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Determining the Academic Achievement of Students Who Use Flipped Classroom Method Supported by a Mobile Application and Their Views on Collaborative Learning

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Abstract

In our study, a flipped classroom method supported by a mobile application was prepared, and students' opinions about collaborative learning were evaluated along with its effect on their academic achievement. In the quantitative research section of this research, a semi - experimental pattern model with pre-test and post-test control group was used for the academic success variable. The population of the study consisted of 48 randomly selected and 48 control group students from the Sancak Secondary School affiliated to the National Education Directorate in the Selcuklu district of Konya province. According to the results of the research, it is that the academic success of the students who utilized the flipped classroom method supported by the mobile application increased, compared with the students who took the traditional -learning method, and this was found statistically significant. In addition, it has been observed that the students' prejudice to mathematics has been removed; they had fun in the process; they liked the lesson and they took an active role thanks to the mobile-supported FCM (Flipped Classroom Method). It is also seen that blending FCM and Collaborative Learning method increased the students' interest, motivation, participation in the class and their sympathy.

Mobil Uygulama ile Desteklenmiş Ters-Yüz Öğretim Ortamını Kullanan Öğrencilerin Akademik Başarılarının ve İşbirlikli Öğrenmeye Yönelik Görüşlerinin İncelenmesi

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Öz

Araştırmamızda mobil uygulama ile desteklenmiş ters-yüz öğrenme ortamı hazırlanmış ve öğrencilerin akademik başarısına etkisiyle birlikte işbirlikli öğrenmeye ilişkin görüşleri değerlendirilmiştir. Bu araştırmanın nicel araştırma bölümünde akademik başarı değişkeni için "Ön Test – Son Test Kontrol Gruplu Yarı Deneysel Desen Modeli" kullanılmıştır. Araştırmanın evrenini Konya ili Selçuklu ilçesindeki Milli Eğitim Müdürlüğüne bağlı Sancak Ortaokulu'ndan rastgele seçilmiş 48 deney ve 48 kontrol grubu öğrencileri oluşturmaktadır. Yapılan araştırma ve bulgulara göre, mobil uygulama ile desteklenmiş ters-yüz öğrenme ortamının işbirlikli öğrenmeyle yapan öğrencilerin, geleneksel öğretim ortamı ile ders gören öğrencilere oranla akademik başarısının arttığı görülmüş ve istatiksel olarak anlamlı bulunmuştur. Ayrıca, mobil destekli TYÖO (Ters-yüz Öğretim Ortamı) sayesinde öğrencilerin matematik dersine olan ön yargısının kalktığı, süreçte eğlendikleri, dersi sevdikleri ve aktif rol aldıkları gözlemlenmiştir. Bir başka bulguda ise, TYÖO ile İşbirlikli öğrenme ortamının harmanlanması öğrencilerin derse olan ilgisini, motivasyonunu, derse katılımını ve sevgisini arttırdığı tespit edilmiştir. Kullanılan yöntemin deney grubu öğrencilerinin akademik başarısına da pozitif yönde etki ettiği görülmüştür.

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Introduction

Developments in science and technology are forcing all areas from economy to health, from art to literature to go through important changes. They in turn lead to changes in the structure of societies and acceleration in other developments. Therefore, these changes reveal the necessity to change the education and training institutions (Kocabatmaz, 2016:14). In today's educational system, it is requested that students go to the centers or instituions rather than to teachers. The behaviorist approaches used in TLM (Traditional Learning Method) are gradually shifted to the constructivist approach (Yıldız, Sarsar & Çobanoğlu, 2016: 187). In addition, the use of many different models and methods to synthesize the information has become important. This has led to the idea that in order to better educate students, practical training should be carried out in a broader period of time (Kocabatmaz, 2016: 14; Yıldız et al., 2016: 187).

Communication has recently introduced the concept of smart mobile devices with the development of computer and telephone technologies. The literary meaning of the word mobile originating from *Mobile* in French is movable and portable (Çakır & Arslan, 2013: 25). With personal smart mobile devices, people have recognized the possibilities of managing audio files, images, information and storage. These tools allow people to share the data with others at any time (Sharples, Corlett & Westmancott, 2002: 220). With mobile devices dating back to the 1970s, learning was carried out in and out of classrooms in the school environment with portable light vehicles such as laptops, tablets, palmtop computers and smartphones (Gökçearslan, Solmaz & Kukul, 2017: 146). ML (Mobile Learning) is defined as a teaching model that enables mobile communication and e-learning areas to access the content in a mobile application as a result of blending together, to benefit from dynamically developed services and to make communication with other people in the learning environment as much as possible without being dependent on time and place (Özcan, 2008: 1).

Many applications have been developed to increase the availability of mobile devices and for commercial purposes. Thanks to these applications, access to information can be provided directly or via the Internet without being dependent on time or a learning method (Tanrıverdi, 2011: 1). Although the features of mobile smart phones such as their small screen size, lack of battery times, low data and memory capacity may limit the use of these devices in learning activities, mobile phones can help with learning through designs suitable for the learning method thanks to their features such as portability and fast communication. Student-centered mobile applications increase academic success (Tanrıverdi, 2011: 1).

Collaborative and communicative skills enabled individuals to develop media and technology literacy, to improve 21st century skills (problem solving, critical thinking, creativity, design, social-cultural skills), to learn how to learn and to make self-assessment (Yıldız et al., 2017: 77). In order for these skills to be developed by the learners, learning-based education is required by multiplying these activities in the classroom. For this reason, active participation of FCM students is necessary. FCM has been preferred in accordance with the constructivist teaching approach since 2000 (Yıldız et al., 2017: 77).

By completely reversing the TLM, FCM makes it possible for students to learn the course material presented during classes and then loaded into the electronic environment regardless of the setting (Moreno, 2004). In the course of the school hours, the course aims to deepen and strengthen the learning by discussing the subject and making reinforcement examples. In short, this method is the opposite of the TLM (Figure-1). As TLM is known, the teacher first lectures in the classroom, while the student is only seen as a passive listener. Homework is given to students to reinforce the subjects lectured. In this process, it is assumed that students will reach up to the first two steps of the Bloom taxonomy, which are recollection and comprehension (Figure 1) (Kara, 2016b: 13). After in-class teaching, students are asked to apply the applications of Bloom taxonomy to more complex and difficult upper steps as homework (Figure 2). FCM students are relatively easy to remember and understand the steps of listening to the course they do at home by themselves. Other difficult and complex upper-level activities are provided by teachers in a classroom setting through active learning methods (Figure 2) (Kara, 2016a: 13).

