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Effects of Cabri 3D Activities Blended into the 5E Model on Geometry Success *

5E Modeline Harmanlanmış Cabri 3D Etkinliklerinin Geometri Başarısına Etkileri

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Abstract: The National Council of Teachers of Mathematics recommends using effective teaching methods to develop geometric thinking. Among the constructivist approach models, the 5E model has come to the fore in the active participation of the learner and the creation of their own knowledge. In constructivist models, it is recommended to use information and communication technologies together. The number of studies using the technology-supported 5E model in mathematics teaching is limited. In this article, the effect of activities suitable for the 5E model supported by Cabri 3D geometry software on geometry success has been examined. Student views on Cabri 3D activities were presented. The study was built on the quasi-experimental method. Activities suitable for the Cabri 3D and 5E model were applied to the experimental group students. The control group students conducted their lessons with textbook activities. Academic Achievement Test was applied to the study group students. After the application, the experimental group was interviewed. SPSS and descriptive statistics were used in the analysis of the data. As a result of this study, it can be said that teaching with the Cabri 3D supported 5E model increases the geometry success of the students and most of the students have positive opinions about Cabri 3D.
Keywords: 5E model, Cabri dynamic geometry software, geometry teaching, geometry achievement.

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Öz: Ulusal Matematik Öğretmenleri Birliği geometrik düşünmenin geliştirilmesi için etkili öğretim yöntemleri kullanımını önermektedir. Öğrenenin aktif katılımı ve kendi öğrenmelerini oluşturması bakımından yapılandırmacı yaklaşım modelleri ve bu modeller arasında 5E modeli ön plana çıkmıştır. 5E yapılandırmacı yaklaşım modeli, öğrencilerin aktif katılımını sağlamaktadır. Yapılandırmacı modellerde, bilgi ve iletişim teknolojilerinin birlikte kullanılması önerilmektedir. Matematik öğretiminde 5E modelini kullanan çalışmalar olmakla birlikte teknoloji ve 5E modelini kullanan araştırma sayısı sınırlıdır. Bu makalede, bir geometri yazılım olan Cabri 3D destekli 5E modeline göre hazırlanan etkinliklerin geometri başarısına etkisi incelenmiştir. Ayrıca Cabri 3D kullanımı ile ilgili öğrenci görüşleri sunulmuştur. Sonuçlarını sunduğumuz çalışma, yarı deneysel bir yöntem üzerine inşa edilmiştir. Cabri 3D ve 5E modeli göz önünde bulundurularak hazırlanan çalışma etkinlikleri daha sonra deney grubu öğrencilerine uygulanmıştır. Kontrol grubu öğrencilerinin dersleri, ders kitabındaki etkinliklere göre yürütülmüştür. Çalışma gruplarındaki öğrencilere ön-test son-test olarak Akademik Başarı Testi uygulanmıştır. Ayrıca deney grubunun Cabri 3D hakkındaki görüşlerini öğrenmek için uygulama sonunda bir görüşme yapılmıştır. Verilerin analizinde SPSS ve tanımlayıcı istatistiklerden yararlanılmıştır. Bu çalışmanın sonucunda Cabri 3D destekli 5E modeli ile öğretimin öğrencilerin geometri başarılarını artırdığı söylenebilir. Ayrıca çoğu öğrencinin Cabri 3D hakkında olumlu görüşü belirttiği gözlenmiştir.
Anahtar Kelimeler: 5E modeli, Cabri dinamik geometri yazılımı, geometri öğretimi, geometri başarısı.

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1. INTRODUCTION

Geometry was formed together with the cultural experiences we have gained from many areas of life (Faggiano, 2012). The National Council of Teachers of Mathematics (NCTM) emphasizes that today's mathematics applications consist significantly of geometric parts, with geometry actively utilized to model and analyze the problems encountered (NCTM, 2001). Geometry learning starts with people's perception of their environment and making sense of it physically (Ubuz, 1999). Students' thinking levels, individual differences, and individual development are directly effective in learning geometry subjects (Toptaş, 2010).

