their definitions. Also, it would be important to examine the level of harmonization between teachers' attitudes, beliefs and their teaching practice.

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