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Attitudes of the Fourth-Grade Primary School Pupils on Learning at Geometry Classes[2]

Extended summary

This paper presents the continuation of the research on the Realistic mathematics education teaching approach (RME) (Đokić, 2014) as the second cycle in a successive model of the mixed-method approach (Teddlie et al., 2009; in: Matović, 2015, 14). In the first cycle, in the quasi-experimental research with parallel groups, the pupils in the experimental group were taught by using the realistic teaching approach, while the pupils in the control group were taught by using the traditional teaching approach.

Primary school teachers play the key role in constructing the knowledge using the RME approach (Cobb et al., 2008; Van den Heuvel-Panhuizen, 2000; Visnovska et al., 2018) and the same holds good for textbooks (Arsaythamby et al., 2014; Laurens et al., 2018; Van den Heuvel-Panhuizen, 2000). Primary school teachers' role as intermediaries and didactical materials are essential for the implementation of the curricula. Teachers using RME focus on the organisation of teaching activities and on the classroom discourse. The priority in the development of the interpretative framework of the RME theory is to put mathematics learning in the social context of the classroom as the learning process is enfolding (Cobb et al., 1996; према: Cobb et al., 2008, 106).

As the effects of the RME approach have been confirmed (Đokić, 2014), this paper *aims to* determine whether the socio-constructivist context within the framework of the RME theory, in which a teacher and a textbook play the key role in the construction of knowledge, can

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have an effect on pupils' attitudes towards learning in geometry classes. The stated aim of the research was operationalised through these *research objectives*: 1) If a social-constructivist context, created in line with the RME theory, influences pupils' attitudes towards learning at geometry classes, identify the most important factors that cause the changes in the affective dimension of learning; and 2) Determine whether the affective-motivational variable can be considered an important predictor of pupils' achievement in mathematics. Using an open-ended questionnaire, we examined the views of one hundred forty-nine pupils of the fourth grade of a primary school in Belgrade on learning at geometry classes. The sample of pupils was deliberate. The experimental group consisted of 73 (48,99%) pupils and the control group consisted of 76 (51,01%) pupils. There were 86 (57,71%) boys and 63 (42,29%) girls. We cooperated with six primary school teachers (three teachers working with both groups respectively). The responses were inductively classified into categories. The so-called open coding was used (Bryman, 2012; Creswell, 2014; Mayring, 2015) regarding positive and negative statements. The procedures of the qualitative content analysis were used for coding (Bryman, 2012; Creswell, 2014; Matović, 2015; Mayring, 2015; Ševkušić, 2011). We processed the data by using the chi-square technique and then we presented the data descriptively.

Based on the first question in the questionnaire (and the selected first category), 5 codes were obtained: 1.1. the way in which learning occurs, 1.2. teacher explanations and guidance, 1.3. classroom climate, 1.4. pupils and their attitudes towards learning and 1.5. learning tasks. Six categories were formed for the rest of the questions (questions 2-6): 2. homework, 3. more difficult and interesting tasks, 4. pupils' motivation to discuss the tasks in class, 5. learning in class with the help of didactical tools, 6. knowledge implementation tasks and 7. pupils' interest in learning from textbooks, for which we did not obtain specific codes given that pupils' replies were varied.

The distributions of frequencies of the two groups for individual categories/codes differ to a great extent. We also checked the statistical significance of the obtained differences for the two teaching approaches.

1.1 There is a statistically significant difference in the distribution of frequencies of the two groups for the first category *learning in class* and for the first code *the way in which learning occurs,* both for pupils' positive statements ($\chi2=5,355$; df=1; p=0,021) and for the negative ones ($\chi2=8,250$; df=1; p=0,004). The pupils in both groups very often gave statements for this code, which indicates that the code plays a significant role in pupils' experience. However, there were more positive statements in the experimental group, while the negative statements prevailed in the control group. The obtained differences indicate that learning in the real teaching approach is more conducive to learning than the traditional way, which, in our opinion, is an important dimension of learning.

