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Извршни издавач:
Педагошко друштво Србије
Теразије 26, 11000 Београд
тел. 011 268 77 49
www.pedagog.rs
E-mail: casopis@pedagog.rs

Суиздавач:
Институт за педагогију и андрагогију Филозофског факултета Универзитета у Београду
Чика Љубина 18-20, 11000 Београд
тел. 011 3282 985

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STUDIES IN TEACHING AND EDUCATION • CONTENTS

ОБУЧЕНИЕ И ВОСПИТАНИЕ • СОДЕРЖАНИЕ

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Examining Pupils' Attitudes toward Mathematics as a Result of Cooperative Learning

Elvira Kovács[1]
Hungarian Language Teacher Training Faculty,
University of Novi Sad, Subotica, Serbia
Zsolt Námesztovszki
Hungarian Language Teacher Training Faculty,
University of Novi Sad, Subotica, Serbia
Lenke Major
Hungarian Language Teacher Training Faculty,
University of Novi Sad, Subotica, Serbia
Dragana Glušac
Technical Faculty "Mihajlo Pupin",
University of Novi Sad, Zrenjanin, Serbia

Abstract *Examining both the international literature and Serbian studies, it can be stated that mathematics is one of the most unpopular subjects among pupils. Instead, maths education should focus on developing mathematical thinking, modeling and problem solving, as these are indispensable. Innovation of the educational process is a continuous challenge for educators, as is the integration of various teaching strategies, groupwork forms and learning methods into their daily classes. Numerous international studies have confirmed the effectiveness of cooperative learning in education. The aim of this research is to examine whether pupils' attitudes towards mathematics change as a result of cooperative learning, and whether students' attitudes regarding cooperation improve. The results reveal that cooperative learning has a positive influence on pupils' cooperation skills and attitude towards mathematics.*

Keywords: *mathematics teaching methods, cooperative learning in mathematics, lower-achieving pupils, students' attitudes, primary school pupils.*

1 elvira.kovacs@magister.uns.ac.rs

Introduction

"All areas of everyday life rely on teamwork, communication, effective coordination, and division of tasks; therefore, it is high time for schools to be more sensitive and reflect the trends of 'adult' life." (Horváth, 1994, p. 17).

"Students' learning of and performance in mathematics is affected by a number of factors, including students' attitude towards the subject, teachers' instructional practices, and the school environment." (Mazana et al., 2019, p. 2).

Together with the rise of positive psychology, the importance of a positive attitude towards educational matters has gained more attention in recent years (e.g., Marsh & Craven, 2006; Seligman & Csikszentmihalyi, 2000). Research has suggested repeatedly that the attitude to mathematics is a critical construct related to learning (e.g., Singh et al., 2002). The extent to which students find mathematics enjoyable, place value on mathematics and believe that it is important for success in school and future aspirations, affects the students' motivation to learn (Ismail, 2009, Mettas et al., 2006; Middleton & Spanias, 1999).

Among the students' factors, attitude is regarded by many researchers as a key contributor to higher or lower performance in mathematics (Mata et al., 2012; Mohamed & Waheed, 2011; Ngussa & Mbuti, 2017). Attitude refers to a learned tendency of a person to respond positively or negatively towards an object, situation, concept or another person (Sarmah & Puri, 2014).

"Attitudes toward mathematics appear more polarised than for any other curriculum area. While many students enjoy mathematics, many others have negative. These negative attitudes are quite resistant to change." (Townsend & Wilton, 2003, p. 473). One possible step towards this change is the application of cooperative learning methods (Townsend & Wilton, 2003).

Pupils must be provided with knowledge and competences applicable in daily life, so that they can meet the expectations of society once they leave school. Thus, it is essential that they become adaptive, collaborative, creative, and problem-solving persons.

The superior international achievements of science, technology, engineering, mathematics (STEM) -focused nations reflect the mathematical literacy assessed in PISA 2012, with the focus on "meeting life needs ... through using and engaging with mathematics, making informed judgements, and understanding the usefulness of mathematics in relation to the demands of life" (Thompson et al., 2013, p. 11).

Mathematical literacy is essential to STEM education, where a facility in dealing with uncertainty and data is central to making evidence-based decisions involving ethical, economic, and environmental dimensions (Office of the Chief Scientist, 2013).

Cooperative Learning, sometimes called small group learning, is an instructional strategy in which small groups of pupils work together on a common task. The task can be as simple as solving a multistep math problem together, or as complex as developing a design for a new kind of school. In some cases, each group member is individually accountable for part of the task; in other cases, group members work together without formal role assignments. According to David Johnson and Roger Johnson (Johnson & Johnson, 1999), there are five basic elements that allow successful small¬group learning:

- Positive interdependence: Pupils feel responsible for their own and the group's effort.
- Face-to-face interaction: Pupils encourage and support one another; the environment encourages discussion and eye contact.
- Individual and group accountability: Each student is responsible for doing their part; the group is accountable for meeting its goal.
- Group behaviors: Group members gain direct instruction in the interpersonal, social, and collaborative skills needed to work with others.
- Group processing: Group members analyze their own and the group's ability to work together.