NCTM has deemed it necessary to use effective teaching methods for students to create their geometric expressions and develop their geometric thinking skills. It is necessary to provide experiences with geometric objects from the beginning of primary education and it is recommended to develop visual skills in geometry by supporting the visualization by rotating and shifting two-dimensional geometric objects with the help of technology (NCTM, 2000). When teaching is not done in technology-supported environments, students will have difficulty making sense of geometric concepts and these concepts will be limited to rote learning (Duatepe-Paksu et al., 2013). For this reason, it's suggested to use technology effectively whereas structuring learning environments that modify students to find out through experience and exploration (Ministry of National Education, 2013; NCTM, 2000).

As a result of advances in computer technology, teaching software that can be used in mathematics teaching has been developed (Çetin et al., 2015). One of them is dynamic geometry software applications, which allow students to create their shapes or to make interactive examinations by using dynamic shapes created by teachers (Ministry of National Education – Board of Education, 2006). They can be used effectively for students to discover, associate and generalize mathematical relationships (Cannon, 2005). In recent years, dynamic geometry applications have started to be increasingly used, as they provide natural learning opportunities to students.

Baki (2002) stated that dynamic geometry software applications enrich educational environments. In addition, it was claimed that teaching environments prepared with dynamic geometry software applications will positively affect both the teaching of geometry subjects and the achievement of students in geometry (Işıksal & Aşkar, 2003). Moreover, research has shown that dynamic geometry software applications help students explore geometric concepts and advance their problem-solving skills (Johnson, 2002).

In this study, as a dynamic geometry software application, Cabri 3D was used. Cabri 3D is useful in visualizing geometric shapes and understanding the perception of three dimensions (Accascina & Rogara, 2006). Shapes that can be difficult to create in a traditional environment can be easily constructed with Cabri 3D. With it, shapes can be rotated, object expansions can be made and shapes can be examined from different directions. This study was carried out to compare the learning of geometry of 7th-grade students taught according to the appropriately prepared activities with the 5E model using Cabri 3D and the 7th-grade students who were tutored in line with the activities within the textbooks. Another objective of this study was to examine student opinions about Cabri 3D. Hence, to achieve these objectives, we tried to answer the following questions.

- Is there a statistically significant difference between the achievements of the experimental group students who were taught according to the 5E model blended with Cabri 3D and the achievements of the control group students?
- How did the use of Cabri 3D software in geometry teaching affect the views of the experimental group students?

The rest of this article is as follows. The relevant literature and the 5E model are presented below. Chapter 2 presents the methodology used in this study. The findings of this study are given in Chapter 3. The final section presents the discussion and conclusions.

Clarou and Laborde (2000) stated that students can experience moving complex geometric shapes dynamically with Cabri 3D, which enhances their observation, impression, exploration, and research abilities. They also stated that using the basic elements of geometry makes it possible to explore different geometric shapes with it and, the differentiation of dimensions by changing only the basic elements without changing the geometrical shape properties is realized with the dynamic menu of Cabri.

In this context, when the literature about Cabri software is examined, it is seen that Cabri supports the development of positive attitudes towards geometry and dynamic geometry environments are found beneficial by students (Güven & Karataş, 2003), students find Cabri's visualization and experience features effective, reasoning, communication and association. It was seen that they developed an opinion that they played a role in creating mathematical structures by improving their skills (Yavuzsoy-Köse & Özdaş, 2009). Okumuş (2011) observed a great increase in the success of the group trained with Cabri 3D in quadrilaterals, and Demir (2011) found that the worksheets prepared using Cabri 3D improved the proof skills of the students. On the other hand, Kurak (2009) stated that there was no statistically significant difference between the results of the experimental and control groups in his study in which he examined the effect of Cabri 3D on geometry success. Filiz (2009) stated that dynamic geometry software applications were effective in increasing students' ability to make assumptions and make inferences, and Eryiğit (2010) did not find any difference between the study groups' attitude outputs towards geometry, although Cabri 3D was stated to be an effective tool in teaching prism. Kaleli-Yılmaz et al. (2010) proved that objects and mathematical concepts visualized with Cabri 3D are effective in making sense of students, Akgül (2014) stated that teaching with Cabri 3D affects middle school students to increase their geometry achievement and attitude. It was stated that geometry education with Cabri 3D facilitates students' conceptual understanding, that students have positive opinions about these environments (Gürbüz & Gülburnu, 2013) and that they make it easier for students to comprehend geometric shapes (Uğur et al., 2016). Considering the studies on Cabri, it is seen that it contributes to the development of positive attitudes and academic success of students in geometry teaching, but it has not been found to be effective in some studies. This situation paved the way for the examination of outputs when different methods and techniques are used together with the Cabri software.