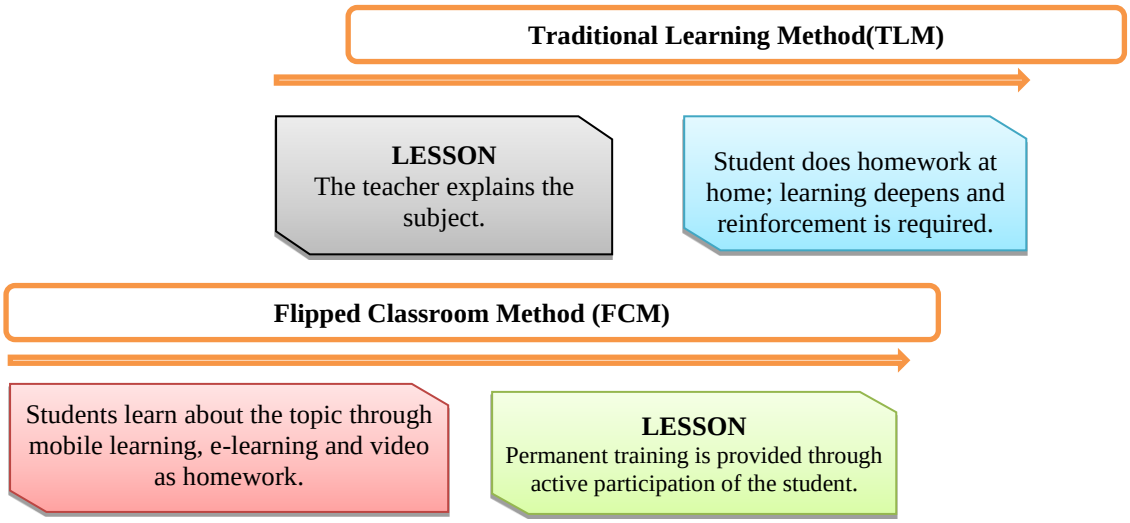

Figure 1. Temporary "TLM" vs. "FCM" (Kara, 2016a:13)

FCM has taken this name because it has displaced the stages of the course of TLM. In summary, this can be defined as completing the lesson at home and doing homework in school. If the definition of FCM is made in terms of education, it is the method in which classroom activities are applied outside the school and all activities in the classroom are applied in the active learning process (Kara, 2016a: 13).

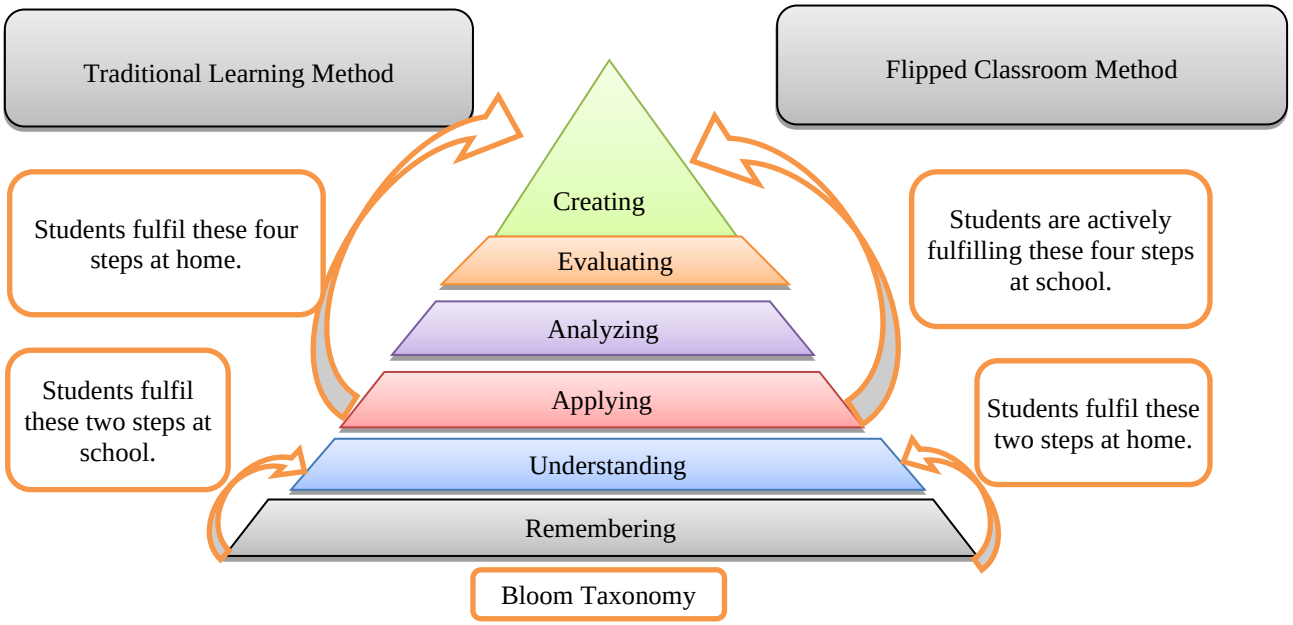

Figure 2. The demonstration of "FCM" vs. "TLM" in the Bloom taxonomy model.

The Flipped Classroom application does not have a uniform shape or model. FCM is a method of transition from teaching at a teacher-centered setting to an active and collaborative learning method centered on students and

learners. Therefore, FCM can be applied with different tools and materials in accordance with the need. (Kara, 2016a).

One of the most important advantages of flipped classroom application in this field is the tendency to interact between the teacher and the student (Artino, 2008). In FCM, students complete their teaching in the center and under the guidance of the teacher in the active learning environment. However, in a traditional setting, the teacher only plays the role of imparting the subject. In the FCM system, the student-teacher interaction is naturally increasing. This process also facilitates the feedback from the instructor (Figure 2) (Kara, 2016b: 13).

Some of the researchers found that students had a negative view of the FCM in their research, which compared the traditional teaching method with the FCM. Doğan (2015), who reported that participants had negative experiences regarding the flipped classroom approach, had positive experiences regarding a pilot study, suggesting that these participants may have prejudices against the flipped classroom approach (Doğan, 2015: 45; Turan & Yüksel 2015: 163). There are also opinions and bodies of research suggesting that the FCM system is positive. It is stated by Ekmekçi (2014) that the FCM yielded positive and positive results on students (Ekmekçi, 2014: 144).

Mobile applications play important roles in blended education model. In a study by Torun and Dargut (2015), it suggested that the learners are willing to use ML, and that the communication between the teacher and students, as well as the one between students, is strengthened. It is observed that ML contributes not only to the positive development of students' academic achievement but also to the development of knowledge and socio-cultural development (Torun & Dargut, 2015: 27).

The failure to design a good learning method leads to the failure to benefit from the FCM method. In our research, it is thought that a FCM learning method with a mobile application will be effective in line with field research. With this study, an example of the basic logic of FCM has been created to use ML environments in teaching mathematics, and students' opinions about this environment have been collected. In this context, the subject of the study was presented to the students in a blended format of the new learning methods, which are mobile learning and flipped classroom learning method. Students received theoretical information in their homes through the pre-prepared mobile application on video, flash card, pill information etc. In the school, the deficiencies were tried to be solved by individual and group studies under the guidance of teachers.