Cooperative learning changes pupils' and teachers' roles in classrooms. The ownership of teaching and learning is shared by groups of pupils, and is no longer the sole responsibility of the teacher. The authority of setting goals, assessing, and facilitating learning is shared by all. Pupils have more opportunities to actively participate in their learning, question and challenge each other, share and discuss their ideas, and internalize their learning (TeacherVision, 2016).

The practices used in traditional teaching are incapable of ensuring the sufficient acquisition of these abilities and skills. Serbian education rarely includes the concepts of cooperation, acceptance, communication, experiential learning, hence the need for innovation of educational activities. For decision-makers and education experts working on upgrading the methodology of teaching mathematics, this is a constant challenge.

The organization of the teaching process must be high quality and up to date, featuring many teaching methods to ensure greater activity by both pupils and teachers (Stanojević, 2009). It is usually difficult for teachers to adopt novel methods and change attitudes as they feel deeply attached to the ingrained, tried-and-tested practices of many years.

There are several reasons why cooperative learning works as well as it does. The idea that pupils learn more by doing something active than by simply watching and listening has long been known to educational and developmental psychologists and effective teachers (McKeachie, 2002; National Research Council, 2000), and cooperative learning is by its nature an active method (Felder & Brent 2007).

In the initial phases of teaching mathematics, it is necessary to apply learning strategies that promote cooperation, empathy, critical thinking and problem solving in pupils. Taking all these factors into account, the authors have focused their attention on examining the effectiveness of cooperative learning in math classes.

The aim of this research is to examine whether pupils' attitudes towards mathematics change as a result of cooperative learning, and whether students' attitudes regarding cooperation improve.

When people are asked to describe their feelings about their own mathematics ability, they often respond with such negative statements as, "I was never any good at maths... I just couldn't get the hang of it... I was too dumb even to ask a question when the teacher explained something." These kinds of statements are typical of those made by people who dislike maths and have a high level of mathematics anxiety. Mathematics anxiety is a fear of maths or an intense, negative emotional reaction to the subject (Bernero, 2000). Some researchers who have studied the problem contend that a majority of adults suffer from

mathematics anxiety to some degree, and it frequently starts in the elementary years (Kennedy & Tipps, 1994). Many people have given up on maths because they learned to fear it when they were young. This fear or loathing of maths "seems to make people unempowered to make decisions themselves. Instead, they'll defer to someone they think is smart," explains Marilyn Burns, founder of Maths Solutions Inservice and Publications (Rasmussen, 1999). Once adopted, these feelings of maths anxiety are hard to lose, even in adulthood (Rasmussen, 1999, p. 2).

Besides pupils who may be feeling maths anxiety, there are pupils that may find maths to be just plain boring, given customary paper-and-pencil repetitive maths problems. Adults who had negative feelings regarding maths report certain teacher practices and expectations that also contributed to their anxieties (Kennedy & Tipps, 1994). These include:

1. Lack of variety in teaching-learning processes;
2. Emphasis on memorization;
3. Emphasis on speed;
4. Emphasis on doing one's own work;
5. Authoritarian teaching.

Kennedy and Tipps (1994) also describe some shortcomings/failures common to typical maths instruction. Among other things, they maintain that in many elementary maths classes more than 70% of the time is spent in independent practice, mostly using the workbook and paper-and-pencil tasks. This means that children often receive insufficient instruction in the mathematical concepts and processes they practice. "Work on your own" has been a dictum in many elementary school classrooms. They also maintain that children have usually been told not to help others or ask others for help. In many instances teachers will accept only "one right way" of working problems. Such practices can lead pupils to believe that mathematics is inflexible, lacking creativity and fun (Kennedy & Tipps, 1994).

A focus on advancing STEM (science, technology, engineering, mathematics) in schools and the workforce is increasing across many nations, with its powerful role across multiple sectors being formally recognized (English, 2015).

There are more and more tasks, and the initial magic disappears. While some of the pupils continue to work with great diligence and ease, many are discouraged, finding no joy in the daily tasks (Józsa, 2000).

The challenge is to create such an atmosphere in the maths class where pupils can trust their peers and even if they do not know the right answer, they will not feel anxious. Pupils need to feel free to ask questions during class and be sure to have their questions answered. In an accepting learning atmosphere, pupils will also enjoy the learning process itself, not just when discovering the solutions to their tasks.

The advantage of cooperative learning is that the barriers within the group vanish, all group members need to participate in the work, so lower-achieving pupils are also more easily accepted.

It becomes possible to successfully implement the teaching and learning of mathematics, to realize the expected outcomes of the subject, increasing its effectiveness and efficiency.