The program update in 2005 included the constructivist learning theory in education (Çetin et al., 2015). Although different teaching methods have been developed within the constructivist teaching model, the most convenient to use is the 5E model (Çetin et al., 2015, Keskin & Tapan-Broutin, 2019; Teltik-Başer, 2008). The 5E model is important in terms of offering students active participation in lessons and providing effective learning and teaching. While the 5E model allows students to develop their unique concepts and skills, it also offers an alternative method to teachers in the learning process. In mathematics learning, the usability of the 5E model, which is suitable for the constructivist learning approach, has been investigated thoroughly in the literature (Hiçcan, 2008; Teltik-Başer, 2008; Tuna & Kaçar, 2013).

In the 5E model, the teaching process is divided into steps. The steps of the 5E model were determined as engage, exploration, explanation, elaborate, and evaluation (Bybee et al., 2006; Keser, 2003). In the engage phase of the 5E model, the teacher aims to draw students' attention to the subject (Wilder & Shuttleworth, 2005). At this stage, the subject to be learned is not told, and the subject is not explained (Balcı, 2005). In the exploration phase, the teacher has to guide only while doing the activities (Akar, 2005). When the teacher sees the mistakes of the students while guiding them, he/she does not immediately correct them. Here, the teacher provides tips for the student to progress (Carin et al., 2005; Özaydın, 2010). In the explanation phase, the teacher is central. First, students are allowed to make their explanations (Campbell, 2000). Afterward, the results obtained by the students until this stage are arranged by the teacher, and the learning deficiencies of the students are completed (Hançer & Yalçın, 2007). The elaboration phase is important in terms of reinforcing the learned concepts and supporting permanence. Considering that there may be students with different learning styles in classes, multimedia applications supported by different materials

should be included in this process (Temizyürek, 2003). Finally, in the evaluation phase, the learning products and outputs obtained at the end of the process are checked. This stage should not be done at the end of the 5E model; it should be considered an evaluation of the whole process and should be done at the end of each stage. It should be considered not only as a stage in which students are evaluated by the teacher but also as a stage where students have the opportunity to evaluate themselves and their peers (Keser, 2003). The 5E model involves activities that increase students' desire for research, respond to their expectations about the subject, and use their knowledge and abilities effectively. Students actively participate in activities at each sub-level of the 5E model. The model encourages students to create unique concepts on the subject. Since the 5E model allows exploration, questioning, and experimentation, it also adds critical thinking skills to students (Ergin et al., 2007).

Models based on constructivism do not only emphasize learning. At the same time, they point out the importance of teaching in which information and communication technologies are integrated (Emrahoğlu & Bülbül, 2010). The Ministry of National Education recommends the use of information and communication technologies (ICTs) in mathematics education programs. Because mathematical concepts can be given with different symbols by using ICTs. With the help of transitions between these symbols, students are allowed to create mathematical connections (Ministry of National Education, 2013). Although mathematics textbooks offer activities based on paper folding and cutting, they do not include activities where technology can be used. Only in teacher's guidebooks, is it stated that dynamic geometry software applications can be used. Although it is recommended to use ICTs in the curriculum, there are no activity plans prepared according to dynamic geometry software applications.

