COOPERATIVE LEARNING IN ONLINE CLASS TEACHING OF MATHEMATICS

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Abstract
The aim of the paper is to examine the opinion of teachers about the representation and limitations of the application of collaborative learning in online teaching of mathematics. The survey conducted on a sample selected from the population of primary school teachers in R. Serbia (N=116), and data were collected about cooperative learning in online mathematics classes. The results showed that the majority of teachers apply group work, and less often online teaching. They believe that it is possible to organize collaborative learning in online mathematics classes in lower grades, but that there are certain limitations in the realization of this way of teaching. A small number of them have realized such activities through online classes.

Key words
Cooperative learning, distance learning, mathematics teaching, online teaching

Introduction

The importance of mathematics in modern society, as well as its role in raising the overall educational potential of students, represents a great challenge and implies a constant search for a more efficient way of implementing teaching practice. The complex social circumstances and challenges we face today determine the implementation of modern teaching and demand, beside the introduction of new content, methods and more flexible forms of work, also a change in the concept of teaching in all its segments and the implementation of modern information technologies in the teaching process. The success of initial mathematics education is significantly influenced by the chosen teaching strategy, which promotes cooperation and tolerance, critical thinking and the ability to solve problems. Mathematics teaching should be experienced as a process, a creative activity in which students actively participate, research, cooperate with each other, discuss, exchange experiences and draw conclusions. By encouraging the teaching of mathematics based on the principles of cooperative learning with the support of computers, the values and competencies that modern education strives for are promoted: social and IT skills are improved, the teaching work becomes more diverse and creative, an atmosphere of shared experience of achievement is created and students' activity, interaction and communication skills increase, which implies higher achievements and more lasting knowledge of students.

The question is how to ensure the optimal functioning of the process of initial mathematics education by applying a cooperative form of learning, in actual emerging complex social circumstances, when for various objective reasons

(distance, illness, emergency, pandemic) the physical presence of students and teachers in school is not possible?

In searching for an answer, with the aim of efficiency and rationalization of the teaching process, we will try to look at the possibilities of the educational system and the most suitable way of organizing initial mathematics lessons. Class teaching of mathematics must be flexible enough to involve modern achievements, which will enable its optimal realization in all social circumstances. Bearing in mind the above, as well as the constant aspiration to find the most effective models of educational work, which will result in greater educational achievements and more developed abilities, we assume that already in initial mathematics education there are didactic-methodical needs and opportunities for effective implementation of online mathematics teaching, based on the principles of cooperative learning. The aim of this research is to examine, based on previous work experience, the opinion of teachers about the use of ICT in the teaching process and the application of collaborative learning through online mathematics teaching, when circumstances do not allow the organization of teaching in schools, as well as about the limitations that make it difficult to implement mathematics content at proper way.

Theoretical background

The effectiveness of mathematics education, achieving the best possible outcomes and competitiveness on the knowledge market, is the primary goal of most educational systems in the world (Milinković & Lazić, 2018). The quality of mathematics education results is largely determined by the way of teaching in the classroom (Maričić, Felda, & Mešinović, 2016), with a special emphasis on active learning methods that include elements of fun and pleasure (Lee, Kim, & Yoon, 2015; Rakić, Lazić, & Marić, 2021).

The increasingly pronounced need for social interaction and the social environment of the teaching and learning process recommends the organization of mathematics teaching based on the principles of cooperative learning, as an active, interdisciplinary, interactive process of acquiring knowledge, which implies more favorable educational and educational results (Maričić & Felda, 2017). Cooperative behavior and teamwork, as a form of student interaction and a basic characteristic of cooperative learning, is one of the priorities of modern education (Dryiden & Vos, 2001). The results of numerous studies indicate the importance and multiple effects of cooperative learning (Benda, 2002; Johnson & Johnson, 1994; Kagan, 2004; Russo, 2014). An active process of acquiring knowledge and a high degree of interactivity contributes to improving the quality of teaching and student achievement (Cohen, 1994; Johnson & Johnson, 1994; Slavin, 1990; Zakaria et al., 2010), socio-emotional development, deeper understanding, more permanent knowledge and critical reflection (Johnson & Johnson, 1989). Teaching is more dynamic (Maričić & Felda, 2017), learning takes place in a collaborative environment (Matijević, 2008), and therefore helps social development and teamwork (Felder & Brant, 2007), enhances motivation (Kagan, 1989) and reduces anxiety (Laal & Ghodsi, 2012).