1.2 There is a statistically significant difference for the second code *teacher explanations and guidance* for pupils' positive statements ($\chi2=12,654$; df=1; p=0,000), but not for the negative ones ($\chi2=3,148$; df=1; p=0,076). This result may be explained by the fact that teachers' role is more direct and stressed in the traditional approach, while a greater participation of pupils in the learning process is more emphasised in the realistic approach. However, some pupils expressed negative opinions about teachers' explanations and guidance in the

traditional approach. None of the negative opinions were expressed with regard to the realistic approach.

1.3 There is a statistically significant difference for the third code *classroom climate* for pupils' positive statements ($\chi2=9,253$; df=1; p=0,002), but not for the negative ones ($\chi2=0,467$; df=1; p=0,494). There were more positive statements regarding classroom climate in the experimental group, which was not the case in the control group. This result indicates that pupils perceive real teaching approach as pleasant for learning, which is an important dimension of learning. None of the pupils who learnt in the realistic approach expressed a negative opinion about the classroom climate, whereas some pupils who learnt using traditional approach did express negative opinions about it.

1.4 There is a statistically significant difference in the distribution of frequencies of the two groups for the fourth code *pupils and their attitudes towards learning* for pupils' positive statements ($\chi2=6,795$; df=1; p=0,009), though negative attitudes were not expressed in either of the two groups. There were more positive statements regarding pupils' attitudes towards learning in the experimental group, which has important methodological implications. The pupils who learnt in the realistic approach expressed a greater commitment for learning than the pupils who learnt in the traditional approach.

1.5 There is no statistically significant difference for the fifth code *learning tasks,* both in terms of pupils' positive ($\chi2=0,068$; df=1; p=0,794) and negative statements ($\chi2=0,001$; df=1; p=0,972). Pupils in both groups provided statements regarding learning tasks very rarely. This result was surprising as far as the experimental group was concerned, given that mathematical tasks are the core of the innovative teaching approaches.

2. There is no statistically significant difference for the second category *homework*, either for the pupils' positive ($\chi2=0,334$; df=1; p=0,564), nor for the negative statements ($\chi2=0,836$; df=1; p=0,360). Such result is altogether not surprising, given that learning tasks were similarly evaluated.

3. There is a different distribution of the frequencies for the third category *more difficult and interesting tasks* for positive and negative statements, and there is no statistically significant difference for the positive statements ($\chi2=3,242$; df=1; p=0,072), while there is such difference for the negative statements ($\chi2=10,754$; df=1; p=0,001). The pupils in both groups responded quite frequently, especially the pupils in the experimental group. This implies a positive attitude towards learning by solving more difficult and interesting tasks, and their motivation to learn when the realistic teaching approach is used. The pupils exposed to the traditional approach gave negative responses more frequently. The pupils who are taught geometry using the traditional approach are not very willing to do more interesting and difficult tasks, which certainly may have methodological implications for teaching geometry.

4. There is no statistically significant difference in the two groups for the fourth category *pupils' motivation to discuss the tasks in class,* both in terms of pupils' positive ($\chi2=0,068$; df=1; p=0,794) and negative statements ($\chi2=0,331$; df=1; p=0,565). Pupils in both groups are motivated to discuss the tasks in geometry lessons.

5. There is no statistically significant difference in the two groups for the fifth category *learning in class with the help of didactical tools,* both in terms of pupils' positive ($\chi2=0,250$; df=1; p=0,617), and negative statements ($\chi2=0,747$; df=1; p=0,387). We have concluded that pupils, regardless of the approach used to teach them geometry, have almost the same opinion regarding the use of didactical tools in geometry lessons.
6. $\chi2$ test did not show statistically significant difference in the distribution of the frequencies in the two groups for the sixth category *knowledge implementation tasks* both in terms of pupils' positive ($\chi2=0,116$; df=1; p=0,733) and negative statements ($\chi2=1,481$; df=1; p=0,224). The tasks involving the implementation of knowledge were evaluated similarly in both groups.
7. There is a statistically significant difference in the two groups for the seventh category *pupils' interest in learning from textbooks* both in terms of pupils' positive ($\chi2=5,925$; df=1; p=0,015) and negative statements ($\chi2=37,548$; df=1; p=0,000). The pupils in both groups evaluated the textbook differently. The pupils in the experimental group provided more positive statements, while the pupils in the control group expressed mainly negative views. There is a big difference between the two groups regarding the negative statements. The innovative model of the textbook used in the realistic teaching approach of geometry is generally well-accepted by the pupils, whereas the pupils using a more traditional textbook expressed generally negative opinions about it.