The aim of this study is to develop different learning methods in teaching mathematics because of the low academic achievement of students, their negative attitude towards the course, their low motivation and difficulty in mathematics. As all over the world, new developments have occurred in Turkey in the field of educational technology. These developments have created new teaching models in the field of teaching. The most important feature of the flipped classroom (Flipped, Homework at Home Course), which is named differently in the literature, is to enable the students to move away from the traditional learning method in which they are just listeners in a passive position. It is seen in field research that students have developed their problem-solving skills and collaborative learning skills significantly through this method.

The aim of the study is to examine the effects of flipped classroom method supported by a mobile application on students' achievement and their opinions on collaborative learning. In this context, the answers to the following research questions were sought;

1. Is there a significant difference between students' academic achievements when comparing the traditional learning method with the mobile application and the Flipped Classroom Method?
2. What do students think about the methods used in the flipped classroom method supported by a mobile application developed and the course applied?
   a. What are the views of students about mathematics lesson and what is the level of their interest in the course?
   b. What are the views of students about collaborative learning?
   c. What are the views of students about the use and applicability of the Flipped Classroom Method supported by a mobile application?

Method

Qualitative and quantitative data were used in the research. The effectiveness of qualitative data analysis in the process of describing and explaining the increasing reputation and social reality in the academic environment has led to a significant increase in the number of studies conducted in this area. It has not been possible to develop a common language in qualitative research which has been done in recent years in qualitative data analysis. Therefore, it is possible to see different analysis methods and techniques in data analysis (Dey, 1993; Özdemir, 2010).

The most appropriate method within the scope of our research subject is considered as the mixed research method. In the quantitative research section of this study, the semi-experimental pattern model with pre-test – post-test control groups was used for the academic achievement variable (Campbell & Stanley, 1966) (Table 1). Experimental patterns are research patterns that reveal the cause-effect relationships and differences between variables. The difference between the quasi-experimental design and the experimental design is the selection of the individuals in the quasi-experimental design, control and experimental groups, rather than randomization. In order for educational research to give accurate results, semi-experimental designs are widely used because it is very difficult to make neutral assignments (Büyüköztürk et al., 2014).

Table 1. Experimental pattern

Pretest-posttest control grouped pattern			
Group	**Pretest**	**Operation**	**Posttest**
Experimental Group	T1	Mobile-assisted Flipped Classroom Method	T1
Control Group	T1	Traditional Learning Method	T1

Working group

The universe of the study was composed of students studying at Sancak Secondary School affiliated with the National Education Directorate in Selçuklu district of Konya province. For random assignment of the experimental and control groups, improved learning model is applied to randomly chosen 48 experimental group students in 7th grade by considering 2016-2017 Academic Year Mathematics lesson 1st semester grade average ($\overline{X}$ = 73.76) and students' mobile application skills and pre-test results ($\overline{X}$ = 32.19). Similarly, traditional learning method is applied to randomly selected 48 control group students in 7th grade by considering mathematics course the first semester average grade ($\overline{X}$ =74.19) and pre-test average ($\overline{X}$ =32.86) (Table 3)(Table 4).

The blended learning model was started by the researcher with 48 students for 2 weeks. However, 42 Experiment Groups and 46 Control Groups were fully involved in the process due to absenteeism and because students did not want to complete the process (Table 2). In order for the research to be neutral, the experimental and control group students were trained by the same teacher.

Table 2. Working Group Gender Distribution

Gender	**Experimental Group**		**Control Group**		**Experiment and Control Group**	
	f	%	f	%	f	%
Male	23	54,76	20	43,48	43	48,86
Female	19	45,24	26	56,52	45	51,14
Total	42	100	46	100	88	100

A comparison of the results of the academic achievement test applied to the experimental and control groups (pre-tests) (independent t-test for unrelated samples) is given in Table 3.

Table 3. Pre-Test Comparison Results Between Groups

	Groups	N	$\overline{X}$	Ss	Sd	t	p
Pre test	**Experimental Group**	42	32,19	9,46	86	-,386	,700*
	Control Group	46	32,86	6,94			

Note. p<0.05

In the preliminary tests conducted in the experimental and control groups (experimental group pre-test average = 32.19; control group pre-test average = 32.86) * p <.05 is not significant because it is .05 <p for significance level (Table 3). Similarly, the grade point averages were similar in both groups (Table 4). In other words, it was determined that both groups were roughly equal before the research.

Table 4. Comparison Results of 1st Semester GPA between Groups

Groups	N	$\overline{X}$	Ss	Sd	t	p
Experimental group	42	73,76	11,30	86	-,188	,851*
Control group	46	74,19	10,32			

Note. p<0.05

Collection Tool and Data Collection

As the data gathering tool within the scope of the study, the *"Academic Achievement Test"* and *"Collaborative Learning and Questionnaire Form",* which were examined by 4 field experts and 2 linguists, were prepared by the researchers.

Before starting the research, pre-analysis of mobile application design was made with the learning method. The existing situation and the desired situation were determined. First, expert opinion and student interviews were analyzed for the development of data collection tools. According to the result of the prepared analysis report, the application process was designed and the instructional learning method design was developed with the tools to be used during the application. During the two-week implementation process, all the stages of the research were recorded in detail with the help of video footage and student views. A rich content was obtained through the collected data. The Academic Achievement Test, which was developed by researchers and experts at the beginning and end of the application, was conducted as pre and post-test.

After the application process, semi-structured Collaborative Learning and Interview Form were developed by the researcher. Qualitative data were collected to answer the second question of the study.

Flipped Classroom Method

The data were provided by the participants before and after the experimental procedure by completing the achievement test, collaborative learning and interview form. Video recordings were taken to examine the students' behaviors. Detailed implementation plan is presented below.

Activities before the Implementation Phase

The following processes were carried out before starting the planned training environment.

- Necessary permissions were obtained from the Konya Provincial Directorate of National Education and parents before 48 students were randomly assigned to the study and control groups.
- On April 16 2017, the students were pre-tested to see their current situation. For the pre-test, the students were asked to complete the "Academic Achievement Test" and "Collaborative Learning and Questionnaire Form."