The most important precondition for effective mathematics teaching is to increase pupils' motivation. Learning must be turned into a motivating activity because skills and abilities will only function optimally given the right motivation (Réthy, 2003). In his research, Béla Kozéki has stated that the success of the acquisition of the curriculum depends only 50% on intellectual factors, with the remaining part determined by the processes grouped around motivation (Kozéki, 1980). The level of anxiety always plays a key role in pupil performance, so the relationship to mathematics is a vital factor.

A a positive learning atmosphere, a fearless open relationship is essential for a good maths class, whereas increasing the pupils' positive attitude towards mathematics is crucial for achieving better results.

Pupils have a positive attitude towards cooperative learning, they believe this way of learning is more useful, interesting, and less frustrating - they feel more relaxed and supported (Buljubašić Kuzmanović, 2009).

In the public-school setting, many classrooms have pupils with a wide range of abilities, but all are working toward the same goal. Pupils learn and understand mathematical concepts in a variety of different ways. Teachers have the sometimes-difficult task of trying to identify which strategy works best for each individual student (Johnsen, 2009).

"Furthermore, it is necessary to develop those social skills that are important within the scientific community, as well as in the relationship between the scientific community and society. For example, today, cooperation and teamwork belong to the basic postulates of scientific work. In teaching, this is primarily realized through various forms of cooperative teaching/learning" (Antić, et al., 2015, p. 623).

Cooperative learning, as a teaching method, provides pupils with the opportunity to develop skills during group interactions and cooperation with peers, which are vital in today's world (Abu & Flowers, 1997). With its diverse and highly flexible strategies, cooperative learning ensures the application of different forms, modes and methods of learning (Ćatić & Sarvan, 2008).

"Cooperative teaching methods are based on the principle that pupils build their own knowledge by exchanging ideas through intensive communication with others. They actively build or construct their own notions of reality, and these constructions result in knowledge. Emphasizing the active nature of the learning process and the active role of pupils in this process is the essence of all models of cooperative learning. Unlike traditional teaching methods, where the content of what is learned is in the foreground, in these methods, the emphasis is on the pupils developing methods and techniques for dealing with problems and solving them. This way, initiative, pupils' independence in work, their decision-making ability, creativity and independent thinking are developed. The paper also presents one of the models of cooperative learning in more detail – the group research model - that is, it analyzes the activities of pupils during classes that take place according to this model" (Ševkušić - Mandić, 1998, p. 355).

Through cooperative learning, pupils do not learn in the classical sense of knowledge acquisition, but they learn through learning together (Stanojević, 2009). In cooperative learning, the pupils' existing competences are built on and improved by adapting to pupils' individual learning pace, which allows those learners with lower learning abilities to be more effective.

In cooperative learning, the team members divide the tasks among each other, with everyone equally responsible for completing the tasks, i.e., all members of the group need to work together, given that overall performance depends on their cooperation.

Group members also need to help and check each other's work. With this method, social competences such as communication, relationship management, patience, empathy can be developed effectively.

"We talk about real cooperative group work when the members of the group carry out the tasks by interacting with each other. Its main feature is the orderliness, content and expediency of the relations, which are indispensable during the cooperation. Pupils work together as part of the group work, which means joint responsibility for the results of the group, for their own work and that of their teammates. The cooperative form of learning, like other forms of active learning, not only allows for constructiveness in contrast to traditional learning methods, but also specifically stimulates this creative operation of the human brain" (Orbán, 2009, p. 35).

The role of the teacher also changes, the teacher is no longer at the center of the educational process, but is responsible for thorough, high-quality planning and ample preparation for the classes.

"The cooperative form of learning starts from the foundation of the fact that pupils possess significant previous knowledge and skills in the domain in which new knowledge is introduced. With such an assumption, learning is no longer a process of transmitting from the one who knows (teacher) to the one who does not know (student), but a good part of the real pedagogical interaction between teachers and pupils." (Ivić et al., 2003, p. 37).

The teacher's role is to inspire the pupils and create a motivating atmosphere. Pupils who develop a certain curiosity, who find the joy of solving a problem, will surely be more successful in mathematics. The basis of cooperative learning is that learning happens in a social environment, the classes are created so as to be playful and rich, full of experiences for the pupils. During such a learning process, there is space for communication, hence working together makes solving the tasks easier for pupils. Most children like these classes, they are more eager, more motivated, more productive in their learning. They learn to pay attention to each other and learn by teaching.

The selection of suitable maths content is the responsibility of the teacher, to ensure that the pupils acquire the given material successfully through collaboration. The teaching material used in cooperative learning should be compiled so that pupils can select and divide the tasks among the group members. The aim is for all pupils in the group to share the task and the group's work becomes the synthesis of all members' joint efforts. (Špijunović & Maričić, 2016).