Cooperative learning in which students work in cooperation, with positive interdependence (Abrami et al., 1995), enables them to develop abilities necessary for an individual in modern society, through group interactions (Dizdarević, 2012). This affects the increase in self-confidence, motivation, level of aspiration and engagement in the teaching process (Stanojević 2009). This way of learning contributes to better mathematical achievements and more affirmative attitudes of students about mathematics (Capar & Tarim, 2015). By applying cooperative learning, students' mutual trust is improved and complex mathematical content is easier to learn (Lavasani & Khandan, 2011).

According to the results of the study (Ke & Grabowski, 2007), cooperative games contribute to increasing achievement and promoting positive attitudes of students about mathematics. The subject of research in certain studies was possible difficulties with concrete proposals for more successful application of this way of working with students (Shindler, 2009; Ševkušić, 2003; Špijunović & Maričić, 2016). The common conclusion is that the indicated shortcomings can be eliminated, that the collaborative form of learning can be effectively applied to different contents of mathematics teaching, and that the advantages of this way of organizing initial mathematics education are numerous.

On the other hand, in addition to the didactic-methodical competences of teachers, the quality of initial mathematics teaching and its outcomes is significantly contributed by the innovation of the teaching process and appropriate teaching aids based on digital technology.

The terms distance education and e-learning have their intersection, which is online teaching. In the age of modern technologies, online teaching means teaching via the Internet. Modern online teaching is conducted through an application or an educational platform, and each of them has different capabilities (Abrami et al., 2011). As a "virtual-place classroom" where, by using the Internet, the teaching process takes place remotely, the platform for online teaching is a service that enables educational institutions, teachers and students to access and learn via computer. It offers modern solutions, the possibility of communication, group work, and assessment of knowledge, sharing of materials and content with other users.

The studies showed that online teaching has its limitations and shortcomings, especially when it comes to the socialization of students, their mutual interaction and communication with teachers (Bozkurt & Sharma, 2020; Carrillo & Flores, 2020). In the domain of socio-emotional reactions, students may experience feelings of isolation, alienation, non-acceptance by other students and misunderstanding by teachers, because of the lack of direct contact and social isolation. In the context of adopting teaching content, there are certain obstacles and difficulties with online teaching, because in the absence of immediate and direct communication, ambiguities and inconsistencies, as well as indeterminacy regarding requirements and expectations, occur more easily. Parents are expected to engage more intensively, and often they themselves have a lack of resources, skills and a problem with time management. All of these are significant limitations of online teaching, which require increased engagement of teachers, adaptation

of students to new working conditions, as well as help to parents, in order for the teaching process to take place in an appropriate manner and to achieve appropriate educational effects (Cvijetić, Marić, & Beljanski, 2022).

Taking into account the mentioned obstacles to the successful implementation of online teaching and the previously described characteristics of cooperative learning, one of the potential solutions for improving the effectiveness of online teaching is the application of cooperative learning in an online environment. In this way, through mutual cooperation and exchange among students, feelings of social isolation and distance can be alleviated and prevented, students feel more accepted and adapt more easily to new working conditions (Brown & Fallon, 2003; Felder & Brant, 2007; Laal & Ghodsi, 2012). The interaction between them becomes more intense and develop the feeling of belonging to a group and team spirit develop. The messages sent by the teachers are better accepted when they are analyzed within the group, and there is less possibility of misunderstandings in the teacher-student relation. Also, parents can consult each other if they have certain common dilemmas and difficulties, which reduces the feeling that they are left to their own devices in dealing with difficulties.

Therefore, it is expected that cooperative learning in an online environment contribute to more intensive cooperation and mutual connection of all participants in the educational process, which significantly reduces their feeling of maladjustment, isolation and mutual distance. Actors, primarily students, work together to solve problems, realize that they are not alone, nor neglected, and cope more effectively with all the challenges of working in an online environment.