Activities in the Implementation Phase

The following processes took place after the studies to be performed before the implementation;

- As of April 17 2017, the implementation of the mobile application and the course were applied to the students for 1 week at home and for 2 weeks in the classroom. Control and experimental groups were divided into two classes as 24 individuals.
- On April 17 2017, the mobile application was pre-installed on students' phones. Information about mobile application was delivered. The students were informed about the teaching model to be applied.
- Students were given 1 week (18-25.04.2017) to study mobile application. Students were told that they must observe every section of the mobile application at home and that they could watch the videos as much as they want. They were told that, during the first week, they would spend 30 minutes a day with mobile application and that they could take short notes if they wanted. They were told that they could ask the questions they wanted in the group communication department that was created with the teacher when they had a problem at home.
- In the 2nd and 3rd weeks, the classroom stage of the reverse facial model was carried out. In this process, it was stated that smart phones might be with them.
- On April 26 2017, the students were divided into 4 groups. A total of 12 groups were formed in two classes. The dates specified in the two classes were used. Only the hours were set differently.
- It was stated that each group should have a leader and a group name.
- In-class activities prepared by the teacher between April 26 and May 3, 2017 were grouped together. Examples were distributed to groups and had them made.
- The students were given the right to speak about the parts they did not understand. The teacher tried to correct the problems.
- On May 4, 2017, the teacher organized a 20-question quiz on the subject in the classroom. The next day, they were asked to take a last look at the mobile application and ask them in the group communication section if they wanted to ask any questions.
- The traditional teaching model was also exchanged between the teachers in the normal classes.

Activities Following the Implementation Phase

The following actions were realized after the completion of the teaching process;

- The students were appreciated for their participation in the learning program for two weeks, and a semi-structured interview form prepared to evaluate the process was applied to the students.
- "Flipped Classroom Method Participation Certificate" was prepared and distributed to the students after participation.
- After the completion of the process on May 5, 2017, the students were asked to do the final test in the same way as "the Academic Success Test" and "the Collaborative Learning and the Course Discussion Form", which were conducted as the pre-test.

Mobile Application Design

The mobile application was prepared and planned by the researcher in accordance with the design principles. The pictures and contents of the mobile application were prepared as described below.

Mobile application was prepared by researchers and field experts in the site **"mobiroller"** (make your own mobile application site). Mobile application content was prepared according to the opinions of 4 field experts. In line with the basic elements of visual design, line, color, shape, balance, value and texture characteristics were compiled by the researchers. At the same time, while designing mobile applications, integrity, difference, emphasis and balance were taken into consideration in visual design principles. After the design and content of the mobile application were prepared, 10 students and 4 field experts who were teaching to the 7th grade were shown the mobile application and their opinions were received. From the warnings taken, the final form of the mobile application was given, and the experimental group was made ready for installation (Figure 3-12).