In this study, we aim to determine the effect of geometry teaching based on the 5E cycle model supported by Cabri 3D on students' geometry achievement. The number of studies in which the 5E model and dynamic geometry software applications are used together is limited in the literature. Therefore, this study has the possibility of contributing to the literature and leading to future studies. In this study, unlike the related studies in the literature, the exploration phase of the worksheets planned according to the 5E model was prepared using Cabri 3D. In this regard, the first objective of this study is to evaluate the effects of geometry teaching with Cabri 3D on students' achievement and the second objective of this study is to find out the student's views on the activities performed using Cabri 3D.

2. METHODOLOGY

In researches, the use of quantitative or qualitative methods can be preferred, as well as the mixed method in which both methods are used together, and the researches can be designed. The mixed method minimizes the limitations of both methods and allows the collection of the most appropriate data with the most appropriate method by using the advantages of both methods (Bedir-Erişti et al., 2013). In this study, mixed research methodology, which includes both quantitative and qualitative patterns, was preferred. The mixed methodology includes the quasi-experimental method and the interview method. The students, in which the teaching activities planned according to the 5E model using Cabri 3D were applied, are the experimental group. The students to whom the teaching activities planned according to the textbook were applied are the control group. The experimental method was used to find out whether there was a difference between the geometry achievements of the experimental and control groups. The experimental method, it is aimed to reveal how the change observed in one of the study groups differs from the change in the other group (Büyüköztürk, 2011). Also, in this study, a semi-structured interview was used to determine the students' opinions about Cabri 3D in geometry teaching. The interview method is frequently used as it allows people to express their ideas, experiences, and feelings (Yıldırım & Şimşek, 2006). In this study, the selection of the experimental and control groups was not made randomly, but according to some pre-measurements and criteria. Before the groups were selected, the first-semester mathematics grade averages of the three classes in the school where the application was made were examined. Based on the mathematics grade point average, the control and experimental groups were randomly selected from three classes that were close to each other.

2.1. Study participants

The study sample consists of 47 selected seventh-grade students. The study continued with 23 students in the control group and 24 students in the experimental group. The sample of the research is an easily accessible case sample. The researcher chose the sample as two seventh-grade branches with a total of 47 students studying at the school where works. The academic achievement test was applied to the experimental group and the control group simultaneously, the interview form was applied only to all the experimental group students.

2.2. Data collection tool

The data collection tools of this study are the Academic Achievement Test and the Interview Form. While preparing for the Academic Achievement Test, the distribution of seventh-grade geometry subjects such as angles, polygons, and circles was taken into account. In the first stage, 75 test questions were determined and the opinions of mathematics teachers were taken to ensure content validity. The test was rearranged according to the feedback of the teachers. Sections of the questions in the Academic Achievement Test are given in Figure 1.