Joint activities, social interaction, and related assessment methods are motivating for most disadvantaged pupils. Inhibited, withdrawn children participate more freely in collaborative work. In addition, the cooperative learning process is good at modelling processes occurring in real life, making such learning feel more lifelike for children as opposed to traditional learning methods (Kovács & Bagány, 2016; Kovács, 2020).

Pupils can gain individual and shared experiences of success. Educational work becomes more diverse and creative. Cooperative work increases pupils' interaction in the classroom, everyone in the group has their own task. Thus, it is not only the better and more capable pupils who do all the work, but all the pupils involved contribute to the group's

outcome, thus it is logical to expect better learning and educational outcomes when maths education takes place in such a favorable environment.

The research methodology

The study is based on a pedagogical experiment, the essence of which was cooperative learning, with the primary purpose of a quasi-experimental methodology design. The classes and pupils of the test group worked in a mathematics class at least thirty times in a full semester. The research was carried out with the involvement of 5 classes for the control group and 5 for the test group.

The study is comprised of the following elements:

1. Examine the changes in the marks of lower grade pupils participating in the mathematics educational program based on cooperative work during a controlled educational study.
2. In the second phase of the research, a questionnaire was used to assess pupils' attitudes towards mathematics before the introduction of cooperative learning.

Pupils in the test group worked in 30 mathematics lessons based on a pilot programme with detailed lesson plans using different cooperative strategy models (Rotation; Team Windows Structure; Picture Stealing; Brainstorming; Student Quartet; Pair Check; One Go, Three Stay; Talking Chips; Cooperative Discussion; Indian Talk). The teachers participating in the pilot worked according to carefully prepared instructions and followed the methodological guidelines. In contrast, the control group worked in a traditional way throughout. In addition, the control group and experimental groups were both taught by different teachers.

3. Investigate the effects of the study after its completion.

The study of the impact of cooperative learning included examining pupils' attitudes towards mathematics.

4. Conduct a second survey six months after the initial final survey to explore how long-lasting the acquired knowledge was.

This paper summarizes the change in pupils' attitudes observed in the second phase of the research. This study involved the implementation of a questionnaire for data collection among 4th grade pupils, aged 9-10. The questionnaire was an attitude test. The survey was completed by the pupils twice, first before the study and then after the implementation of the program. The reliability of the attitude scale: Cronbach's alpha is 0.82.

The items of the six-point Likert scale were:

1. I like maths. 2. I find maths difficult. 3. I find maths boring. 4. The maths tasks are difficult for me. 5. I don't understand what I need to do in the tasks. 6. I do my maths homework regularly. 7. I like the textual maths tasks. 8. I like doing my maths homework.

Multiple-choice questions:

9. I like doing maths: on my own / with my mates working in a group. 10. Do you collaborate with your friends during maths class? yes/no

A total of 243 pupils participated in the study and their ages were 9-10. The knowledge and change of attitude of 123 pupils in the test group and 120 pupils in the control group was examined.

Results

(1) Gender: the test group was made up of 45.5% boys and 55.5% girls. The percentage of boys in the control group was 48.3, with 51.7% girls, as presented in Table 1.

Table 1
Gender structure of the pupils in the sample

	test group		control group	
Gender	*N*	%	*N*	%
Boys	56	45.5	58	48.3
Girls	67	55.5	62	51.7
Total	123	100	120	100

(2) Grade average: both groups had the highest proportions of pupils with a grade average 'excellent'. The proportion of pupils with a grade average 'excellent' was 46.3% in the test group and 49.2% in the control group. Pupils with an average 'very good' and 'good' were present in both groups to an equal extent. Only three pupils in the control group had a grade average 'sufficient' (see detailed grades structure in Table 2).

Table 2
Grade average of pupils

	test group		control group	
Average	*N*	%	*N*	%
Sufficient	0	0.0	3	2.5
Good	18	14.6	11	9.2
Very good	48	39.0	47	39.2
Excellent	57	46.3	59	49.2
Total	123	100	120	100

(3) Maths grades: based on the results of the last semester prior to the study, the pupils in both groups had a maths grade average 'excellent' (31.7% and 40.8%) and 'very good' (32.5% and 37.5%). About a quarter of the pupils in the test group, 24.4%, and 15.0% in the control group had a grade average 'good', whereas 11.4% in the test group and 6.7% in the control group had a grade average 'sufficient', as summarized in Table 3.

Table 3
Pupils' grade average in maths in the previous semester

	test group		control group	
Grade	*N*	%	*N*	%
Sufficient (2)	14	11.4	8	6.7
Good (3)	30	24.4	18	15.0
Very good (4)	40	32.5	45	37.5
Excellent (5)	39	31.7	49	40.8
Total	123	100	120	100

The value of the mathematical attitude of the pupils in the test group before and after the experiment

Pupils' overall attitudes towards learning and, specifically, learning mathematics in the first part of primary education is crucial, as it will greatly determine pupils' progress in mathematics education and the results achieved. In investigating the effects of cooperative learning, the authors aimed to examine its effect on pupils' attitudes toward mathematics. The assumption was that cooperative learning would contribute to increasing pupils' positive attitudes toward mathematics.