Figure 3. Mobile Application Homepage

Figure 4. Mobile Application Videos

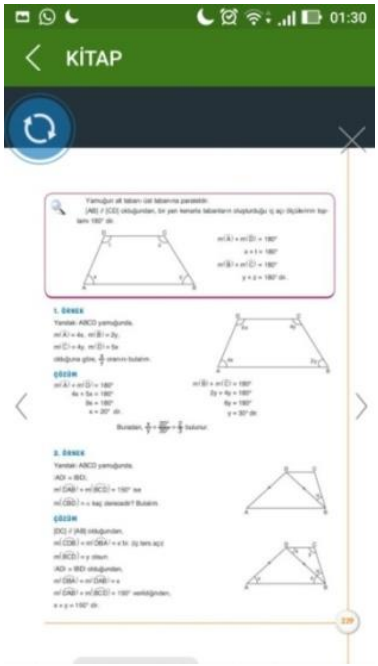

Figure 5. Mobile Application Textbook

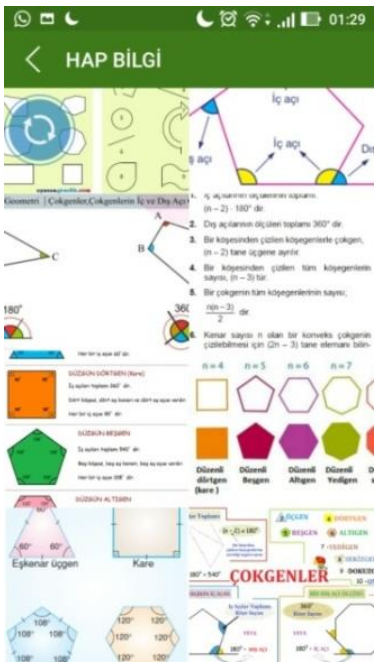

Figure 6. Information on Mobile Application Pills

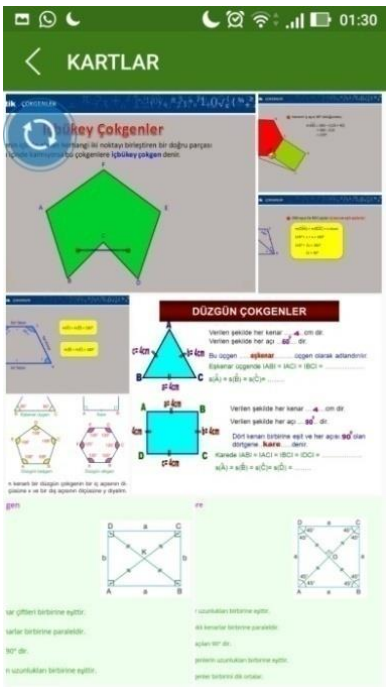

Figure 7. Mobile Application Cards

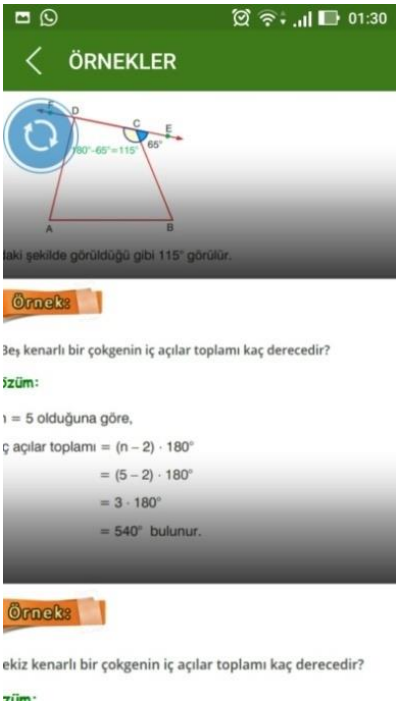

Figure 8. Mobile Application Examples

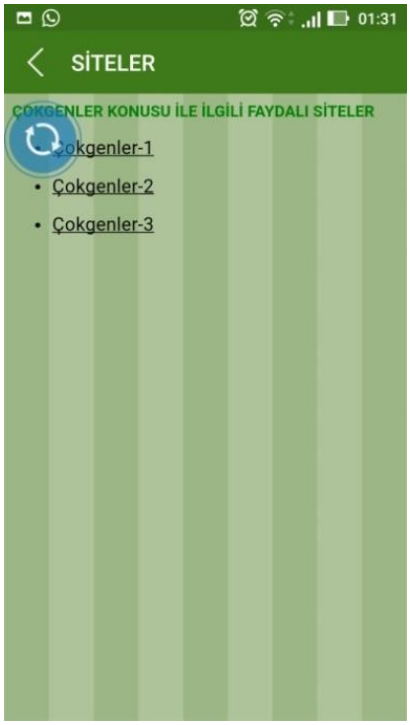

Figure 9. Mobile Application Sites

Figure 10. Mobile Application

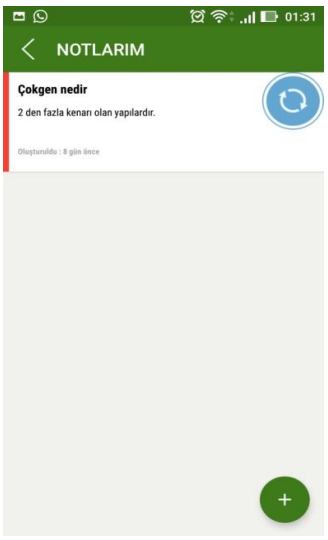

Figure 11. Mobile Application Notes

Figure 12. Mobile Application Communication

Findings

The In this part of the study, the research questions and the results of the statistical analyses performed according to the data collected from the research are presented in detail.

The experimental group students performed the tasks given in the developed classroom and so did the control group students in the traditional classroom environment. The students completed the content of the 2-week Math "Polygons" subject (4 + 4 lecture hours) within the given time period. FCM activities were conducted in an empty classroom suitable for the students to avoid problems during the learning method. Video recordings and pictures were taken to examine how the teaching process took place. In order to examine the problems and classroom behaviors of students, video recordings and "*Collaborative Learning and Questionnaire Form*" were used. After the completion of the FCM activities, students were asked to complete the semi-structured "*Collaborative Learning and Questionnaire Form."* Students were asked about their opinions regarding the process during video recording. General thoughts about the learning method developed during video recording were asked and recorded. As a result of the semi-structured interview form, academic achievement test and video recordings, the students were coded as follows when the findings were given.

EG: Experimental Group, **CG:** Control Group.

Is there a significant difference between the students' academic achievements when compared with the traditional learning method and the Flipped Classroom Method supported by the mobile application?

The level of significance between the students using the flipped classroom and the students' academic achievement was examined.

Experiment group pre-test - posttest comparison (Paired t test)

As a result of the application, the results of the comparison of the pre-test and post-test to determine the academic development status of the experimental group students are given in Table 5.

Table 5. Experimental Group Pre-Test-Final Test Comparison Results

	Test	N	$\overline{X}$	Ss	Sd	t	p
Experimental Group	Pre-test	42	32,19	9,46	41	22,049	**.000**
	Post-test	42	83,52	10,28			

* p<0.05

There was a statistically significant difference (p <0.05) between the pre-test and post-test scores (pre-test average $\overline{X}$ = 32.19; final test average $\overline{X}$ = 83.52). It was determined that the experimental group students increased their academic achievement as a result of the application they participated in with the flipped classroom method (Table 5).

Control group pre-test – post-test comparison (Paired t test)

As a result of the application, the results of the comparison of the pre-test and the post-tests to reveal the academic status of the control group students are given in Table 6.

Table 6. Control Group Pre-Test-Final Test Comparison Results

	Test	**N**	$\overline{X}$	**Ss**	**Sd**	**t**	**p**
Control Group	Pre-test	46	32,86	6,94	45	32,079	**.000**
	Post-test	46	55,91	14,71			

Note. p<0.05

There was a statistically significant difference between the control group pre-test post-test scores (pre-test average $\overline{X}$ = 32,86; final test $\overline{X}$ = 55,91) for the statistical significance * p <.05 (p <0.05). A significant difference was found in the academic achievement of the control group students (Table 6).

Experiment and control group posttest comparison (Independent t test)

The results obtained from the students using the inverted learning method (experimental group) and those who received traditional learning method (control group) compared to their "academic achievement" are given in Table 7.

Table 7. Between Groups (Experiment - Control Group) Final Test Comparison (T - Test) Results

Groups		**N**	$\overline{X}$	**S**	**Sd**	**t**	**p**
Post-test	Experimental Group	42	83,52	10,28	86	10,112	**.000**
	Control group	46	55,91	14,71			

Note. p<0.05

In post-treatment tests, there was a significant difference in favor of the experimental group, since * p <.05 was 0.00 <.05 for the final test. In the final tests (EG posttest average test $\overline{X}$ = 83,52; CG posttest average test $\overline{X}$ = 55,91), the posttest scores of the experimental group were found to be higher than the posttest scores of the control group (Table 7). This result shows that the application was in favor of the experimental group. The effect of the mean difference between the experimental group and the control group was examined for the neutrality of the results. In the calculations, Cohen's d value was 2,176. The effect size (r) was calculated as 0.736.

What did the students think about the methods used in the flipped classroom method supported by the mobile application developed and the course applied?

The methods used in the learning method and the views of the students about the teaching of the course were investigated. In this context, the answers to the three research questions were sought.

1. What are the views of students about mathematics lesson and their interest in the course?

The students were asked about the benefits of the learning method and the changes in their interest in the course. The students used the expressions that FCM and the mathematics courses were prevented from being boring. In addition, the students stated that their prejudices in the teaching of difficult mathematics lessons with FCM were removed and their interest in the lesson increased. Some of the students expressed that they liked mathematics lessons with this method.

In the research, students were asked about *"the benefits of the learning environment related to the mathematics course and the changes in their interest in the course".* Most of the experimental group students responded positively to this research question. The students stated that the flipped classroom method was fun for the math lesson. In addition, the students found this method very useful and expressed that they liked the mathematics lesson. The students stated that they had the opportunity to do a lot of repetition at home with the flipped classroom method. Thus, it is easy to learn mathematics. On the other hand, students expressing negative or abstentious stated that the new methods were good for students with a high success but not so good for students with a low success. Another negative statement was that individual study would be good rather than group work.

Table 8. Benefit rate for mathematics course

Favorable	Unfavorable	Neutral
39	1	2

According to **the video recordings,** it was observed that the students enjoyed themselves with the developed learning method. It was observed that the students were active participants throughout the course. In the course of teaching mathematics, it was found that they benefited greatly from pills and flash cards. The students stated that the prepared activities were suitable for the mathematics course. It was observed that students experiencing a negative or abstaining opinion about the method experienced unrest in the group. In the examinations, 39 students used the method; 1 student was useless and 2 students were found to have abstinence (Table 8). This situation shows that the most important factor in increasing the academic success of mathematics course with FCM is that it causes students to have fun during the course and hve a high interest in the course.