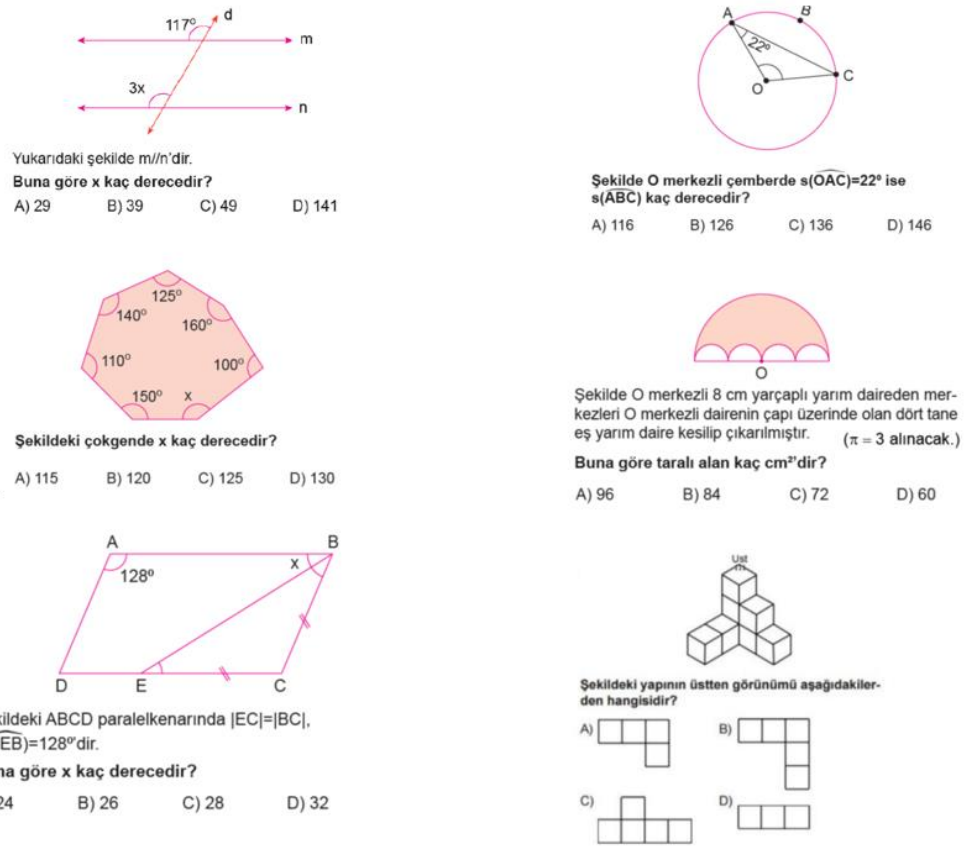

Figure 1. *Section of the questions in the Academic Achievement Test*

Then, an achievement test was applied to seventh -grade students in a different school, and an item analysis of the obtained data was made. The item discrimination indexes of the Academic Achievement Test were found to be between -0,19 and 0,75. The item discrimination index indicates the correlation between the item scores and the total score. A positive and high correlation indicates that the behaviors measured by the items are similar and the test has high internal consistency. If the discrimination power is 0,19 or less, it should be preferred not to take the test. Items with a discriminative power between 0,20 and 0,29 can be

taken to the test with correction if necessary, while items with a discriminative power between 0,30 and 0,39 can be included in the test without any correction. Items with a discriminative power of 0,40 and above are quite good and are tested in their current form (Tekin, 1991). If the item difficulty index is less than 0,29, it is interpreted as a difficult item; if the index is between 0,30 and 0,49, it is interpreted as a medium item; if the index is between 0,50 and 0,69, it is interpreted as an easy item; if the index is higher than 0,70, it is interpreted as a very easy item (Hasançebi et al., 2020). Based on this, 45 out of 75 questions were eliminated after the pilot application, as they did not meet the difficulty index and discrimination criteria. The item difficulty index and item discrimination values of the 30 questions in the final version of the test are given in Table 1.

Table 1.
Academic Achievement Test Item Analysis Results

Item No	Item Difficulty Index	Item Discrimination Power
1	0,38	0,61
2	0,62	0,59
3	0,54	0,58
5	0,38	0,43
6	0,50	0,52
7	0,38	0,47
9	0,50	0,48
13	0,23	0,44
14	0,23	0,38
15	0,33	0,35
23	0,23	0,76
32	0,19	0,44
34	0,22	0,49
39	0,38	0,41
43	0,27	0,58
46	0,50	0,63
47	0,27	0,77
49	0,32	0,36
50	0,31	0,51
52	0,23	0,47
54	0,19	0,47
55	0,32	0,45

64	0,38	0,65
65	0,45	0,56
67	0,32	0,44
68	0,54	0,63
69	0,42	0,55
70	0,50	0,70
72	0,54	0,55
74	0,46	0,58

The Cronbach Alpha coefficient (Cronbach, 1951) is used to investigate whether the test creates a homogeneous structure. If it is high, it is understood that the test items are so consistent within themselves and it is understood that the test consists of items measuring similar properties (Alpar, 2016). The Cronbach Alpha coefficient of achievement tests should be greater than 0,70 (Büyüköztürk, 2011). For this Academic Achievement Test, it was 0,912. The Academic Achievement Test, which was applied to the study groups as a pre-test and post-test, was determined as 30 questions as a result of validity and reliability analysis.