The results obtained during the study were derived from the average score of the answers given to each question. The Likert scale is treated as an interval scale in order to take advantage of the possibilities offered by complex statistical procedures, and scores can be added up accordingly (Csapó, 2002). Pupils could answer the questions on a 5-point Likert scale. The value of 1 ("strongly disagree"), reflected the least positive, while the value of 5 ("strongly agree"), marked the most positive attitude towards mathematics. Among the responses, the pupils could also select the value of 0 given as an option, indicating that they could not answer the question. Accordingly, pupils could score a minimum of 1 and a maximum of 5 points for each item. A value 3 ("indifferent / neither agree nor disagree") indicated a neutral attitude. Values above this indicated a positive attitude, values below this referred to a negative attitude in the examined question. For the full scale, values ranged from 8 to 40, with a score of 24 considered neutral.

Based on the results obtained, the pupils did not achieve a neutral value of 3 only in the case of inversely formulated items, which, in fact, indicated the same positive attitude as the average score above 3 for the other questions. To sum up, pupils already had a positive attitude value in the first survey (as shown in Table 4), disagreeing with the statement that they found maths was difficult and tedious; their answers reflected that they believed they were able to comprehend the tasks, they knew what they needed to do to solve the maths problems. The analysis of attitudes following the end of the pilot program highlighted the fact that pupils had changed their attitudes to some extent, becoming even more positive compared to the initial survey.

Using a paired t-test, the authors tested the statistical significance of the deviation to determine the effects of cooperative learning on pupils' attitudes toward mathematics. Comparing the results of the first and second surveys revealed a significant difference in 5 statements as a result of cooperative learning.

For items 2, 3, 4 and 5, the values decreased significantly. For the statement: *I find maths difficult* the results were (first survey: $M = 2.57$; $SD = 1.3$) and (second survey: $M = 2.09$; $SD = 1.2$); ($t = 2.88$; $p = 0.005$). The results for the statement *I find maths boring* were: (first survey: $M = 2.37$; $SD = 1.6$) and (second survey: $M = 1.58$; $SD = 1.1$); ($t = 4.76$; $p = 0.001$). For *The maths tasks are difficult for me* the following values were obtained (first survey: $M = 2.61$; $SD = 1.3$) and (second survey: $M = 2.23$; $SD = 1.2$); ($t = 2.61$, $p = 0.01$). These are the items whose values decreased. However, since these were inverse items, the change actually indicated a significant increase in attitude value. Next, the results for the item *I like the textual maths tasks* were (first survey: $M = 3.55$; $SD = 1.3$) and (second survey: $M = 4.03$; $SD = 1.1$); ($t = -2.82$; $p = 0.006$). For the statement *I like doing my maths homework* the following

results were given by the pupils: (first survey: $M = 3.98$; $SD = 1.2$) and (second survey: $M = 4.31$; $SD = 0.9$); ($t = -2.08$; $p = 0.04$). For these listed items, a significant increase in values, i.e., a more positive attitude toward mathematics, could be traced, while for the other items, the change is not considered statistically relevant (see the summary in Table 4).

Table 4
The change in attitude towards mathematics before and after the experiment in the test group

Statements	first survey		second survey		neutral value	paired t-test	
	M	SD	M	SD		T	p
I like maths.	4.18	0.9	4.28	1.1	3	-0.59	0.5
I find maths difficult.	2.57	1.3	2.09	1.2		2.88	0.005
I find maths boring.	2.37	1.6	1.58	1.1		4.76	0.001
The maths tasks are difficult for me.	2.61	1.3	2.23	1.2		2.61	0.01
I don't understand what I need to do in the tasks.	1.97	1.1	1.93	1.1		0.26	0.7
I do my maths homework regularly.	4.61	0.7	4.58	0.8		0.43	0.6
I like the textual maths tasks.	3.55	1.3	4.03	1.1		-2.82	0.006
I like doing my maths homework.	3.98	1.2	4.31	0.9		-2.08	004
Overall scale	25.83	4.6	25.0	3.9	24	1.58	0.1

The correlations between attitude towards mathematics background variables

Each of the background variables showed some correlations with attitudes toward cooperative work. Correlations were detected between pupils' background variables and attitudes toward mathematics.

The variable "grade average" revealed a negative, moderate correlation with the statement *I don't understand what I need to do in the tasks* ($r = -0.35$; $p = 0.001$), while in the case of the statement *I do my maths homework regularly* ($r = 0.29$; $p = 0.001$), it indicated a weak, positive correlation. The maths grade variable for the statement *I don't understand what I need to do in the tasks* ($r = -0.31$; $p = 0.001$) showed a negative, moderately strong correlation, for the item *I do my maths homework regularly* ($r = 0.29$, $p = 0.001$), it was positive weak, whereas the statement *I like doing my maths homework* ($r = -0.2$; $p = 0.02$) indicated a negative weak correlation (see Table 5).