2. What are the views of students about collaborative learning?

The following findings were obtained in the experimental group students filling *"Collaborative Learning and Interview Form".*

42 students who completed the FCM process were asked through CL whether it had helped them learn the lessons better. According to Table 9 from EG, 38 students gave the answers "yes" and 4 students "no". The students who answered "Yes" were asked how it contributed to their learning. The reason for their negative answer was asked to students who gave the answer "No".

Table 9. Percentage of Students Considering Contribution to Collaborative Learning

Yes	No
38	4

The experimental group students' ideas about collaborative learning were found to be positive. The students specifically stated that they could express themselves in group work in this method. The students also stated that they were having fun in the class as they worked together with their friends. It is seen that the students benefit from this method in understanding the subject by doing activities together with their friends. Group mates correcting each other's errors have a positive effect on understanding the subject. The students who did not find cooperative learning useful were found not to be in good agreement with their friend and therefore they did not like collaborative learning.

In the research, it was determined that FCM had a significant learning effect on students through collaborative learning method and their active participation in the course.

The students were asked about the most pleasing aspects of this method in IO studies. The positive thoughts of the students were collected in 5 categories (Table 10). Some of the students liked the CL method in a few ways.

EG7 students did not make any comment. The conditions that students liked about the environment are listed in Table 11. According to the findings, 15 experimental students stated it as “asking their friends what they didn’t understand”, 11 experimental students stated as “activities and lessons at home”, 10 experimental students stated it as “Group work”, 8 experiment students stated it as “Help and Sharing” and 4 experimental students stated it as “using the phone”.

Table 10. The ratio of students' likes in collaborative learning

Group work	Activities and lessons at home	Help and sharing	Phone use	Asking friends what we don't understand
10	11	8	4	15

In the research, *what the aspects they didn’t like and the difficulties they encountered in the application of collaborative learning were* asked. In Table 11, the problems and difficulties experienced by the students are gathered in 5 categories. 26 students from the experimental group stated that they did not encounter any difficulties in the process and they easily performed the whole process. In CL with FCM, 5 of the students stated that they had problems with the negative behavior of their friends; 4 of the students replied that they disagreed with group friends. 3 students complained about “selfishness of group mates” and “Internet problems”, and 1 student stated his problem as “activities”.

Table 11. Problems experienced by students in CL

Not being able to agree with group friends	Negative behavior of our friends	Selfishness of group friends	Internet problems	Activity
4	5	3	3	1

As shown in Table 11, the individual errors made by the students during the CL process had a negative impact on the other students. However, in this study, it was determined that students did not prevent them from being successful in FCM environment. The academic success of the students who had problems in the examinations didn’t decrease.

Students were asked w*hat the changes that they see during group work were. The* general answers given by the students in Table 12 were collected in 5 categories. 6 of the experimental students stated that their participation in the class increased, 18 stated that they understood the subjects more comfortably. 5 remarked that they had increased motivation to the course. 7 stated that they had fun in group work. 3 stated that their interest in mathematics increased. Students EG7 and EG27 stated that they did not see any change in themselves.

Table 12. The Ratio of Changes That Students saw in Themselves Through CL

Active participation increase	Easy to understand topics	Motivation increase	Fun group work	Increased interest in mathematics
6	18	5	7	3

Students were asked h*ow they evaluated face-to-face communication with their group friends during the implementation of the method.* The answers of the students were collected in 3 categories (Table 13). Students are divided into three groups; those who saw the communication with their group friends as good, the ones who saw the communication with their group friends as bad, and the ones who generally saw the communication with their group friends as good although they had some problems.33 students stated that they had good communication with their friends. 4 students noted they didn’t get along well and 5 students stated that they had arguments but the communication was still alright. According to the findings of the research, it was determined that the blending of

CL with FCM increased the level of communication between students themselves and between teachers and students.

Table 13. The level of communication between group colleagues in CL

Students who describe their communication with their friends as good and fun.	Students who responded as not getting well with their group friends.	Students who state that they both went well and argued occassionally.
33	4	5

Students were asked *whether there were any characteristics of their group friends that they hadn't noticed before but did so during their group work.* Students' answers were collected in two main categories. Table 14 reveals the students who noticed the difference in their friends and those who didn't. 23 students noticed a change, but 19 students did not notice any changes in their friends. Some students' answers are as follows;

Experimental group students remarked that they had noticed some personality characteristics in their friends during cooperative learning noticed. The students in the experimental group stated that their friends were entertaining, helpful and mobile addicts.

Table 14. Change in group friends during CL

During CL, students noticed a change in their friends.	During CL, students didn't notice a change in their friends.
23	19

The students were asked h*ow they had solved this problem when there were missing places that they and their group friends didn't understand.* It is seen that students resorted to one or more of the three different solutions (Table 15). When the experimental group did not understand the subject, the majority of the students stated that they asked the teacher first. The students then stated that they benefited from the mobile application and their friends. These solutions involved friends, teachers and mobile applications. 22 of the students stated that they took advantage of their friends, 34 of their teachers and 31 of mobile applications.

Table 15. Methods of assistance in CL

Friend	Teacher	Mobile App
22	37	31

Many of the students repeatedly stated that they overcame their problems with the guidance of a teacher. As it can be seen in Table 15, it was determined that the teacher was the one that the students most frequently applied to. At the same time, it was determined that most of the students' cognitive load decreased through the teacher.

Students were asked *whether they would like collaborative learning method to be used in lessons and why.* Those who said yes and those who said no are collected in two categories (Table 16). While the number of students who wanted CL to be applied in lessons is 38, the number of those who didn't want is 4. It was determined that the combined use of FCM and CL environment increased the willingness of the students for CL method to be applied in the courses.

Table 16. Ratio of CL method to be applied in courses

willing	unwilling
38	4

The experimental group students stated that they had a good time thanks to the CL method; they benefited from their friends' knowledge and learned easily thanks to their group friends. On the other hand, students who thought negatively about CL stated that they could not get along well with their group friends.

The students were asked w*hat should be considered to ensure the efficiency of group work and what they recommended.* The experimental group students suggested that the choice of their group friends should be done

by the student himself, that each student should have a task within the group and that there should be silence in the group during the solution of the questions.

3. What are the views of students about the use and applicability of the Flipped Classroom Method supported by mobile application?

The students were asked about their positive and negative thoughts about the developed Flipped Classroom Method. The experimental group students said that the videos were simple to understand and easy to work at home. It was also very reasonable to do homework at school because the students stated that there were many people to ask for help about the points they didn't understand while at school. It was seen that the students had fun in the implementation of this method. It should be noted that the mobile application contains a lot of information about the subject and that students are efficiently learning the subject. On the other hand, the experimental group students who revealed negative opinions stated that they had problems with their group friends. These students said that the problem of internet shooting at home had a negative impact on the applicability of FCM.

