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Full Length Research Paper

Use of technology in constructivist approach

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Over the course of history, the structures of societies have changed at certain periods depending on technological and scientific developments. In today's societies, such mental processes as information processing and production have become prominent and the educational systems are revised according to the constructivist approach, which focuses on mind and is based on developing cognitive skills. Technological tools have a significant place in ensuring active learning. These tools contribute to the educational system in general, to students, teachers and the entire process. In this study, the use of technology in the constructivist approach in an educational environment is discussed based on scientific research. The result of the study revealed that constructivist approach supported the educational environments in terms of activating prior learning, sensitivity to individual differences, accessing the sources of information, forming experiences, supporting individual learning, supporting lifelong learning. Also included ae: supporting learning when required, supporting collaborative learning, enabling process evaluation, communication, ensuring active learning, enabling interaction, providing guidance, providing flexibility in curriculum, supporting the use of high-order cognitive skills, supporting skills development, arranging learning environments, supporting activity-based learning, and supporting the construction of a positive attitude towards learning.

Key words: Constructivism, technological tools, educational environment, benefits, restrictions.

INTRODUCTION

Technology is defined as "the tools that human beings develop to control and change their material environment and the knowledge of all relevant things" (TDK, 2018). Behaviors towards controlling and changing the environment started with the existence of human beings. When humans do not have the power, they use their mind to design and develop tools for their use. The same skill has been used in learning-instruction environment and various tools have been developed for use in these environments.

The industry, which was the indicator of the power of societies in the past, created a structure based on production, using existing knowledge. As in master-apprentice relationship, the education systems during the time focused on knowing existing information and using the tools. During the time, when the behaviorist approach was practiced, people's behaviors were changed and assessed. Educational environments, tools used in these environments and activities were organized to serve this aim.

Scientific and technological developments later led to changes in the social structure. Information has become

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the most important factor determining the power of societies. Those societies that produce information have a voice in the world. Producing and processing information take the center stage as important values. Existing information rapidly increase and such bulk of information increased the learning capacity of people. Educational systems that took the function of instruction failed to teach the bulk of information. In addition, the concept of learning changed. Although having knowledge on many fields including history, science, geography, arithmetic calculation, and writing foreign language skills were regarded important for years, it was understood that this knowledge and skills did not guarantee comprehension of the subject area (Perkins, 1993).

It is seen that in a period in which such cognitive processes as processing and producing information have become prominent, using an approach that focus on human behavior will not provide expected results. Therefore, first the philosophy of education changed. Education is comprehended as an objective in using knowledge and skills actively (Perkins, 1992). In addition, it is believed that an educational philosophy, that is the constructivist approach, which focuses on the mind of people, with the aim to improve cognitive skills, claims that "information is formed as a result of one's interaction with his environment (Bagci, 2001)". This philosophy is believed to meet the requirements of today.

Constructivist approach

Constructivism is an approach that takes a role in developing instruction methods based on the construction of knowledge by an individual, based on his/her prior knowledge, skills and competences.

Balkan Kiyici (2003) claims that constructivism approach is a model which arose with the idea of making education more efficient and lasting; and one that uses the existing instructional strategies but gives a new direction to them. In constructivism, learning occurs with the active efforts of the individual and constructed in one's mind (Gunes, 2013).

Turgut et al. (1997) summarize the main principles of constructivist approach as follows:

(1) Information is appropriated to the mind and called assimilation; information perceived does not conflict with the existing prior knowledge of the individual and is incorporated in existing categories in one's mind.
(2) It creates an imbalance in mind if the perceived information does not fit any categories in mind. In order to incorporate this imbalance, learners use a set of cognitive processes. Moreover, this restructuring process is called accommodation, while the procedure of restructuring is called self-adjustment. The process of incorporating imbalance is affected by one's prior knowledge and cognitive skills. If one of these falls short, self-adjustment process fails and unaccommodated behaviors of the individual continues to exist.
(3) People can experience this imbalance without receiving information from the external world and by asking questions themselves. In such a case, such creativities, as producing original information and finding an original method, are formed.

Teachers adopting constructivist approach tend to use educational technologies more frequently in their classes and try to include their students more in the process of teaching (Niederhauser and Stoddart, 2001; Coppola, 2004; Ertmer, 2005; Baser and Mutlu, 2011).

METHODOLOGY

This review article starts with presenting an overview of constructivism and technology concepts which are based on scientific works, then goes on to how and why technological tools are used to support constructivist approach. Key issues related to the relationship of constructivism and technology were identified through reviews of the literature on constructivist approach and the literature on the technological tool used in the education environment.

RESULTS

Continuously, reforms are made in the concept of education and educational systems in order to educate individuals who research, access information, question, relate, discuss and construct new information and to meet the requirements of the society. With the adoption of constructivist approach, the curriculums and course books have changed and through in-service trainings, teachers have been informed on the issues of guiding the learning process and how they will plan and implement activities in the classroom such as assessment and evaluation activities. Technological tools are also used in educational environments. Yilmaz and Naci (2017) advocate that the constructivist learning theory applied in Turkey last year, used information technologies as imperative for the development and implementation of teaching programs. In addition to all these changes, the ways tools are used have also changed.

In the current study in which the conveniences of using technological tools in learning environments could bring to the implementation of constructivist approach was discussed, it was found that technological tools could support constructivist approach by activating individual's prior learning. It could also support sensitivity to individual differences, accessing the sources of information, forming experiences, supporting individual learning, supporting lifelong learning, supporting learning when required, supporting collaborative learning, enabling process evaluation, and communication. Ensuring active learning, enabling interaction, providing guidance, providing flexibility in curriculum, supporting the use of high-order cognitive skills, supporting skills development, arranging learning environments, supporting activity-based learning and supporting the construction of a positive attitude towards learning are also included.

DISCUSSION

Here, the benefits of supporting constructivist educational environments with technology are discussed in the light of the studies in the literature.

Creating a learning environment that is convenient for the constructivist approach is the responsibility of the teachers. Using their skills and knowledge, teachers try to provide students with an environment where students will show their prior knowledge, find out new information, make sense of the new information and derive results. During these steps, technological tools are the most important supporters of teachers. Technological tools have a significant place in ensuring active learning. These tools contribute to the educational system in general, to students, teachers and the entire process.