The Interview Form is the most preferred data collection tool among qualitative data collection tools (Yıldırım & Şimşek, 2006). The interview can be done in three different forms. One of them, the structured interview, includes predetermined questions. Another one is the unstructured interview form in which questions are directed according to the flow of the interview. The semi-structured interview form is a mixture of the two previously mentioned interview methods. (Gay et al., 2006). In semi-structured interviews, the researcher prepares a protocol with questions to be asked. Depending on the answers given during the interview, different or sub-questions can be asked to enable people to explain their thoughts (Türnüklü, 2000).

Semi-structured interviews were preferred to get the thoughts of the group who was taught geometry using Cabri 3D. The researcher took the work of Gürbüz and Gülburnu (2013) as an example to prepare an interview form for the interviews conducted in this study. After three mathematics teachers examined the questions in the interview, the researcher made the necessary arrangements and the interview took its final form. With each of the experimental group students, approximately 15 minutes of interviews were held.

2.3. Data collection process

The worksheets developed according to the 5E teaching model were applied to the experimental group of students for seven weeks under the supervision of the researcher. Since the experimental group consisted of the classroom where the researcher lectured, the researcher managed the planning and execution process of the study. The lessons were carried out according to the instructions in the worksheets. While preparing the lesson plans of the experimental group, attention was paid to: enabling the students to reach generalizations by comparing the results and deepening their knowledge. Figure 2 shows sections of one of the worksheets used in the study.

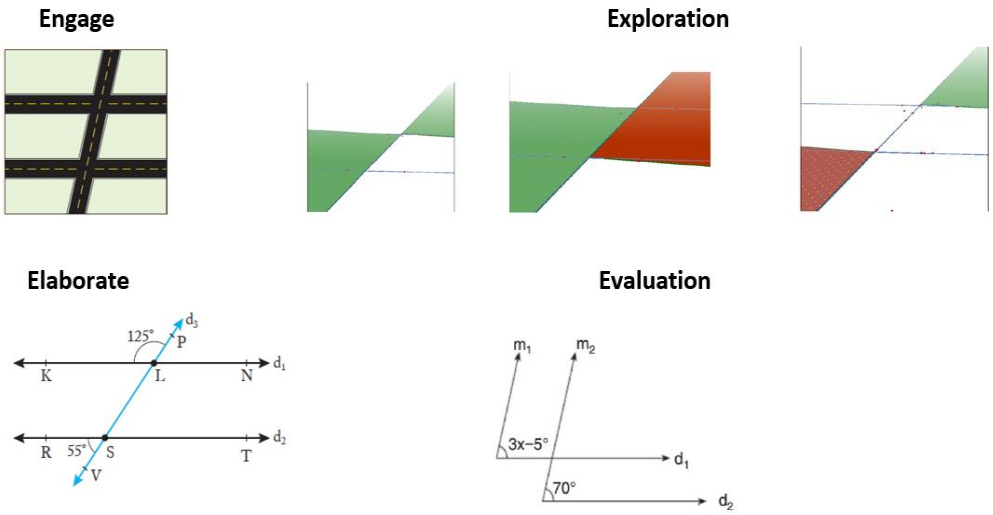

Figure 2. *Excerpts from a worksheet used in the study*

The visual in Figure 2 was shown to the students at the engage stage, and the student's attention was drawn to the subject, and questions were asked to determine their pre-learning. The visual in the exploration phase conveys the drawings that students will create by following the steps in the Cabri 3D activity instruction. During these process steps, the students were guided by the researcher to obtain the information through their discoveries. Using the dynamic structure of Cabri 3D software, students were able to easily rotate and displace the shapes they created. In this way, the students were able to observe that the properties of the shapes did not change. Sections of these applications related to the Cabri 3D application process with rhombus and parallelogram are given in Figure 3.