Table 17. Reflections on improved teaching environment

Positive Feedback	Negative Feedback	Both positive and negative feedback
36	2	4

As examining the results, we collected the opinions of the students in three categories as indicated in Table 17. 36 of the students stated positive, 2 of them negative, and 4 of them both positive and negative opinions.

Students were asked w*hat you thought about the applicability of the applied learning method in schools.* The experimental group students stated that the developed teaching method can be easily applied in secondary schools. Students can learn difficult topics easily through the developed learning method. The students stated that they were learning at their own pace thanks to this method. The students also remarked that this method was applicable in all courses. On the other hand, students with negative opinions stated that they were not sure whether the students would comply with all the rules.

Table 18. Applicability of FCM

Applicable	Not applicable
41	1

In the examinations, 41 students commented on the applicability of FCM in schools as positive and 1 student as negative (Table 18).

Discussion

In a comparison between the traditional learning environment and FCM supported by mobile application, significant differences were observed among students' academic achievement. According to the results of the research conducted by Akgün and Atıcı (2017), Çalışkan (2016), Galway et al. (2014), Boyraz (2014), Ekmekçi (2014), Dill (2012), Roshan and Roshan (2012), Marcey et al. (2012) and Moravec et al. (2010), participants who study with FCM are more successful than the participants studying with traditional media. In addition, Pierce and Fox (2012), Tune et al. (2013), Wilson (2013), McGivney-Burelle and Xue (2013), McLaughlin et al. (2013), Baepler et al. (2014), Murphree (2014) and Hung (2015) made a study about FCM students stating that their academic success increased. Similarly, in the study, it was determined that the FCM group composed of the experimental group students was more successful than the TLM group made up by the control group students. At the same time, a statistically significant change was found in academic achievement. But Howell (2013), Davies et. Al. (2013), Clark (2013) and Marlowe (2012) stated otherwise in their research and that there were no significant changes in academic achievement.

The views of the students about the course and their interest in the course were also taken. Fulton (2012) stated in his research that FCM education has increased students' interest in mathematics education. For some subjects of mathematics 2 course, FCM was prepared and applied to 45 experimental group students in Albalawi (2018). He stated that there was a significant increase in the performances of the students in the activities he tried on 45 people but there was no statistical significance. In the research, the findings of the students' performance and

interest during the course process were determined. In addition, a significant result was obtained in the experimental group students' academic achievement in the subjects determined in the mathematics lesson.

Students' opinions were asked about collaborative learning. Herold et al. (2012) and Fulton (2012) stated in their research that the duration of the communication between the teacher and students and between students and students increased. They also stated that classroom discussion environments were more efficient. This situation coincides with the research done. This research has revealed that FCM's students' learning in a collaborative learning method is an important factor in students' interest in the course, their fun and active participation. It is seen that students can solve many problems through group interaction. In this way, it is thought to contribute to the success of the process and the academic success of students.

Turan and Göktaş (2016), Artino (2008) and Moreno (2004) stated in their research that students' cognitive burden decreased thanks to teacher guidance in FCM's classroom activities. In the research, it was found that the students' cognitive burden was mostly removed by teacher guidance and similar results with the literature were obtained.

Larsen (2009) stated in his research that the students who took courses with FCM were more willing for collaborative learning rather than individual learning. This situation coincides with the findings and it is seen that the students use these expressions to improve their skills. In another study, Frydenberg (2012) stated that those who were taught with CL were more motivated than those who received traditional education. Similarly, in the study, it was observed that collaborative learning method had a positive effect on students' interest and motivation.

Ekren and Akkul (2013) stated in their research that the videos used in education would be useful for the students in explaining the subject. In addition, they stated that the visual and audio video techniques that appeal to many sensory organs contributed to the students' motivation. Fulton (2012) revealed in his research that students did not like it when they had difficulty understanding while watching videos. This situation does not correspond with the research. On the contrary, they liked to watch the videos over and over again and to have their teachers available while doing homework at school. Deperlioğlu and Köse (2010) stated in their research that, thanks to video, audio, visual and presentations from multimedia technologies, the students displayed a positive effect in the success of the course and that these presentations provided students with a collaborative and constructivist education. Bergmann and Sams (2007), in their research, formed the basis of FCM with videos. They stated that the videos would be an advantage of learning technology by designing them according to the five senses. Bishop and Verleger (2013) stated that they rejected studies related to the FCM method which does not include video lessons. Similar results were obtained in the literature. In the answers given by the students, the importance of videos and visuals was repeatedly expressed. Especially through the use of mobile applications with smart phones and independent from place limitations, they stated that their interest in the lesson increased and they were prepared for the lesson. This finding is consistent with the high academic achievement.

Mason, Teodora and Kathleen, (2013), Herold et al. (2012), Lage et al. (2010) stated in their research that the participants in the classroom made better use of time by applying the environment of FCM. Similar results were obtained in the study. Students also stated that there were extra times for fun activities throughout the process.

Roach (2013) stated in his research that FCM made a significant contribution to the students' understanding of the subjects and initiated a period in which students were active in education through innovations. He also stated in his research that there were no definite beliefs about the applicability. In Francl's (2014) study, it is determined that FCM approach in this age of technology is a viable system. He stated that the lessons and homework done with traditional learning method were left behind. Now, smart phones and portable tablets should be used in the Internet era (Francl, 2014). In another study, the implementation of the FCM approach was examined. In their study, 450 students stated that their grades increased, general conditions improved and job satisfaction increased (Hamdan et al., 2013). Similar results were obtained in the study. The applicability of the developed FCM in the courses was favourably stated by the students.

Results

With the technological developments, the use of technological tools in education has increased. Many teaching models have been developed to achieve full learning in education. The use of technological tools in developed teaching models comes to the fore. In this study, a mobile application has been developed for the subject of 7th

grade polygons in mathematics course in order to integrate FCM with smart phones which are technological tools of new learning methods. With this mobile application, the aim is for students to follow the lessons easily without limitations of time and place and thus understand the subject with enriched visuals.

The academic achievement test was prepared after taking expert opinions to measure the students' success. Demographic characteristics, the level of motivation, pre-test results and general academic averages of the experimental and control group students were determined by random sampling method before the application. As a result of the statistical analysis of the pre-test results of the experimental and control group students, it was determined that they were similar groups and the application process was started.

Results of the First Research Question

According to the results obtained from the experimental group and the control group academic achievement scores;

- When the pre-test and post-test results of the experimental group were compared, it was found that the academic success of the students increased significantly after the application.
- When the pre-test and post-test results of the control group were compared, it was seen that the academic success of the students increased significantly after the application.
- The experimental group and the control group post-tests were compared and were found significant in favor of the experimental group. Accordingly, the post-test averages of the experimental group were found to be higher than those of the control group.