Over the last twenty years, technology has reorganized how we live, how we communicate, and how we teach (Siemens, 2005). The use of technological tools in educational environments makes these environments advantageous in terms of making it easier to access the sources of information and supports individual learning, lifelong learning, environmental learning and learning in times of need. Also, such tools encourage learning sensitive to individual differences; ensure the transfer of situations that cannot be formed via simulations in learning environments to these environments; create exact learning environment; support learnings convenient for the readiness of students; encourage learning by fun via educational games and providing opportunity to develop different skills (Isik, 2014). The use of teaching materials and materials in education provides students with more active participation in the lessons, giving them the opportunity to learn by doing and experiencing, providing more attention to the wishes, ideas and needs of the students in education. It also enrich the educational process by supporting teaching, facilitating learning by providing concreteness in the perception of information, reducing disremembering, encouraging the student, achieves by making-living and naturalizes the learning environment (Çelikkaya, 2017).

Kilic et al. (2003), who claim that technology takes the role of transferring information or, in other words, the role of the teacher in traditional methods, believe that learners use technology-supported constructivist environments to analyze the world, to access information, to interpret and organize their own knowledge and to share it with others. Using technological tools in learning environments will provide certain benefits in the implementation of the constructivist approach.

Activating prior learning

Gunes (2014a) indicates that the first step in constructivist educational environments is activating prior learning. Watching a video, listening to a voice record or an image at the beginning of the lesson will provide the environment in which students' prior learnings will be activated. The teacher will be able to control whether the prior knowledge is true and will correct if it is wrong. If the student does not have prior knowledge, the teacher will provide the opportunity for the formation of this prior knowledge by additional activities.

Sensitivity to individual differences

There are individual differences among the students in the classroom. Some students need to make more exercise and repetition to learn compared to others. If the teacher arranges the learning activities, these students will not only bore the teacher because of their human nature but also those students who learn faster. In addition, those students who learn slower will be psychologically disturbed. Moreover, in an exact opposite case, the students who learn slower will not understand the subjects. Computers will enable students make as many repetitions and exercises as they want without insulting them and will help them to learn and feel psychologically easy. Besides, computer will score students' answers faster than the teacher will and will instantly correct mistakes with instant feedbacks. Students are ensured to see the correct answer when they make a mistake via instant feedbacks and to access the information on the subject. It is claimed that because technology supported constructivist approach makes it easier to get to know the students, it will enable an education that takes individual differences into account (Kaleci, 2013; Ciglik and Bayrak, 2015).

Accessing the sources of information

Technological tools make it easy to access the sources of information. Students have the opportunity to access information over the internet or the information they store in their storage tools at any place and time. Accessing this information when they need provides a ground for more permanent learning. In addition, during reviews in order to find the certain information they will come across different information and learn the ones that attract their attention.

Technological tools are highly important in interpreting information using the prior knowledge and thus, constructing new information step of the constructivist approach, which forms the ground of this approach. Technological tools provide great convenience while remembering prior knowledge, compensating gaps, accessing new information, obtaining additional information required during comprehending this information. In this respect, they contribute to the formation of educational environments convenient for the constructivist approach.

Forming experiences

Taking the fact that it is real-life situations where learning occurs best, technology-supported constructivist learning environments should offer real-life situations for learners to construct information. Situations, which are not possible to include in learning environments, are transferred to the learning environment via simulations. This will provide the basis for students to learn by experience and thus, learn permanently. Among the reasons for using simulations in learning environments are its effect on learning, the opportunity it offers to bring cases that are not possible to create the learning environment with less difficulty and enabling students to experience the situations in a safe environment (Isik, 2010). The advantage of reflecting events that are time-consuming, dangerous and impossible to observe in real life should be certainly utilized (Kilic et al., 2003).

Supporting individual learning

In individual teaching, students sit before the computer and learn everything on the computer. This enables individual learning. However, constant use without supporting it with any other types of learning will have negative effects on students' socialization.

Supporting lifelong learning

As a requirement of the information society, the process of obtaining and processing information expands to all areas of life; and with the rapid development of technology, on the other hand, there are rapid changes and developments in daily life. Those individuals who successfully adapt to these developments become the ones demanded in business life while others lose their qualifications. In this respect, learning has become a lifelong activity. Technological tools help individuals in terms of accessing the sources of information and providing them with learning activities. In addition, they also support adult education by providing flexibility in time and place.

Supporting learning when required

In order to ensure efficient learning, it is necessary to relate the information to be learned with daily life. Individuals, adults, in particular, are more positive towards learning information that they will use in daily life. Learning especially the information that is required for the solution of a problem experienced is easier. Technological tools provide individuals with the opportunity to access and use the information they need when they need it and thus, to learn it by providing access without any time and place limitations.

Supporting collaborative learning

In their study, Yavuz Konakman et al. (2013) found that prospective teachers see constructivist education environments as environments supporting cooperative work. Since the internet makes it easy to access experts and learners, which is something that is not possible geographically, cooperating with others and discussing the ideas created, which is something that constructivist approach supports, is possible. In addition, various software supported by technological tools are used in sharing information with other people (Tezci and Gurol, 2001). Technological tools enable individuals that work in cooperation with each other to share the materials and files they created without any limitations in time and place. Besides, the existence of software that provides the opportunity to work on the same file at the same time support collaborative learning. Unal and Cakir (2016) investigated the effect of constructivist learning environment supported by cooperative technologies on academic achievement. According to the results of the study, it was found that the students had high academic interests throughout the application. Moreover, it was found that most of the students were satisfied with such an implementation process. On the other hand, according to the results of the interviews with the students, it was found that the constructivist-learning environment supported by collaborative technologies contributed to collaborative work skills, contributing to permanent learning, problem-solving skills, occupational and planned working skills.

Enabling process evaluation

In constructivist approach, evaluation does not only cover learning outputs as in traditional methods but the process of learning and student's self-assessment. Technology also offers many advantages in the evaluation. Technological means are used in recording student's information constructing process and storing the information they reached and the conversations in discussion environments (Tezci and Gurol, 2001; Kilic et al., 2003; Isik, 2010).