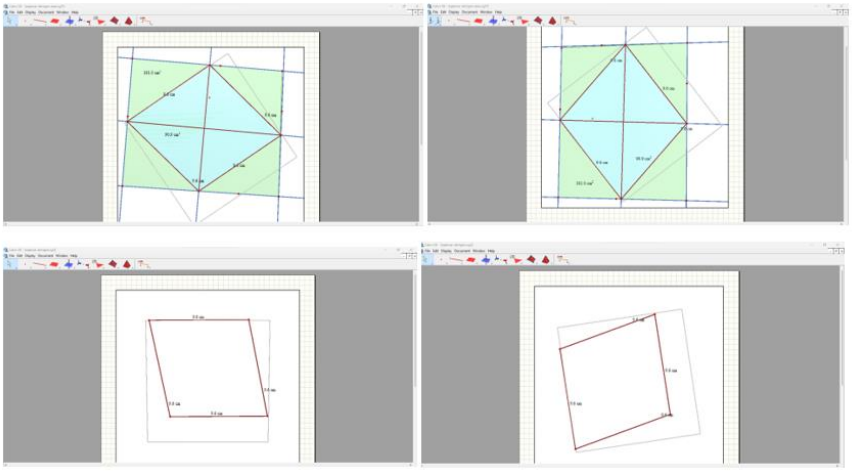

Figure 3. *Sections from Cabri 3D worksheet*

Since the teacher explained the subject at the explanation stage, this stage was not included in Figure 2. With the visual in the deepening phase, the students were able to adapt the information they learned through exploration to new situations. With the visual in the evaluation phase, it has been determined whether the students have achieved the targeted achievement. Sections of the Cabri 3D application process with students in the informatics classroom are presented in Figure 4.

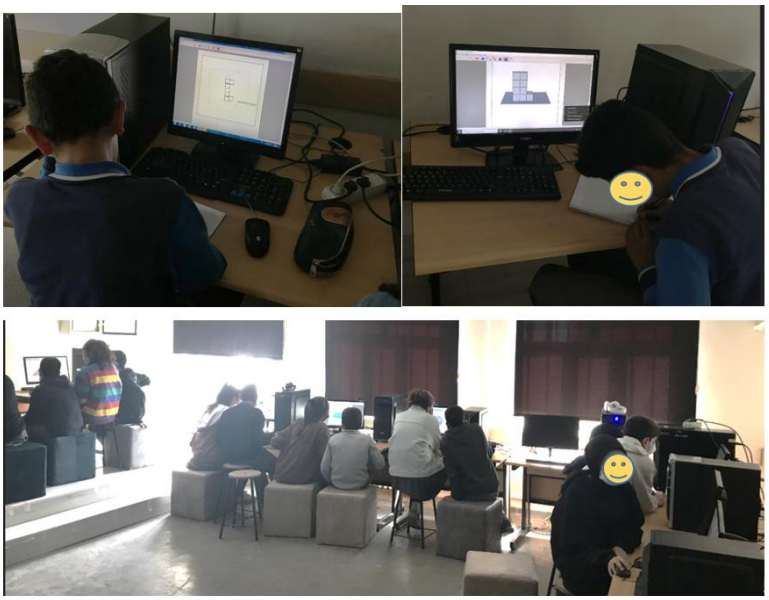

Figure 4. *Sections to the application process with Cabri 3D*

In the 2021-2022 academic year, the control group students continued their lessons with the help of the activities in the textbook (paper folding, turning, cutting activities) and the materials in the school. The Academic Achievement Test was implemented in each group in the study as a pre-test before the application and seven weeks later, this test was implemented again as a post-test. At the end of the activities, interviews were held with the experimental group and their opinions on geometry teaching of Cabri 3D were taken depending on their experiences in this process.

2.4. Data analysis

The analysis phase of the data obtained from The Academic Achievement Test was continued with SPSS 26.0. In cases where the sample size is less than 30, the use of non-parametric tests is envisaged. The descriptive statistical values of the data obtained from the Academic Achievement Test of this research are given in Table 2.