Table 5
The correlations between attitude towards mathematics background variables

Statements	Grade average	Maths grade average
I like maths.	$r = 0.05$ $p = 0.51$	$r = 0.06$ $p = 0.49$
I find maths difficult.	$r = -0.09$ $p = 0.31$	$r = -0.13$ p= 0.13
I find maths boring.	$r = -0.03$ p = 0.68	r=-0.05 p = 0.5

The maths tasks are difficult for me.	$r = -0.1$ $p = 0.2$	$r = -0.09$ $p = 0.2$
I don't understand what I need to do in the tasks.	$r = 0.35$ p 0.001	$r = -0.31$ $= 0.001$
I do my maths homework regularly.	$r = 0.29$ p=0.001	r =0.29 $p = 0.001$
I like the textual maths tasks.	$r = 0.1$ $p = 0.2$	$r = 0.06$ $p = 0.4$
I like doing my maths homework.	r =-0.07 $p = 0.3$	$r = -0.2$ $p = 0.02$

The one-way ANOVA test showed a statistically significant difference in the attitudes of pupils with different grade averages for the statement *I find maths difficult*, while the post hoc test showed no deviation from this statement. Pupils with the grade average 'good' scored the lowest on maths ($M = 1.81$; $SD = 1.2$); while pupils with the grade average 'excellent' achieved the highest value ($M = 2.39$; $SD = 1.2$); whereas the values for pupils with the grade average 'good' were ($M = 1.88$; $SD = 1.0$); ($F = 3.37$, $p = 0.03$), as summarized in Table 6.

When analyzing the statement *I find maths difficult*, it can be seen that pupils with the grade average 'very good' achieved the lowest scores compared to other pupils. The pupils with the grade average 'good' provided significant results, namely following the pilot program, the lower achiever pupils showed a more positive attitude than their more successful peers due to classroom collaboration.

Table 6

Correlation between pupils' background variables with mathematical attitudes based on grade average

	Good		very good		Excellent		one-way ANOVA	
Statements	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*
I like maths.	4.53	1.1	4.28	1.1	4.21	1.1	0.53	0.5
I find maths difficult.	1.88	1.0	1.81	1.2	2.39	1.2	3.37	0.03
I find maths boring.	1.29	0.6	1.47	1.2	1.75	1.2	1.33	0.2
The maths tasks are difficult for me.	2.35	1.4	2.04	1.3	2.34	1.2	0.79	0.4
I don't understand what I need to do in the tasks.	2.12	1.2	1.83	1.2	1.95	1.1	0.40	0.6
I do my maths homework regularly.	4.71	0.6	4.49	0.9	4.61	0.7	0.51	0.5
I like the textual maths tasks.	4.00	1.2	3.91	1.1	4.13	1.1	0.43	0.6
I like doing my maths homework.	4.29	0.9	4.30	1.0	4.32	0.9	0.01	0.9
TOTAL	3.26	0.5	3.3	0.5	3.15	0.5	0.82	0.4

After the completion of the research program conducted using cooperative learning, it can be stated that there was no statistically significant difference in the pupils' attitudes in terms of their maths grades versus their attitude towards mathematics. (Table 7)

Table 7
Correlation between pupils' background variables with mathematical attitudes based on maths grade average

	sufficient (2)		good (3)		very good (4)		excellent (5)		one-way ANOVA	
Statements	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	F	p
I like maths.	4.64	0.8	4.10	1.3	4.26	1.1	4.32	0.9	0.78	0.5
I find maths difficult.	1.93	0.9	1.83	1.3	2.13	1.1	2.32	1.3	0.98	0.4
I find maths boring.	1.00	0.1	1.59	1.3	1.59	1.1	1.76	1.3	1.49	0.2
The maths tasks are difficult for me.	2.43	1.5	2.21	1.2	2.10	1.1	2.29	1.3	0.26	0.8
I don't understand what I need to do in the tasks.	2.36	1.5	1.90	1.2	1.87	1.1	1.84	1.0	0.75	0.5
I do my maths homework regularly.	4.50	1.1	4.66	0.7	4.59	0.8	4.53	0.7	0.17	0.9
I like the textual maths tasks.	3.93	1.6	3.93	1.1	4.03	0.9	4.13	1.1	0.20	0.8
I like doing my maths homework.	4.64	0.7	4.03	1.1	4.33	0.8	4.37	0.9	1.42	0.2
TOTAL	3.2	0.5	3.47	0.6	3.13	0.4	3.14	0.6	2.47	0.06

Another point of interest in the course of the research was whether cooperative learning would influence pupils' attitudes towards learning mathematics in teams and through collaborative work. The results demonstrated that for both these points there was a significant (approximately 100%) change of opinion in pupils' perceptions of the use of cooperative learning.