Although there are some researches on this problem, it is evident that the research theory and practice of teaching based on a combination of cooperative learning and online teaching in elementary mathematics education has not been sufficiently explored or represented. The results of research on the cooperative approach in online mathematics teaching conducted in Italy showed that cooperation not only affects the creation of social skills, but also the improvement of mathematics knowledge and the improvement of problem-solving competencies (Faggiano, Roselli, & Rossano, 2007). In Bahrain, a study was conducted about online mathematics teaching, in which parents and teachers were tested. In addition to the already mentioned advantages, certain disadvantages of this way of working are also indicated, which are primarily related to spending too much time at home, parents do not have the ability to control children when working on the computer and their activity while following lessons, and a certain obstacle for online work was also the financial aspect (Al-A'ali, 2008). In 2013, most online mathematics learning in Australia was reduced to traditional teaching, so new ideas began to be considered. An Australian study of primary school students in Melbourne, aged 10 to 12, examined the introduction of online mathematics learning and its effects. The results showed that the students liked this way of working, but although there is shared responsibility for what was achieved, not all students were sufficiently active. At the same time, it was especially shown that this way of working was much more effective

when they were in smaller groups of 3 to 5 students, than when the mutual cooperation of all students in the class had to be achieved. In addition, there was an improvement in the ability of critical and mathematical reasoning in students with lower achievement in mathematics (Symons, 2017).

In this way, the activities of all subjects are integrated in the teaching, the program objectives are more easily and successfully realized, and students acquire a better mathematical education, primarily through the stimulation of creative thinking and more functional knowledge of abstract content. By applying this way of learning, the visual representation, i.e. the materialization of abstract mathematical concepts and the possibility to look deeper into some mathematical concept or rule, is facilitated, which contributes to greater stability of knowledge and more successful transfer. However, to what extent such organized mathematics teaching will be truly successful in a qualitative sense, depends first of all on the degree of transformation and responsiveness of teachers and students in such circumstances (Mićanović, 2017).

When it comes to the application of this approach to learning in elementary mathematics classes in the Republic of Serbia, a review of the available literature shows that research of this problem is rare, and that there is a lack of adequate work models as an example of good practice, which leads to the conclusion that cooperative learning in online mathematics classes, in theory, and especially in practice, has not been sufficiently developed or applied. Regarding to this, in complex social circumstances, the assumption about the possibility of effectively organizing online class mathematics teaching in the educational system of Serbia, based on the principles of active collaborative learning, is justified.

Aware of the fact that the organization of teaching in the described way is not simple and that teachers encounter many difficulties in that process, in this paper we examined the opinions of teachers about the use of ICT in the teaching process and the application of collaborative learning through online mathematics teaching, as well as the limitations that make it difficult to implement the contents of mathematics in the described way.

Research methodology

The problem of the research can be formulated as a question: *What do teachers think about cooperative learning and online mathematics teaching?* The problem of this research is significant because cooperative learning in mathematics class teaching as a model has found application in the classroom, but not enough when it comes to teaching via the Internet, even though educational software allows virtual groups to be organized and cooperation to be carried out outside the boundaries of the classroom.

Modern teaching through the integration of collaboration and digital technologies, which is the problem of this research, is something that is current, but not sufficiently studied. The subject of this research is focused on online classroom teaching of mathematics based on the principles of cooperative learning. It is necessary to examine the effect of the positive interdependence of students in online mathematics classes in the younger grades of elementary school. Since it is desirable and possible to successfully

implement cooperative learning at the elementary school age, with good organization, and in the lower grades, the question is whether it is possible to realize it through the online teaching as well. The aim of this research is to examine, based on previous work experience, the opinion of teachers about the representation of ICT in the teaching process and the application of collaborative learning through online mathematics teaching, when circumstances do not allow the organization of teaching in schools, as well as about the limitations that make it difficult to implement mathematics content in this way.

In accordance with the specific problem and the defined goal of the research, the descriptive method was applied in the study in order to collect data on cooperative learning in online mathematics classes. The collected data influence the extension of knowledge about cooperation via the Internet in class of mathematics and improving of the educational process through this work (Knežević & Florić, 2012).

The survey technique was used for data collection.The implementation of digital education in elementary schools is a long process, and it is still not possible to practically carry out an experiment without prior preparations and work with students. Therefore, the population of this research consists of teachers of certain primary schools from both urban and rural areas. The survey, conducted via Google survey, was carried out during 2022 year. The sample consisted of 116 respondents. The sample of this research is random because the survey was available to teachers from all over Serbia. The majority of respondents were female (111 in total), and the ratio of respondents who worked in urban and rural schools was approximately equal. The average age of the respondents was approximately 45 years, most of the respondents were between the ages of 41 and 50. A total of 84 respondents were between the ages of 40 and 60. Most of the respondents had work experience in the interval 21-26 years - a maximum of 34. Other years of experience were approximately evenly distributed, so the obtained results could be used for further analysis and comparison.