Our research shows that pupils very frequently express positive attitudes about the ways of learning as a significant dimension of learning in the realistic teaching approach. They observe very clearly that learning implies understanding. In addition, they are more willing to take part in the geometry-related activities, which the research of García et al. (2016) confirms.

The research conducted by Towers et al. (2018) indicates the importance of examining contextual influences on pupils' emotional attitudes towards mathematics from the very start, in initial education, given that some pupils develop negative attitudes at this stage. According to the research of Op't Eynde et al. (2006), the affective-motivational variable is an important predictor of pupils' achievement in mathematics. Therefore, we may conclude that pupils' achievement when the realistic teaching approach is used and their attitudes towards the environment in geometry class, speak in favour of using the realistic innovative teaching approach. Such results can be of great value for the initiatives in the education policies in Serbia related to the school climate and its improvement resulting in a better quality of teaching and learning (Baucal et al., 2009; Tarr et al., 2008; Ševkušić, 2017).

There are no differences between the groups in the responses related to learning tasks, nor regarding their motivation to discuss the learning tasks. Cai cites the results of various research (Carpenter et al., 1998; Hiebert & Wearne, 1993; Wood & Sellers, 1997; in: Cai, 2003: 13) that confirm that pupils' achievement is greater only after they have finished a two-year innovative programme of the problem-oriented mathematics curriculum, while in our research the effects of the experimental programme were evident after only two weeks of implementation. The research of Hershkowitz (1998), and Hunter et al. (2016) demonstrates that the selection of mathematics tasks, apart from the time that pupils spend in an active participation in developing the classroom culture, is a very important aspect of innovative teaching approaches

that shape the teaching context and foster classroom culture. Schoenfeld (1989) claims that the structure of the discussion facilitated by the teacher in mathematics classes is also very important. In our opinion, the adaptation of the RME theory, presented by Cobb et al. (2008) after their consideration of numerous studies in which teachers are perceived as intermediaries in terms of the meaning of the unconventional symbols used by pupils in the process of mathematisation, when they turn the elements of the realistic context into mathematical objects and relations according to the cultural meaning of the unconventional symbols (Davydov & Radzikhovskii, 1985; Tharp & Gallimore, 1988; in: Cobb et al., 2008, 110). Unlike the social and cultural shaping of the educational design as a transfer of meaning of the mathematical symbols from one generation to another, the researchers of the RME theory suggest an educational design that supports the emergence of mathematical meaning in the classroom. Clearly, one of the main principles of the RME theory is symbolisation which is not limited to conventional mathematical symbols, but the role of a teacher as an intermediary is still considerable.

Our research indicates that, unlike the pupils who have used the realistic teaching approach, the pupils who have worked on mathematics tasks according to the traditional approach and the pertaining textbook show little enthusiasm for tackling the more complex tasks and have mostly negative opinions about the textbook. Pupils think that the innovated mathematics textbook, designed in line with the realistic approach, stimulates them to learn more, given that the concept of this textbook was aimed at motivating pupils and arousing their interest to learn mathematics by re-discovering. The previous research confirms this conclusion (Arsaythamby et al., 2014; Laurens et al., 2018).

We also raised some questions for further research of innovative teaching approaches over a longer period of time to examine the pupils' attitudes that gradually transform into their long-term *beliefs* and *evaluation of mathematics* (Goldin et al., 2016; Hannula, 2006; Leder, 2015; Törner, 2014).

Keywords: pupils' attitudes, dimensions of learning, geometry teaching, RME, realistic teaching approach.

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