When pupils were asked in what learning format they would prefer to learn mathematics, in the first survey, 70% of the respondents claimed they preferred to work in groups, while 30% said they would rather work on their own. In the second survey, following the research program, a total of 99% of the participating pupils stated that they would prefer to work in a group. Based on the result of the paired t-test ($t = -6.73$; $p = 0.001$), this change can be considered significant (Table 8).

Table 8
Attitudes towards the use of the cooperative work form before and after the pilot program in the test group 1

replies	first survey				second survey				paired t-test	
	on my own		with my mates working in a group		on my own		with my mates working in a group		*t*	*p*
	N	%	*N*	%	*N*	%	*N*	%		
I like doing maths:	37	30	87	70	1	1	122	99	-6.73	0.001

At the time of the first survey, 87% of the pupils responded that they collaborated with their peers while learning maths. By the second survey, this rate increased to 98%. The change is also statistically significant based on the values of the paired t-test (3.96; $p = 0.001$) see (Table 9).

Table 9
Attitudes towards the use of the cooperative work form before and after the pilot program in the test group 2.

Replies	first survey				second survey				paired t-test	
	Yes		no		yes		No		*t*	*p*
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*		
Do you collaborate with your friends during maths class?	107	87	16	13	121	98	2	2	3.96	0.001

As part of the study, the authors also investigated whether pupils' opinion had changed depending on their maths grade and overall learning outcome. They found that the "maths grade" background variable did not statistically significantly affect the pupils' opinions when asked if they would prefer to work individually or in groups.

However, there were statistically significant differences in the pupils' opinions when observing attitudes about collaborating in maths classes ($F = 5.69$; $p = 0.001$). Pupils with a maths grade 'sufficient' (2) held a significantly more positive view ($F = 5.69$; $p = 0.001$) than those with a maths grade 'good' (3), 'very good' (4), or 'excellent' (5). Thus, pupils with a grade 'sufficient' (2) achieved the highest attitude value ($M = 1.14$; $SD = 0.3$); while pupils with a grade 'good' (3), 'very good' (4), and 'excellent' (5) achieved the same attitude value ($M = 1.00$; $SD = 0.1$); ($F = 5.69$; $p = 0.001$). These results are presented in Table 10.

Table 10
Pupils' attitudes towards mathematics after cooperative learning, depending on their maths grade

	sufficient (2)		good (3)		very good (4)		excellent (5)		one-way ANOVA	
Statements	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*
I like doing maths.	2.00	0.1	1.97	0.1	2.00	0.1	2.00	0.1	1.04	0.3
Do you collaborate with your friends during maths class?	1.14	0.3	1.00	0.1	1.00	0.1	1.00	0.1	5.69	0.001

The presented results indicate that pupils displayed a need to work together; especially pupils with lower grades in maths were particularly fond of working together, they felt good when working on solving tasks as part of a group, and maths in this form became much more enjoyable for them. Simply put, they liked these types of maths classes better. When it comes to the control group, there were no significant changes in attitudes.

The obtained results and conducted analysis led to the conclusion that cooperative learning in the first cycle of education can significantly influence pupils' attitudes towards mathematics. These research outcomes are significant and highlight the importance and implications of cooperative learning in the teaching of mathematics.

Several other researchers (Capar & Tarim, 2015; Debrenti, 2015; Dizdarević, 2012; Hossain & Tarmizi, 2013; Kovács, 2020) came to similar results, since in their respective studies, they also observed changes in pupils' opinions as a result of cooperative learning.

In their 2013 research, Hossain and Tarmizi demonstrated that pupils' performance increased significantly as a result of cooperative learning, and pupils' perception of mathematics also showed a marked improvement (Hossain & Tarmizi, 2013). In 2015, Capar and Tarim collected a number of studies on cooperative learning and presented their results.

Those works revealed that cooperative learning was more effective than other methods used in traditional education, and this claim was based on examining pupils' performance and attitudes (Capar & Tarim, 2015).

Based on the present research results, lower-achieving pupils showed a significantly better attitude than their more successful peers, thanks to cooperative work. They loved working together, were braver in asking their peers questions thanks to this way of teaching and had more support in figuring out the solution to a given task.

The results of a number of studies have shown that more than half of the pupils considered negative attitudes towards education to be their greatest obstacle to achieving better educational outcomes (Clasen & Clasen, 1995). According to Wentzel and Watkins, pupils who believed in the help and support of their peers were more likely to participate more actively in the event, try to portray prosocial behavior, and achieve better school results (Wentzel & Watkins, 2002).

The study by Dizdarević also emphasized changes in pupils' attitudes as a result of cooperative learning. His work demonstrated that pupils became better at assessing affective relationships, increasing their initiative and adaptability in roles. Moreover, their positive feelings and opinions about themselves also improved (Dizdarević, 2012). As for pupils with lower grades in maths, collaboration was especially important for them since they found it much easier to solve tasks with the help of their peers.