Communication

Another main element of the constructivist approach is social learning. Individuals are social beings and they learn by interacting with their environment. Using technology provides ease in ensuring communication. The internet provides the opportunity for people from all around the world to communicate. In addition, with different programs, people can communicate orally, visually or in writing either synchronously or asynchronously. It enables the student to communicate with their classmates or teachers outside the classroom as well as with anyone from anywhere around the world. Thus, accessing primary sources and experts can be supported. Gilakjani et al. (2013) argue that “another positive and desirable effect of bringing technology into the classroom is the increase in collaboration among teachers and students”. Thus, students will be able to benefit more from the guidance of their teachers.

Ensuring active learning

Ciglik and Bayrak (2015) claim that through using the constructivist approach in distance education system, all technology, materials and people in the process of learning could prioritize students. By using technology cleverly, teachers can make their classes more interesting, student-centered and dynamic (Becker and Ravitz, 2001; Judson, 2006). In the constructivist approach, the aim is to make individuals, not the ones instructed but individuals who learn. By using technological tools, individuals can access information individually, construct new information and produce new things by using this information. Thus, they can actively take part in the process of learning.

Enabling interaction

Technology-supported learning environments enable an interactive medium for learners. Learners are able to share their ideas, discuss with others and change if they have any wrong ideas. In interactive environments, there are connections for learners to reach raw and scientific information. In this respect, enabling interaction provides learners the opportunity to guide their own learning. By enabling interaction, more efficient learning is ensured (Koile and Singer, 2006).

Providing guidance

The constructivist approach enables learners to guide their own learning and in addition to that, it requires teachers not to be instructors but guides for learners. In order for teachers to act as guides for learners, they should know the learners with all their individual characteristics, as well as follow and monitor them individually during the activities. Depending on the number of students in each classroom, this is mostly not possible to do. However, with the use of technology providing guidance becomes easier. In some cases, computers take the guidance responsibility. Interactive software, in particular, show high performance in guiding individuals. In addition, such software provides the opportunity for teachers to examine the process of the activity in detail by recording these activities, to assess students’ individual progress and give learners new responsibilities depending on their performance.

Providing flexibility in curriculum

In the classical way, curriculums show which information will be delivered at which periods, as well as the activities and methods, will be used. However, in constructivist approach individuals should manage their own learning. With the use of technological tools for learning, individual is able to manage his/her learning in line with his/her knowledge and skills. The learner is able to reveal his/her own prior knowledge, learn incomplete knowledge, Access raw information, learn at his/her own pace, decide on the content according to his/her interests and produce unique information at the end of the process. Utilization of such portable devices as mobile phones, laptops and palmtops, smart phones and tablets provides freedom of movement and m-learning (Adar and Kandemir, 2008). Thus, learning could happen anywhere and anytime.

Supporting the use of high-order cognitive skills

Moersch (1999) indicates that by using technology properly, it is possible to support the development of higher-order cognitive skills and complex thinking skills. Information society forces individuals to access information, process this information and construct new information. In this respect, it is necessary for individuals to use high-order cognitive skills actively in order to be successful in today’s society. In traditional teaching, students are expected to receive the information instructed and repeat it at the examination given at the end of the process. In the process of receiving information, whether the student comprehends the information, internalizes it or memorizes it is not taken into account. In constructivist approach, on the other hand, students are expected to construct information by processing it cognitively. Laney (1990) states that the use of technology in constructivist approach is efficient in developing high-order thinking skills including identifying and solving problems as well as producing convenient solutions. In his study, Kaya (2008) found that interactive computer-supported teaching not only increased success but also improved high-order thinking skills and thus, enabled students to comprehend instead of memorizing. In addition, Renshaw and Taylor (2006) states that properly designed computer-supported teaching could affect some students' high-order cognitive skills positively. Similarly, Salomon (1996) indicates that using multi-media programmes makes it easier for learners to comprehend knowledge.

Supporting skills development

Gunes (2014b) indicates that developing skills rather than changing behaviors is among the modern developments of today's educational environment. With different programs on the computers, students are engaged in the different application and develop various skills. For instance, in order to develop problem-solving skills, students could be asked to collect data and find scientific information using computers. In addition, students could be given a problem; and then, those students who use a programming language at a good level could be asked to write program that solves the problem. Computer-controlled experiments can be used to develop experiment skills. With these software, student can determine variables, change certain features of these variables whilst computer can make the measurements for students, reflect the results of the changes in question, enable students to draw graphics of the results of the experiment via different software and to prepare experiment report. Word processing programs, which correct grammar mistakes and dictionary programs, can improve students' language skills and writing skills. Technology develop students' perspective to see things from different points of view or enable people to see things from the perspective of others by speaking to experts and asking them questions (Tezci and Gurol, 2001). Aedo et al. (2000) states that compared to traditional methods, computer-supported education develop problem solving and decision-making skills significantly. Bagci and Yalin's (2018) study is based on 5E learning model which is a model for using constructivist approach in education. According to the findings of the study, experimental groups had higher test scores than the control groups in academic achievement test. Moreover, it was found that experimental groups had higher retention test scores when compared to the control groups. In Simsir et al. (2018)'s research, students' achievements were analyzed with the developed laboratory activities for the General Chemistry Laboratory-II course. The developed laboratory activities were based on constructivist approach, enriched in terms of science process skills, to enable students actively participate and adopt the hypothesis based laboratory technique. As a result, it was found that there was a significant difference between experimental group and control group, academic achievement was in favour of the experimental group.

Arranging learning environments

In constructivist approach, which is based on the assumption that students construct their own knowledge by using scientific methods, the richness of the learning environment and students' own cognitive skills determine the construction of knowledge. Considering such opportunities of computer-supported education as bringing real-life into the classroom, offering such animations, which combine sound and image, its enriching effect is seen. What one can confer from this are that rich learning environments that will form the basis of real constructivist approach can be ensured via computer support.

Supporting activity-based learning

Gunes (2014b) claims that it is necessary to learn by discovering through activities in today's educational environments. In traditional learning environments, although there are different activities used, it is generally paper-based activities that are used. With technological tools, on the other hand, interactive activities supported with multimedia content such as sound, video and animations can be used.

Supporting the construction of a positive attitude towards learning

In many studies conducted, it is found that conducting the classes with a constructivist approach has positive impacts on students' attitudes towards the classes (Bilgin et al., 2013). In education, computer games are used in activities towards understanding a topic and making exercises. Students play games but at the same time learn the topic they should learn and have fun doing the exercises that are boring while on the book (Isik, 2010).