The questionnaire contains of 14 questions, of which 3 are open-ended and 11 are closed-ended. It is made up of three parts, where the first is dedicated to cooperative learning in classroom mathematics classes, the second refers to online classroom mathematics classes, while the third part is a combination: cooperative learning in online mathematics classes. We interpreted and qualitatively analyzed the data and presented it in tables and graphically.

Results

The results of the survey conducted through an online questionnaire show that 50.9% of teachers sometimes use the group form of work in mathematics classes, while 25.9% of them answer that they apply the mentioned form of work often. On a five-point scale (1-never, 5-regular), the grade of using group work in mathematics classes would be 3.1, which means that teachers sometimes use group work in this subject. Only 2.6% of respondents answered that they never use group work in mathematics classes. This fact provides the possibility of organizing group work with students in

mathematics classes in the lower grades of elementary school. Within the total number of respondents (116), only four do not apply group work, from the first to the fourth grade in mathematics classes. This means that there is an opportunity to implement cooperative learning in mathematics classrooms. About 96% of teachers state that they apply cooperative learning in their work. In their opinion, students like working in pairs the most, followed by individual work and finally, group work. Almost all teachers spoke positively about cooperative learning, believing that the application of this form of work in mathematics classes contributes to the socialization of children. In this way, students learn better through interaction with others, without pressure and fear of expressing their doubts publicly. In those situations, peer teaching takes place, where the boundaries of the teacher's authority no longer represent a barrier to learning the material. The largest percentage of respondents, 80% of teachers, have the opinion that cooperative learning has a positive effect on the acquisition of mathematical knowledge and skills, while 13.8% of teachers believe that it has no significant effect. It has been shown that the cooperative form of learning should be applied in mathematics classes in classroom teaching, because through it is easier to achieve the planned educational outcomes.

The obtained results showed that a small number of teachers, 20 of them, never applied online teaching in the implementation of mathematical content. They state that they had in mind that the absence of conversations and discussions in online classes is not conducive to fostering cooperative learning and socialization of children. The research showed that 41% of teachers applied primarily the oral conversation method during online mathematics classes. Bearing in mind that most teachers based their work on the use of Viber and Google Classroom, the implication of the extent to which they discussed and communicated was obvious. In this regard, they are have opinion that it is necessary to additionally train students in the use of applications and educational platforms, so that they can communicate orally, and not only through messages. Without oral communication, the effectiveness of group work is reduced, so additional work should be done in that area, for better performance of cooperation in small groups. According to the results of the research, within 96 respondents who apply online mathematics teaching in their work, five teachers believe that the students were not interested in working in those classes. Although motivation and interest in work is one of the basic segments of teaching and every single lesson, it is very important that it is present in the teaching process. The students' motivation for online mathematics teaching was at the expected level, and one of the conditions for the implementation of online mathematics classroom teaching was fulfilled. Although online teaching is unusual and interesting to students, using a computer or other device is a great incentive for students. The average grade, looking at the answers as a five-point scale (1-unsatisfactory, 5-excellent), or the grades that students would receive on average for knowledge in mathematics classes, according to the sample, would be 3.53, which means that the students achieved very good results in mathematics through online teaching. The obtained results also confirm that adequate motivation really has an impact on success in achieving educational

outcomes in mathematics teaching. The most used application for online teaching of mathematics was Viber - 62.9%. The Viber application can be used to communicate, send content, and can be accessed from any device, including a computer. There is a possibility to carry out group correspondence, group video calls (to 20 people at the same time). Through this application, students are able to actively collaborate, discuss tasks, ideas, and it is suitable for group work.

Google classroom, according to this research, has found application in online mathematics classes, and it was created for the purpose of education. This is confirmed by the results, which show that 50% of teachers have used Google Classroom for online math lessons. It allows teachers to create virtual classrooms, where content can be shared, graded, and communicated. An additional benefit is that anyone can connect to this application and use it through an email address. Correspondence is used for communication. In addition, it is easy to use for making materials. It can be used in combination with an additional chat-enabled application, such as Google Meet. The Zoom platform appeared in third place in the survey. To use it, it is necessary to have the application installed on a device (phone, computer, tablet, etc.) and for the invitee to join the meeting. The Zoom application was used in 22.4% of situations by teachers who were part of the research sample. In addition to the mentioned applications, Microsoft Teams, E-classroom of publishing houses (Logos, Vulkan, Klet, etc.), followed by Skype, Edmodo, Facebook and others appeared in a smaller numbers. One response from the teacher was that phone calls were used for distance learning, because the student did not have the means to afford a computer and the Internet, so they found an alternative to work.