This view has already been confirmed by other educational researchers (Buljubašić Kuzmanović, 2009; Debrenti, 2015; Kovács et al., 2020; Spasenović, 2004).

Spasenović's opinion also reflectes the view that cooperative learning stimulates collaboration and assistance between pupils. Cooperative learning as an educational method encourages cooperation and help, it is especially suitable for developing prosocial behavior and the mechanisms underlying prosocial orientation (ability to imagine oneself in others' position, recognizing the impact of one's own behavior on others, self-esteem, etc.) (Spasenović, 2004).

Buljubašić Kuzmanović also studied pupils' views on cooperative learning. Pupils highlighted the importance of human relationships in this learning method, the willingness to help and cooperate, the joy of conversation, and the acceptance of peers as well as awareness of the contribution to their own learning process (Buljubašić Kuzmanović, 2009). Another item of examination was whether cooperative learning positively influenced relationships and processes within a group. Pupils stated that cooperative learning contributed to them feeling less inhibited during class, overcoming their fear of negative evaluation, and failing at school. The research results of Kovács et al. showed that cooperative learning had a positive effect on group collaboration, activity, development of communication skills, and pupils' individual performance in mathematics (Kovács et al. 2020).

It must be mentioned that even during cooperative learning implemented in maths education, other teaching methods and learning forms should also be used alternately. In the course of this study, the authors found that there was maths content, teaching units where cooperative learning was best suited, whereas other material called for different methods of teaching. This is also supported by Debrenti (2015) in the summary study of cooperative learning.

Based on the results presented in this work, the authors have concluded that using cooperative learning is beneficial and should be implemented as much as possible in mathematics classes, so that learning maths would become a pleasant experience.

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Утицај кооперативног учења на ставове ученика о математици

Елвира Ковач
Учитељски факултет на мађарском наставном језику у Суботици,
Универзитет у Новом Саду, Суботица, Србија

Жолт Наместовски
Учитељски факултет на мађарском наставном језику у Суботици,
Универзитет у Новом Саду, Суботица, Србија

Ленке Мајор
Учитељски факултет на мађарском наставном језику у Суботици,
Универзитет у Новом Саду, Суботица, Србија

Драгана Глушац
Технички факултет „Михајло Пупин",
Универзитет у Новом Саду, Зрењанин, Србија

Апстракт Истражујући међународну и домаћу литературу, можемо закључити да је математика један од најнепопуларнијих школских предмета међу ученицима. Математичко образовање треба да буде усмерено на развијање математичког мишљења, моделовања и решавања проблема узимајући у обзир њихову неопходност. Иновација наставног процеса је стални изазов за наставнике, као и интеграција различитих наставних стратегија, начина организације групног облика рада и наставних метода у свакодневну праксу. Бројне међународне студије потврдиле су ефективност кооперативног учења у образовању. Циљ овог рада је да се испита да ли се ставови ученика о математици мењају под утицајем кооперативног учења, као и да ли су њихови ставови према кооперацији афирмативнији. Резултати указују на то да кооперативно учење позитивно утиче на оспособљеност ученика за сарадњу као и на њихове ставове према математици.

Кључне речи: методе у настави математике, кооперативно учење у настави математике, ученици са слабијим постигнућем, ставови ученика, ученици основних школа.

Влияние кооперативного обучения на отношение учащихся к математике

Эльвира Ковач
Факультет подготовки преподавателей венгерского языка,
Ново-Садский
университет, Суботица, Сербия

Жолт Наместовски
Факультет подготовки преподавателей венгерского языка,
Ново-Садский
университет, Суботица, Сербия

Ленке Майор
Факультет подготовки преподавателей венгерского языка,
Ново-Садский
университет, Суботица, Сербия

Драгана Глушац
Технический факультет «Михайло Пупин»,
Ново-Садский университет, Зренянин, Сербия

Резюме *Исследуя зарубежную и отечественную литературу, можно сделать вывод, что математика является одним из самых непопулярных школьных предметов среди школьников. Математическое образование должно быть направлено на развитие математического мышления, моделирования и решения задач с учетом их необходимости. Инновация учебного процесса является постоянным вызовом для учителей, также как интеграция различных стратегий обучения, способов организации групповой работы и методов обучения в повседневную практику. Многочисленные международные исследования подтвердили эффективность кооперативного обучения в образовании. Целью данной работы является изучение того, меняется ли отношение учащихся к математике под влиянием кооперативного обучения, а также становится ли их отношение к сотрудничеству более позитивным. Результаты показывают, что кооперативное обучение положительно влияет на способность учащихся к сотрудничеству, а также на их отношение к математике.*

Ключевые слова: *методы обучения математике, кооперативное обучение математике, учащиеся с низкой успеваемостью, установки учащихся, школьники основной школы.*

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