RECOMMENDATIONS

The results of the study reveal that technological tools support constructivist educational environments in many ways. Teachers' job is to use the limited resources in the most productive way, to know their students, organize the learning environments according to their individual characteristics, guide the students in the learning process, and to evaluate their learning. The methods used in traditional educational environments for all these activities bring a burden on teachers and since teachers have difficulties in this process, they cannot fulfill some of their responsibilities. Using technological tools in this process will make teachers' job easier.

Using technological tools will also support student learning, and make it easier to learn. It will enable identifying their individual differences, preparing convenient learning environments and evaluating them in the process. Considering all aforementioned in the light of the findings of the study, it is suggested to improve teachers' knowledge and skills of using technological tools, to provide technological equipment support in the classroom, and to support the use of technological tools in learning environments.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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The effect of cooperative learning on the academic achievement and attitude of students in Mathematics class

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In the axis of basic skills and values, students' enjoyment of mathematics lesson and the realization of learning by taking a certain distance depend on the appreciation of the effort of the individual. Cooperative learning provides this requirement with a great deal of reward and success. Success increases individual's self-confidence and making him/her more powerful and positive in mathematical learning. By developing an individual's positive attitude, mathematical barriers that may adversely affect his/her success in social interaction with friends might be removed. An individual can also help his/her friends in learning and reinforce his belief and self-esteem. This study aims to reveal the effect of cooperative learning method on students' academic achievement and attitudes towards mathematics in primary school fourth grade math class. The study was carried out with "pre-test -post-test control group experimental design". This pattern allows for the comparison of the success of the cooperative method used in the mathematics course to improve students' achievement and positive attitude towards mathematics."Team Play Tournament Supported Student Teams and Achievement Divisions" (TPT supported STAD) technique, which combined the application of Student Teams Achievement Divisions (STAD) and "Team Play Tournament" (TPT) techniques from the cooperative learning applications, was applied to the test group. In the control group, the lessons were taught usingthe instructions in the Ministry of National Education (MoNE) 4th grade Mathematics Teacher's Guide Book. 4th grade primary school students in Malatya Battalgazi during the 2015-2016 academic year were the study participants. They were 40 students (20 in test group and 20 in control group). "Mathematics Attitude Scale" developed by Baykuland "Mathematics Achievement Test" developed by the researcher were applied to the test and control groups as pre-test and post-test. TPT supported STAD technique is more effective in increasing the academic achievement of the students in mathematics course compared to the teacher-centred teaching; however, it is less effective than teacher-centred teaching in their mathematics attitudes.

Keywords: Cooperative learning, teaching mathematics, mathematics attitude, academic achievement.

INTRODUCTION

Human beings can be organized as a group in order to reach a general purpose in modern life and thus they can be successful in realizing any purpose in business life, sport and military fields. Cooperative activities, one of the most important human activities (Slavin, 1981), aim to work together to achieve the same goals. Collaborative work is based on the idea of creating a common solution to a problem by combining the power and abilities of individuals with different abilities, which are related to the problems of each of the individuals in a group or the solution of a general problem concerning a group. Cooperative learning is a way for students to help each other in learning academic content by working together in small groups (Slavin, 1980). In Turkey, where the constant transformation taking place in the field of education, schools is not sufficiently effective in the training of the type of people required by age. The education system needs to be renewed in the light of scientific developments in accordance with the paradigms that can build the future (Açıkgöz, 2009). In recent years observable corruption has invaded humanitarian values such as social interaction, sharing, cooperation, empathy and devotion. Corporate training has also been affected by these negative developments; the format of the teacher-student relationship has changed; with the rapid changes in technology and other areas of life, education has entered a path of change that educators have to keep up with (Üre, 2008). The targeted student type has changed. Depending on this, instead of a person who is uninformed, powerless, incomplete, directed, accepting and obedient, a person with less experienced, asking, curious, with the potential of learning, critical thinking who can make his or her own decisions independently was brought to the agenda (Cüceloğlu and Erdoğan, 2015).

Theorists, looking at the rooted education approach from a critical perspective, have suggested that knowledge has a social formation and that the world in which we live is symbolically created by the brain through social interaction with other beings (McLaren, 2011; Charles, 2003). In the understanding of constructivism, which constitutes the theoretical basis of the understanding that directs Turkish Education System, it is assumed that information is structured both in an individual and social context through continuous and communicative experiences. The individual structuring occurs with individual experience; whereas in social structuring the experiences of the individual, who is a part of the community, take place based on interacting with the environment. This importance given to communication within the group emphasizes the impact of social relations on learning and building knowledge (Atay, 2003). Nevertheless, the interaction of students, which is the basic dynamic of development, is neglected. A great majority of teaching time is dedicated to the proper regulation of interaction between students and teaching materials. While some time is spared for the interaction between teacher and student, the way students interact with each other is relatively ignored (Johnson and Johnson, 2009).In solving this problem, there are critical tasks that fall to the share of the trainers in the creation of classroom environments in which knowledge is supported within the interaction. Since the students have different nature, teachers should undergo diversity of understanding by changing their perspective from "How will we teach?" to "How will students learn?" The classes, where social relations are emphasized and students are taken to the centre and encouraged to cooperate on the basis of scientific values, are one of the most needed learning environments for today's society. Only in this case, important concrete steps will be taken in developing students' thinking skills and the permanence of learning (Mısır and Çalışkan, 2007).

Problems in teaching mathematics can be shown in one of the most obvious signs of the Turkish Education System not being based on a scientific understanding. Mathematics, the center of positive sciences from the past to the present, is the common language of the age of science. This is because numbers are the basis of all kinds of information technology. Many jobs of computer technologies that make lives easier in every area are products put forth based on mathematical operations. The accounts of giant organizations require a great deal of mathematics activity. The basis of many quantitative and qualitative activities such as classification, sorting, appraisal, reasoning realized in the human mind are in the field of mathematics. In this sense, a life independent of mathematics and targeted social development without taking mathematics into account are a thought distant from scientific facts.