The majority of teachers (66.4%) believe that online teaching of mathematics based on the principles of cooperative learning can be successfully applied. At the same time, when asked whether they applied such a method of work in mathematics classes, only 21% of them answered in the affirmative.

Opinion on the possibility of applying group work in online classes			
	Can be applied.	Can not be applied.	$\sum$
f	77	39	116
p	66.4	33.6	100

Table 1: Possibility of applying group work in online classes

According to the teachers, the biggest advantage of cooperative learning in online mathematics classes is the possibility of working from anywhere. 23 teachers believe that there are no advantages of this way of working. Within 116 respondents, only 9 believe that the contents are easily adopted in this way, which is 7.8%. Based on the answers they gave, the advantages of this way of working were identified, which are systematized in the following figure 1.

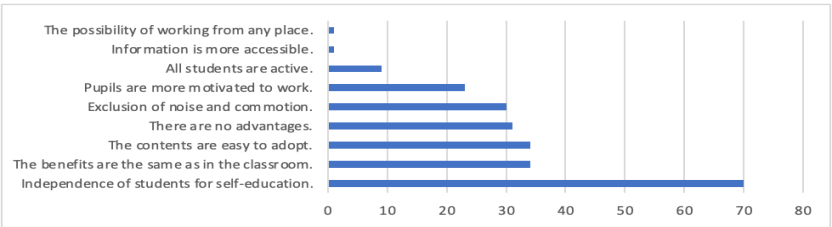

Figure 1: Advantages of cooperative learning in online classroom mathematics

Therefore, starting from the goal of the research, the obtained results show that there is a connection between the teacher's opinion that the advantage of collaborative learning in online mathematics classes is higher student motivation and the application of collaborative learning in online mathematics classes.

One of the questions is related to the shortcomings and limitations of the application of cooperative learning in online mathematics classes. The results are summarized in figure 2.

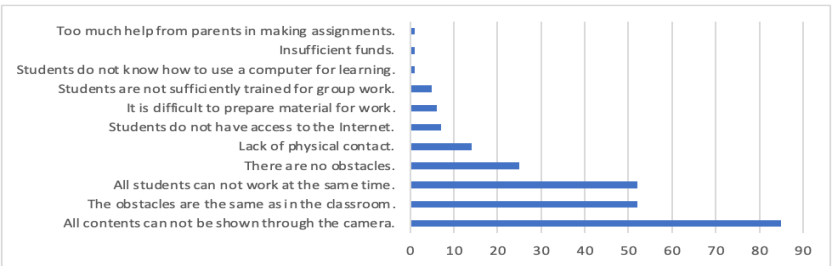

Figure 2: Disadvantages of cooperative learning in online mathematics classroom teaching

The teachers answered that the biggest disadvantage of the application of collaborative learning in online mathematics classes is too much help from parents (85 of them). This answer is followed by items related to the lack of resources and insufficient training of students in using computers. In connection with the above, only 5 teachers stated that there are no obstacles in performing this way of working. More teachers answered that the problem is a lack of competence for using computers for educational purposes, than those who said that students do not have competence for group work. This means that additional work should be focused on creating competencies for computer work, use of the Internet and educational technologies, as well as that additional work should be done on the information literacy of students in Serbia, for the benefit of using online platforms for the teaching process.

In addition to the above, the results of the research implicitly pointed to the basic prerequisites for the realization of cooperative learning in online mathematics classes (table 2).

Requirements for implementing cooperative learning in online mathematics classes	Reasons for achieving of the requirements
1. *Willingness and motivation of teachers and students to work.*	In order to achieve success, it is necessary to have the desire and will of all participants in the class.
2. *Acceptance of the fact that it is a lesson, not an extracurricular activity.*	Many students do not understand online teaching as real teaching, so it is necessary to provide conditions for students to behave responsibly and approach work without the parental supervision.
3. *The teacher's ability to organize group work in online classes.*	The teacher should have organizational competences (time and space management), for group work and the order of material processing, etc.
4. *The teacher's ability to choose the platform and prepare the material.*	The teacher should well know the teaching units and, based on the content, choose and prepare adequate material for work, which will successfully help in learning, and to choose a platform that has all the facilities that students need to successfully adopt the teaching unit.
5. *Possession of a computer (with all input and output devices), good internet flow and access to the platform.*	If each of the students does not have a computer and good internet flow for work, as well as an installed application or the platforms for learning, it is impossible to organize this type of work.These are resources without which this teaching cannot be realized.
6. *Computer competences of teachers and students.*	Competences for the correct use of computers are necessary, because computer skills are one of the key conditions for the positive implementation of online teaching.
7. *Effective work in a group with rules of behavior.*	Students should know how to work in a group and that there is a division of responsibilities, while respecting the rules of beavior. If this is not fulfilled, group work in online classes loses its meaning, and students do not achieve the intended goals and outcomes of the class.
8. *Possibility of oral communication among group members.*	As communication on many platforms is possible with the help of electronic correspondence, it is necessary to ensure oral communication among group, in order to better agree and communicate about work.
9. *All group members should actively participate and work together.*	The effectiveness of group work is at the highest level when each group member works and participates. If one part of the group members or an older person took over, the purpose of continuing online teaching through group work does not exist. Group work is designed for a positive output and progress of each member.
10. *Adequate method of evaluation of work.*	The teacher and students should mutually agree on the method of evaluation, so each of the students can be encouraged by the evaluation as an external motivation. It is necessary to announce that the whole process is evaluated.