Regarding the first research question, it is observed that the students who used FCM supported by a mobile application with collaborative learning increased their academic achievement compared to the students who utilized traditional learning method. In other words, there was a significant difference in favor of the experimental group students who applied the two week quasi-experimental education process.

The main reason for the high academic achievement in favor of the experimental group is the interactive, collaborative and active participation of the students in the FCM process. In addition, it is observed that their interest in mathematics lesson increased with the mobile application and that the activities in which the students were in the center contributed to the meaningfulness of the experiment group.

Results of the Second Research Question

In the scope of the research, the changes in the teaching process and in the interest of the students in mathematics education are revealed in general terms as follows;

- The experimental group students stated that they participated actively through FCM.
- The students expressed that mathematics course was not a boring course in a FCM environment supported by a mobile application.
- The students stated that lessons such as mathematics became easier for them.
- The main reason for the success in the mathematics course was that FCM became fun and the students' prejudices against the mathematics lesson disappeared with this method.
- Some of the students stated that they liked mathematics thanks to FCM supported by a mobile application.
- Students also stated that FCM supported by a mobile application was beneficial in mathematics lesson.

Concerning the second research question in this research, thanks to the mobile-supported FCM, the bias against mathematics lesson was removed, students had fun in mathematics class which they had earlier seen as boring, and they liked mathematics lesson by taking an active role in the process.

Results of the Third Research Question

Within the scope of the research, students stated the following thoughts about collaborative learning in the FCM supported by mobile application.

- In FCM, it is determined that the students' course work with collaborative learning method has an important effect on students' interest in the course, their fun and active participation.
- It is determined that students can solve many problems with group interaction.
- Some of the students' individual errors and negative behaviors in the CL method were seen to have an impact on other students. However, there was no decrease in academic achievement.
- In FCM, the students stated that they enjoyed themselves during the group work, the participation in the class increased and they understood the subject more easily.
- The students stated that their communication with their friends increased positively during the group studies.
- It is seen that communication between teacher-student and student-student has increased in a positive way.
- The majority of the students stated that they saw features that they did not realize before because of group work.
- It was determined that the students solved their problems during the process with the teacher, the mobile application and the group friends respectively.
- Most of the students think that the CL method should be applied in the courses.
- The collaborative learning method mixed with the mobile application supported FCM increased the students' motivation to the course.
- The experimental group stated the elements that should be considered while preparing the CL method of the students.
    - The selection of the group friends by considering the demands of students can affect the process positively. However, it was determined that the students who were close friends before the research caused grouping and threw other members of the group out of the process. Therefore, it is thought that very close friends should not be in the same group.
    - Group members need to be understanding with each other.
    - Everyone in the group must have a role.
    - The members of the group should be ready for the learning method.
    - It was stated that students with low success should not be in the same group.
    - It is stated that the number of members of the group does not exceed 4.
    - It is emphasized that there should be a leader in the group work and he/she should prevent any confusion.

According to the results of the third research question; the experimental group stated that the students liked collaborative learning, enjoyed their group friends in the process, understood the lesson better than the traditional learning method and increased their interest in the mathematics lesson. The experimental group students who participated in the process stated that they had an active role in the developed learning method, thus increasing their academic success. It was observed that they developed positive communication with their friends throughout the whole implementation process. In addition, the first time students encountered in this learning method has been found to have little difficulty. However, students who use negative expressions have generally emphasized the individual errors and negative behaviors of their friends.

Research results show that; FCM and CL method increase the students' interest, motivation, attendance and sympathy to the course. This situation is thought to be realized by the mixture of FCM and CL method and it is seen that students' academic achievement is also a significant increase.

Results of the Fourth Research Question

Within the scope of the research, the students generally stated their comments about the FCM supported by a mobile application as follows;

- The importance of videos and visuals was repeatedly expressed by the students and it was remarked that they played an important role in learning the lesson.
- The experimental group stated that the students had the opportunity to watch videos through their smart phones whenever and wherever they wanted. In this way, they had the chance to repeat as much as they wanted according to their pace of learning.
- The interest of the students in the course increased thanks to their use of mobile application via smart phones in the developed learning method, and this application enabled them to prepare for the course.
- The students stated that they could solve a lot of examples on the subject and use their time better through FCM.
- The students noted that the developed learning method could be applied in schools. In addition, they stated that this teaching method should be applied to not only in mathematics course but also in all courses.
- It was stated that all the rules required by the students should be followed and the activities should be completed in order to achieve success in the developed learning method

As regards the fourth research question, it was observed that almost all of the students in the experimental group thought that the developed learning method could be easily implemented in schools. At the same time, it was seen that the students' interest in classes had increased thanks to the collaborative learning method through a mobile application-supported FCM. During the application process, the students learned the subject at the time and place of their own learning speed, and this increased their academic success.

Suggestions

Considering the data obtained from the research, the following suggestions can be made regarding the application and the research to be carried out.

Application recommendations

- The mobile application has been used by the students for homework during the implementation stage of FCM. In the mobile application used, attention should be paid to the design principles.
- The videos in the mobile application should be as simple, clear and concise as possible. Long videos may adversely affect the process.
- In-class activities take time to create. For this reason, it is important to get prepared in advance.
- During the application, there are some drawbacks in communication between the groups and within the groups. For this reason, while forming the groups, keeping students who are opposite together or having very close friends in the same group may adversely affect the process.
- The students stated that they liked the pills information with the colorful flash cards in the mobile application. In addition, they stated that it would be useful to have educational games on the subject in the mobile application. Therefore, designing and placing games related to the mobile application can make the home-learning process more entertaining and efficient.
- The interaction of students with students and teacher with students in the learning process is very important in order to ensure that the developed learning method is efficient. In this respect, the fact that there are many fun activities such as in-group studies and quizzes in this process can increase the academic success and interest of the students.
- Students need to be motivated to watch the course videos at home. If not motivated, they may be adversely affected by this process. For this reason, it is necessary to have entertaining activities associated with the video to enable students to watch videos.

Research recommendations

- In this research, the effect of a mobile application-supported FCM on students' academic success and collaborative study skills were examined. In future studies, different teaching outcomes such as creative thinking, problem solving and critical thinking can also be examined.
- Flash cards, pill information, sample solutions and videos are included in the developed mobile application. In the mobile application, missing games, chats and test sections can be added and their effect on the student can be evaluated.
- The study group of this study consists of 7th grade students. Differences can be made between them by applying the research sample to all levels of secondary and high school because the reactions of high school students and secondary school students to the method may be different.
- In the study, the effect of mathematics course on the academic achievement of students in polygons was surveyed. It is important to consider whether the applied process will have similar effects on other branches.
- The study was designed with the help of a mobile application. This design was determined in the investigations that attracted the attention of the students. It is important to compare FCM and the developed learning method which will be supported by augmented reality and virtual reality that will attract more attention of students.

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