In the past, various projects and trials were conducted on how mathematics teaching should be done in Turkey. The opinion that the students' level of achievement in mathematics plays a more decisive role than the achievement in other courses is common in a large part of society (Karaçay, 1985). However, in addition to that, due to transforming experiences obtained with senses into a structure that works only with abstractions, instead of the physical world, mathematics is often perceived as a metaphysical science. This intangible feature of mathematics also gave rise to its eerie appearance in the eyes of society (Başkan, 1985). Another important problem is the belief that mathematics is an innate skill. Such a belief leads to the fact that people, who appear as ordinary, are not expected to understand what is desired, and negative attitude towards mathematics occurs (Bruning et al., 2014). With the understanding of the direct contributions of the fields of science, which are directed by mathematics, to the economy, the importance

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of the methods adopted in mathematics teaching has also gained a new dimension. Depending on the transfer of the scientific content entering a rapid development process during the 20th century to new generations; the development of new and more effective methods and techniques, rather than traditional methods and techniques, has been generally accepted. In this sense, it is understood that mathematics is not just a discipline for making calculations; it also includes the skills of problem solving in new and different situations (Aptik, 1985).

It is not surprising that mathematics teaching is more at the forefront compared to other problems in the education system. It is because math, which transforms the human mind into an unlimited tool of calculation, has always kept its importance and priority due to their contribution to scientific developments as well as facilitating people's daily life. However, new job and career opportunities that emerge depending on the information and communication technologies have become a situation that requires mathematical skills. Therefore, mathematics is the key to problem solving and to bringing a way of thinking that deals with events in this understanding in addition to the knowledge and skills required by daily life (Altun, 2013). From past to present, starting from pre-school it has become one of the most important criteria of the success for the individual in his/her education life in the eyes of society. Although it goes unnoticed in the flow of daily life, steady behaviour of natural assets and events and the fact that this determination can only be explained on the basis of mathematics is another important aspect that brings mathematics its importance. Especially, the fact that problem solving improves the thinking and reasoning of the person and increases the quality of cognitive structures is one of the other important features that makes mathematics valuable (Altun, 2006). The need for abstraction has always been accepted in transforming the experiences gained through experience into knowledge and providing permanence. Conceptualization of sensory codes of a real experience or directly conceptual thinking require abstraction. This is an indication of the importance of mathematics built on abstraction in the development of human cognitive structure (Çüçen and Ertürk, 2008).

Mathematical anxiety, which makes academic life difficult for many students, is defined as feelings of anxiety and tension that prevent the solution of problems in many different areas of school life and daily life and that interferes with the processing of numerical data. This can cause loss of self-confidence in students. Cooperative learning structures enable students to be active learners, take more responsibility for learning and participate more in the course in overcoming these and similar challenges (Panitz, 2010).

Especially, monotonous teaching disconnected from life, one-way traditional approaches used in measurement and evaluation prevent students from reaching the desired level of achievement and lead to cultivating individuals with negative attitudes towards mathematics (Umay, 1996). Exam-oriented education in schools due to the selection exams can be shown among the reasons of the problem that become apparent. This system, based on elimination and categorization instead of development and cultivation, has made learning perceived as a preparation for exams, has brought the exams into the state of aim and education to the state of means (Işık et al., 2005).

In terms of human beings trying to explain life through certain rules, the fact that the "concept of absolute right" has lost its seat pushed the education to go beyond teaching the right and useful (Çağlar, 2010). If the students, who need to adapt to today's world which gains a more complex feature each day, cannot use critical thinking, reasoning and problem solving skills in interaction with others, what kind of benefits such skills might have is an important question to be answered. To provide appropriate models of social behaviour, cooperative learning is an important practice in bringing together students by creating environments similar to adults, engraining reasoning behaviours of the adult world in them (Borich, 2014). In the schools surrounded by one-way test-oriented understanding, teaching-oriented approaches that restrict the interaction of students among themselves are inadequate in providing academic and socially expected development. Therefore, researchers and teachers have to focus on learning approaches that support the social development of the individual that increase the persistence of learning and students enjoy learning. Cooperative learning, among learning methods that can meet these needs and expectations, draws attention as an important option. It is because cooperation exists in the nature of human beings (Efe et al., 2008).

In the schools that push social development into the background, that are focused on academic achievement, cooperation and collaboration culture are damaged only with activities related to teaching. In works with collaboration, helping others is not in the form of bringing the helper into an awkward state; on the contrary, it helps the individual to release his or her skills. The contribution of student studies provides qualitative and group success rather than quantitative, ensuring that education is organized in a surrounding and social basis (Dewey, 2010). Moreover, it is important that the child cooperates with friends in affecting cognitive development. When individuals work together in collaboration with others, it feeds cognitive development. In other words, cognitive development shows a progress towards self-regulated behaviours from behaviours organized by others (Senemoğlu, 2012).

Modern life imposes an individualistic and competitive personality structure to people. This understanding manifests itself by classifying learners as winners and losers in educational environments. However, a modern basic education process should promote socializing values such as peace, solidarity, cooperation and sharing among students and the classes should be far from transforming the classes into a destructive competition environment (Ural, 2014). The basic skills are emphasized in the classes, which are far from meeting the educational expectations of the age. Teachers expect students to answer questions correctly while dictating knowledge to them. Evaluation of what students learn is usually done with tests and they are often encouraged to work alone (Schunk, 2014). Although the school is a community, it is common that students are kept separately at their own desks to prevent them from causing problem. This understanding reveals that positive effect of cooperation among students in schools is ignored. However, in promising education, it is essential to create meaningful activities for students that they will have to work on problems with others. It is because the key to real learning is cooperative, purposeful activities in social environments (Philips and Soltis, 2004).

In order to improve students' academic achievements by improving their positive attitudes towards mathematics, there are many research oriented methods. Among them, to achieve a positive result in mathematics teaching, researches, supported by different methods such as music (Yağışan, et al., 2015; Koçoğlu, 2015), computer (Aşıcı, 2014), narration (Coşkun, 2013), impersonation (Şengül and Ekinözü, 2004), visualization (Koğ and Başer, 2012), multiple intelligence (Kuloğlu, 2005), were carried out.

Institutionalized educational practices are sensitive and irreversible, time-limited activities aiming to create a happy school life and future using the moment experienced. Therefore, the renewability and repetition of learning experiences in the classroom environment is quite difficult and costly. In this sense, as a requirement of efficient use of time in teaching applications, recording of the knowledge and experiences obtained by teachers to ensure maximum efficiency from planned learning experiences in schools is important for the formation of an important scientific knowledge.