Table 2: Conditions and reasons for implementing collaborative learning in online mathematics classes

Conclusion

Class teaching of mathematics can be applied in innovative way, with different resources. One of the ideas of the modern age is a cooperative learning in online classes. It has certain prerequisites for implementation, but according to teachers in Serbia, there is a possibility for implementation through adequate preparation. Teachers, regardless of their age, years of experience and the environment in which they work, equally apply the group form of work. Most teachers (about 80%) start group work in the first and second grades, which is suitable for collaborative learning over the Internet. The majority of teachers believe that mathematical content can be successfully adopt through group work. It showed that only 5% of students were not interested in online mathematics teaching, and the rest were divided: partially and very interested. According to the teachers, the knowledge of

mathematics that students have acquired through online teaching is, on average, very good. Most teachers have implemented online mathematics lessons, and the most used applications are Viber, Google Classroom and Zoom. It would be desirable to apply platforms that are aimed at education, but due to their complexity and lack of daily use, students were not able to monitor and participate in classes through these applications. The presence of oral communication was only 41%, which is not conducive to the realization of collaborative learning in online mathematics classes. It showed that earlier oral communication is related to the application of cooperative learning in online mathematics classes, and these two parameters are mutually dependent. In addition, most teachers believe that is possible to organize collaborative learning in online mathematics classes in younger grades, but a few of them believe that it is important for easier acquisition of content and achievement of educational outcomes in the subject of Mathematics. We can connect this attitude of teachers with the fact that only 20 teachers applied this type of teaching when implementing mathematical content.

The biggest obstacle in the implementation of collaborative learning through online teaching, according to teachers, is that parents provide a lot of support to students when creating assignments. After that, it follows that there are not enough funds for this way of working, that students do not have enough competence to use computers for educational purposes, and that they do not know enough how to work in groups. The advantages that the teachers mentioned are that they can work from anywhere, then the availability of information, all students are motivated and active, as well as the exclusion of noise and commotion, which can happen when group work takes place in the classroom. The lack of human factor or physical contact between students was mentioned several times as one of the disadvantages of collaborative learning in online mathematics classes. Personal experience has shown that there are certain obstacles in cooperative learning in online mathematics classes and their organization. First of all, students are not trained to work on platforms, and all parents are not able to help and guide students. We can also consider a disadvantage that all students need to independently access the platforms (mainly prepared in the Latin alphabet), and the second alphabet is learned only in the second grade of elementary school. The selection and preparation of content, and then the organization of group work make the teacher's job complex. This type of teaching is the most difficult to organize with first graders.

A modern way of teaching, such as collaborative learning in online mathematics classes, has advantages for developing communication, social and computing competencies, functional knowledge, such as developing mathematical and critical thinking, and it also encourages emotional development. Cooperative learning on an online platform imitates the understanding of peer groups as an important factor for the overall development of a child's personality, because a suitable climate and healthy relationships in the community are created through groups. This way of working can also be practiced in other subjects, extracurricular activities, and students can work together on projects or homework in these conditions. For them, the Internet does not have to be just fun and entertainment, but it can

enable them to learn and progress through mutual interaction. The possibilities of computers and the Internet encourage students who are less communicative or need additional educational support to participate and integrate into the social community. Are the work challenges really the same as when it comes to regular teaching in a school classroom, or are there some teaching units that cannot be done through an online class and does it need to be additionally studied and tested for technology or to be further improved, remains as a question for discussion and a recommendation for further research.

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