Learning and teaching are dynamic processes that occasionally require controlled and scientific interventions. It is essential that guidance and interventions by trainers in the teaching process increase the quality of learning and the students develop positive attitudes towards classes. In this context in making lessons interesting for students, the method-techniques chosen by the teachers, who are in the position of guides in education-teaching, are critical factors in the process. It is important that this is tried by a specific research method and transformed into theoretical knowledge. Information based on experimental applications in classroom environments will often provide theoretical support to practical learning environments.

In this context, the aim of the study; cooperative learning method in primary school fourth grade mathematics course reveal students' academic achievements and their impact on mathematics attitudes. The study is limited to the "calculation of the environmental lengths" in the 4th grade mathematics course and 23 course hours.

Problem clause

What are the effects of the cooperative learning method on students' academic achievements and attitudes in mathematics?

Sub-Problems

In accordance with the aim of the study, the following sub-questions were sought:

Is there a significant difference between the academic gain of the test and control groups in the mathematics course?

Is there a significant difference between the attitude gain of the test and control group students towards mathematics?

METHODS

Many studies conducted in education are based on quasi-experimental design. The design contains running multiple instances in a specific time period. In this sense, it has a relatively low level of validity compared to classical experimental designs (Can, 2014). In the design of this research, pre-test-post-test control group design (PPCD), which is a mixed design often used in the field of social sciences, was used. This pattern gives the opportunity to compare the success of the collaborative method used in the research in the mathematics course to improve student achievement and positive attitude towards mathematics. In this pattern, the participants are measured in relation to the experimental procedure before and after the test procedure. PPCD is a related pattern because the same persons are measured twice on the dependent variable. However, it is also an unrelated pattern because it allows comparison of the measurements of the test and control groups composed of different subjects. Therefore, this pattern can be characterized as a mixed design (Büyüköztürk, 2014). Information on the procedures to be carried out to the test and control groups during the stages of this study is presented in Table 1.

The study group of this research consists of students studying in the 4th grade in the Battalgazi district of Malatya connected to the Ministry of National Education in the spring semester of 2015-2016. In order to make an appropriate comparison, the students were selected from the same environment as the socio-cultural sample. Although the test group participating in the study was designated as the class that the researcher worked, the control group was determined according to the pre-test results. The students continued their learning process in their classrooms. The characteristics of the test and control groups are presented in Table 2.

Table 2 shows the distribution of test and control groups, a

Table 1. Experimental Design Processes.

Group	Pre-test	Subject Field	Experimental Process	Post-test
Test	Achievement test	6th Unit: Calculating Perimeter Lengths	Cooperative Learning Method (TPT supported STAD technique)	Achievement test
Control	Achievement test	6th Unit: Calculating Perimeter Lengths	Teaching activities conducted in accordance with the guidelines in the mathematics teacher's manual	Achievement test

Table 2. Characteristics of the study group.

Group	Gender		Total
	Female	Male	
Test Group	10	10	**20**
Control Group	10	10	**20**
Total	20	20	40

numerically equivalent distribution is observed both in groups and between groups in terms of gender. Depending on this situation, in the creation of study teams, which are important factors of cooperative learning, numerical equality could be achieved in terms of gender. Also based on the study findings, in the comparison of test and control groups, numerical equality is important in terms of gender. In the study, t-test was used for unrelated samples to determine the similarity of test and control groups in terms of academic achievement. According to the analysis results, the arithmetic mean of the students related to pre-test scores showed no significant difference according to the group they were in [$t_{(38)}$=0,15 p>.05]. These findings can be interpreted as the test and control groups were similar in terms of their academic achievement according to pre-test scores.

Data collection tools

Mathematics achievement test and mathematics attitude scale were used in collecting the data of this study. To determine and compare the mathematical attitude of the study group, mathematics attitude scale, developed by Baykul, (1990) was used. The mathematics achievement test developed by the researchers was used to determine and compare academic achievement.

Data analysis

The data collected within the scope of the study were analysed by coding in the SPSS program. In the scope of the study, the progress points series have been created by calculating the difference between the pre-test and post-test points of the students in both groups; later these gains, which are indicators of the progress of the test and control groups, were compared with the t-test for unrelated samples (Can, 2014). In the context of study, it was measured whether the difference between the pre-test and post-test scores in the test group, where the collaboration learning approach practices were conducted, was significantly higher than the difference between the pre-test and post-test scores in the control group, where the teacher-centred teaching methods were conducted.

Test process steps

In the first phase of the study, a test of achievement and attitude scale, related to the subjects to be covered in the research process, were applied to the students in the test and control groups as pre-test. The pre-test findings obtained in the test group were taken as the basic score and 5 cooperative learning groups of 4 persons were formed by considering gender differences. In the test group, warm-up activities were carried out to ensure that the students were prepared for cooperative learning. Work sheets and monitoring tests with activities to maximize the interaction between students were prepared and reproduced in sufficient numbers. The "Team Play Tournament supported Student Teams and Achievement Divisions" (TPT-supported STAD) technique, containing the implementation of techniques "Student Teams Achievement Divisions" (STAD) and "Team Play Tournament" (TPT), which are among the cooperative learning applications, was applied in the test group. At the evaluation stage, a total of 11 tournaments were conducted during the survey, one for each gain. Three questions were asked to each level group in the tournaments and competitors received 10 points for each correct answer. In this case, each competitor was able to collect a maximum of 30 points for his or her team on the tournament table. In addition, 11 monitoring tests were performed in order to measure each gain. Team scores were calculated by adding monitoring tests and individual scores obtained in the tournament. As a result of monitoring tests and tournaments, the students who earned 30 points for their team were awarded with blue certificate; students who earned 20 points were awarded with a red certificate; those who earned 10 points were awarded with a green certificate. This application was also made for the teams. The teams with a total score of 200 or more were presented an award of star team certificate; a score between 150-200 was awarded with bees' team certificate; the teams under150 points were awarded with ants team certificate.

FINDINGS

In this experimental study, which examines the effect of cooperative learning method on learning in primary

Table 3. Pre-test and post-test averages for mathematics achievement test.

Group	Pre-test			Post-test		
	N	$\bar{X}$	ss	N	$\bar{X}$	ss
Test	20	55.20	19.34	20	71.10	20.38
Control	20	55.29	18.82	20	64-66	18.84

Table 4. T-test results For Academic Success Gain Points

Group	N	$\bar{X}$	ss	sd	t	p
Experimental	20	15.91	11.27	38	2.03	**0.049**
Control	20	9.37	8.95			

Table 5. Pre-test post-test means related to the mathematics attitude.

Group	Pre-test			Post-test		
	N	$\bar{X}$	ss	N	$\bar{X}$	ss
Test	20	3.52	0.702	20	3.65	0.730
Control	20	3.73	0.914	20	3.65	1.01

school 4th grade mathematics course, tests were applied before and at the end of the unit to a group of 20 people, whose mathematics lessons are taught according to cooperative learning method, and to the same number of other group where lessons are taught according to teacher-centered teaching. The averages for the test results are presented in Table 3.

As seen in Table 3, while the average score of pre-trial mathematics achievement test of the students who study according to the cooperative learning method is 55.20, this value was 71.10 after the trial. While the mean score of pre-trial mathematics achievement test of the students who were educated according to teacher-centred teaching method was 55.29, it was 64.66 after the trial. According to these values, it is seen that there is an increase in the mathematics achievement of the students who study according to both cooperative method and teacher-centred teaching methods. However, post-test averages in the experimental group increased more. The descriptive statistics of this increase and the t-test results for unrelated samples are given in Table 4.

It is seen that after the trial, the mean progress scores in the test group where cooperative learning method is applied ($\bar{X}_{test}$=15,91) is significantly different [t$\bar{X}$ (38)=2.03, p<0.05] than the mean progress scores in the control group where the traditional method ($_{control}$=9,37) is applied. This situation can be interpreted as the cooperative learning method is significantly more effective than the traditional method on student success in mathematics lesson in 'calculating perimeter length' unit. Although, the t-test for unrelated samples gives an idea of whether there is a significant difference between the means, it does not give clear information about the extent of this difference. Therefore, it is important to calculate the effect size as well as statistical significance. The effect size in T-test is calculated with *Cohen d* formula. The effect size calculated on the effect of the method on mathematics achievement is found as "*d*= .642". Based on the classifications in the literature, it can be said that the effect of the cooperative learning method applied in this experimental research on the mathematics achievement is between medium and large effect sizes (Can, 2016).

In order to obtain finding related to the second sub-problem that examines the effect of cooperative learning method on students' attitude towards mathematics, mathematics attitude scale was applied to the test and control groups before the unit starts and at the end of the unit. The means related to the test results are given in Table 5.

While the mean score of the mathematics attitude scale of the students, who are studying according to cooperative learning method, before the experimental process $\bar{X}_{test}$ = 3.52, this value was $\bar{X}_{test}$ = 3.65 after the trial. While the mean score of the mathematics attitude scale of the students, studying according to teacher-centred teaching method, before the test process was $\bar{X}_{control}$ = 3.73, it was $\bar{X}_{control}$ = 3.65 after the trial.

Table 6. T-Test results for mathematics attitude scale gain scores.

Group	N	$\bar{X}$	ss	sd	t	p
Experimental	20	0.124	0.515	38	1.006	0.546
Control	20	-0.78	0.737			

According to these values, while the mathematical attitude scale mean of the experimental group, in which the cooperative learning method was adopted and increased after the test process; the mathematical attitude scale of the control group, where the traditional method was applied, decreased. The descriptive statistics of the resulting gain scores concerning pre-test - post-test means and t-test results for unrelated samples are given in Table 6.

When the changes in the mathematical attitude scale of the students in the test and control groups after the test process are compared with t-test for unrelated samples, it is seen that the mean of the attitude gain scores in the test group,in which the cooperative learning method is applied ($\bar{X}_{test}$=.124), is higher than the average of the attitude gain scores of the control group in which the traditional method is applied ($\bar{X}_{control}$=-0,78). However, according to the results of the analysis, this difference between the test and control groups was not found to be significant [$t_{(38)}$= 1.006, p> 0.05].

DISCUSSION

Direct instruction, the most widely used method in the Turkish Education System, takes part at the end of the list about the persistence and recall of learning. However, the permanence and recall of knowledge is directly proportional to the degree to which the student is involved in the learning process. Cooperative learning, which is subject to the study, and teaching techniques in learning groups organized according to this approach have been known for many years. From the 70s, researchers working on education, examined small group activities and the interaction of students within the group. Such research has made significant contributions to the development and becoming widespread of cooperative learning techniques (Erden, 1988). When the course in question is mathematics, prejudices and negative attitudes of the students take precedence over the course content. At this point, learning-teaching methods and activities are the most critical factors. When we look at it in terms of the age group of the students, there is a need for instant help in developmentally necessary points in education activities in primary school years. In this critical period of development, provision of the support children need by their classmates, teachers, and learning environment without them being aware is a situation that naturally supports the positive learning environment.

In the experimental practice within the context of the study which lasted for five weeks, it was concluded that the TDT-supported STAD technique was more effective in increasing the academic achievement of students compared to the traditional method in the 4th grade math class "Calculation of Perimeter Lengths" subject where the gains for the implementation step of the cognitive dimension are predominant. In his study conducted with meta-analysis method taking into account 31 researches, Tarım (2003) found the overall effect size of cooperative learning on academic achievement as "*d* = 0.82". As a result of his meta-analysis on 26 studies, Özdemirli (2011) determined the effect size of cooperative learning on academic achievement in mathematics course as *D* = 0.59". In a meta-analysis study consisting of multinational students from 11 countries which included comparison of traditional methods of cooperative learning and 148 studies, significant findings have been reached in favour of cooperative learning in academic achievement and positive peer relations (Roseth, Johnson and Johnson, 2008). Research results showed that cooperation is more effective than interpersonal competition and individual studies; also cooperation provided by sustaining inter-group competition is more effective than individual competition and studies (Johnson et al., 1979). Along with that, in meta-analysis on 122 research, results were obtained in favour of cooperative learning; there was no significant differences found between the interpersonal competition and individual studies. The results have been consistent in concept learning, problem solving, classifying and reasoning in age and all subject areas including language, reading, science, art, physical education and mathematics (Johnson et al., 1981). Cooperative learning has been widely used and researched worldwide since the 70s (Vaughan, 2002). It has been confirmed by research findings that cooperative learning in terms of academic achievement is more effective in acquiring cognitive behaviours especially at the level of knowledge, comprehension and application; positively affect the relationships between students; increase their confidence; students have a more positive attitude towards school and lessons (Slavin, 1980). In addition, cooperative learning techniques are considered as a contemporary method of improving students' emotional and social aspects as well as cognitive aspects (Erden, 1988). It has been supported that cooperative learning is more effective than traditional methods in increasing students' academic achievement in mathematics (Erçelebi, 1995; Yıldız, 1998; Bozkurt, 1999; Deane, 2001; Yıldız, 2001; Vaughan, 2002; Kramarski and Mevarech, 2003; Tarım, 2003; Araz, 2004; Bosfield, 2004; Carlan et al., 2005; Ural, 2007; Karagöz, 2007; Özdoğan, 2008; Akbuğa, 2009; Conring, 2009; Özsarı, 2009; Zakaria et al., 2010; Özdemirli, 2011; Yıldırım, 2011; Sofeme, 2012; Torchia, 2012; Johnson, 2013; Kabuk, 2014; Koç, 2015; Titsankaew, 2015; Pesen and Bakır, 2016; Egüz et al., 2018). It increases their oral exam achievements (Bozkurt, 1999), persistency (Arısoy, 2011; Ünlü and Aydıntan, 2011), problem solving skills (Posluoğlu, 2002; Bernero, 2000) and geometric learning (Bilgin, 2004; Çırakoğlu, 2009; Torun, 2009; Marangoz, 2010; Gülsar, 2014; Dirlikli, 2015). A wide range of positive effects of cooperative learning based on academic achievement on mathematical learning were revealed by many different experimental studies. These positive findings cover different characteristics various study groups. For example; it has been determined that the cooperative learning environment is more effective than traditional learning approaches on students' mathematical calculation skills (Bosfield, 2004). More successful results have been achieved in cooperative learning groups than traditional methods (Erçelebi, 1995). Collaboration has been shown to support students' development of mathematics and social skills (Yıldız V., 1998; Koç, 2015). While making mathematics lessons more fun for students and teachers, (Gülsar, 2014) it has shown improving effects on self-esteem of students (Bernero, 2000), self-efficacy perception (Tuğran, 2015) and interaction skills (Deane, 2001). It was observed that there was an intense exchange of information between the students during teamwork and because of this, the students learned more solution strategies and realized their deficiencies by reinforcing their knowledge (Ural, 2007). Ensuring that teachers are more aware of the mathematical skills of their students (Carlan et al., 2005), increase in the interest of the students to the course, their being better motivated are among the positive results achieved (Arısoy, 2011). Students' being more engaged in problem solving, transition from competition to collaboration, exploring different solutions of problems can be counted among the other positive effects (Carlan, et al., 2005). The cooperative learning process has had positive effects on students' timid, dependent and competitive learning styles (Vega and Hederich, 2015; Tunç, 2016; Koçoğlu, 2017). Considering the large number of positive results, it can be predicted that the academic success of the students will increase due to the increase in the frequency of the use of cooperative learning method in primary school mathematics classes.

Cooperative learning techniques can be used to achieve academic and social goals at the same time and place, without sacrificing one to another (Slavin, 1981). Teachers who used cooperative techniques in their classes stated that they believed that cooperative learning would provide many benefits in terms of academic, social and psychological aspects such as students' development of positive attitude towards mathematics; increasing success, sharing, interaction, self-confidence, motivation; development of awareness of responsibility (Macit, 2013). Based on the data provided by a large number of studies, it is necessary to use the concept in the right course and the age range by making appropriate determinations instead of questioning the contribution of cooperative methods and techniques to success or attitude (Türkmen, 2016). A lot of research has been done in recent years to evaluate the effectiveness of cooperative methods and techniques Most of these studies have validated that cooperative methods and techniques are more effective than traditional competitive methods and techniques in increasing students' achievement. Perhaps more importantly, these studies showed that cooperative learning strategies significantly increase the motivation of students at low and middle achievement levels. Moreover, it is understood that cooperative learning strategies do not only increase academic achievement but also seed the values of help and cooperation and is highly effective in ensuring social development. Thus, it is thought that cooperative learning method can help not only cognitive development but also affective competencies.

In one or more stages of cooperative learning or any activity, working together in small groups is an important part of learning (Eurydice, 2011). One of the primary benefits of cooperative learning, to increase the self-esteem attitude that motivates students to participate in the learning process. Cooperative based efforts shaped in this way result in the success of the participants. Students help each other to improve the performance of their teams, where friends from all levels are in (Panitz, 1999). Researches have proven that cooperative learning can be highly effective developing positive attitudes towards school and encouraging student interaction (Vaughan, 2002). Researches also indicate that the cooperative approach has positive effects on students' attitude towards mathematics (Vaughan, 2002; Gelici and Bilgin, 2011; Özdoğan, 2008; Andersen, 2009; Ural and veArgün, 2010; Efe, 2011; Çapar and Tarım, 2015; Titsankaew, 2015; Akman and Koçoğlu, 2016). In traditional learning environments, as the students are not sufficiently aware of each other, the attitude that may arise as a result of the interaction does not develop positively; in teamwork, it is possible to develop positive attitudes about mathematics based on interaction and common success. For example, 45% negative attitude towards mathematics prior to cooperative learning practices were identified at 90% positive level at the end of the practices (Bernero, 2000). It has been seen that cooperative learning experiences in mathematics lessons increase students' confidence and to develop positive attitudes related to the ability to work on mathematics (Brush, 1997). Providing the skills and requirements needed for learning in cooperative practices requires time and practice for students and teachers (Harding and Fletcher, 1994). The scientific fact that needs to be taken into account is that the reason why the test procedure applied in this study did not provide a statistically significant expected development of students' attitude towards mathematics can be caused by the uncontrolled variables in the context of study conditions, duration, limitations and possibilities. Based on the results, the following suggestions are given.

Primary school teachers should be encouraged to use strategies and techniques that involve collaborative team work by raising awareness of the benefits of cooperative learning.

In mathematics teachers' guidebooks, activities organized according to cooperative learning methods and tools such as work sheets, monitoring tests and certificates that will enable these activities to be carried out in a practical way should be readily available.

Cooperative learning practices in mathematics courses should be started in early classes and students should benefit from each other. Thus, it is thought that students will be able to develop more positive attitudes towards mathematics by increasing their academic success.

Similarly, in experimental studies, longitudinal studies should be carried out which include intermediate measurements that can be used to evaluate the process by keeping the experimental application time longer. Thus, it is thought that cooperative learning process may have more positive effects on attitude.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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