Table 2.
Descriptive Analysis Of Data Collection Tools

Scale	N	X	S	Skewness/s.e.	Kurtosis/s.e.	Shapiro Wilk (p)
Control pre-test	23	6,22	2,679	0,56/0,48	-0,41/0,93	0,339
Control post-test	23	10,43	5,151	0,35/0,48	-0,55/0,93	0,786
Experiment pre-test	24	6,79	2,654	0,79/0,47	0,08/0,91	0,126
Experiment post-test	24	13,75	5,399	0,33/0,47	-0,64/0,91	0,558

The fact that the skewness and kurtosis values take values between +2 and -2 (Emhan et al., 2012) and the ratio of the skewness and kurtosis values to the standard errors of the data sets with less than 50 sample size is between +1.96 and -1.96, it is interpreted that the data meet the assumption of normal distribution. (Can, 2020; Kim, 2013). When Table 2 is examined, it can be stated that the data meet the normality assumption. In this case, the data of the study groups showed normal distribution and the variances of the data were homogeneous. In such cases, parametric tests can be used (Büyüköztürk, 2011). Considering that

parametric tests can be used, a t-test was applied to compare achievement test scores. It was required that the statistical significance value of the test results be less than 0,05 (Field, 2009). In case of a statistically significant difference as a result of the t-test, the effect size was calculated and interpreted. Cut-off points of the effect size are used as low for 0,01, medium for 0,06, and large for 0,138 (Cohen, 2007).

Descriptive analysis, which is a qualitative analysis method, was applied to the data obtained from the interviews. In the descriptive analysis method, the data are interpreted by dividing them into groups according to certain themes (Miles & Huberman, 1994). Then, the data are systematically described and explanations are made. This way, it is aimed to establish the cause-effect relationship of the data and to reach inferences. After transferring the results to the computer, the conversations are transcribed and analyzed in detail. Considering the answers of the students, categories were formed, sub-categories and codes related to them were arranged, and their frequencies were determined. Also, it was tried to find common views among them by taking the opinions of the students. For this purpose, the frequency distributions of the texts were analyzed by separating the categories, sub-categories, and codes.

2.5. Ethical approval

In this study, all rules stated to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions specified under the title of "Actions Violating Scientific Research and Publication Ethics," which is the second part of the directive, have not been carried out.

Ethics committee approval information:

Ethical committee = Trakya University, Social and Human Sciences Research Ethics Committee

Data of ethical approval= 26.05.2021

The number of ethical approvals=2021.05.60

3. RESULTS

First, the t-test was used to determine whether the pre-test scores of the study group students were equivalent or not, and the results are presented in Table 3.

Table 3.

The T-Test Result of the Pre-Test Scores

Groups	*n*	$\bar{X}$	*s*	*sd*	*t*	*p*
Experimental	24	6,79	2,654			
Control	23	6,22	2,679	45	0,738	0,464

Table 3 shows that there is no statistically significant difference between the pre-test scores of the study groups in terms of t-test results (t_{45}=0,738, p>0,05). From this, it is interpreted that the geometry achievements of the study group students are equal before the study.

Secondly, the t-test was applied to determine whether there was a difference between the pre-test and post-test scores of the experimental group, and the results are presented in Table 4.

Table 4.

The T-Test Result of the Pre-Test and Post-Test Scores

Scores	*n*	$\bar{X}$	*s*	*sd*	*t*	*p*
Pre-test	24	6,79	2,654			
Post-test	24	13,75	5,399	23	-6,614	0,000

Table 4 shows that as a result of the comparison of pre-test and post-test achievement scores with the dependent sample t-test, a statistically significant difference was found in the post-test direction [t_{23}=-6,614, p<0,05]. Here, the effect size was found to be 0,655. Based on this result, it has been interpreted that the use of worksheets prepared by following the steps of the 5E model using Cabri 3D has a great effect on increasing the success of geometry.

In the third step, a t-test was administered to determine whether there was a difference between the pretest and posttest scores of the control group, and the results are presented in Table 5.

Table 5.

The The T-Test Result of the Pre-Test and Post-Test Scores

Scores	*n*	$\bar{X}$	*s*	*sd*	*t*	*p*
Pre-test	23	6,21	2,679			
Post-test	23	10,43	5,151	22	-3,205	0,004

Table 5 shows that when the pre-test and post-test achievement scores of the control group were compared with the dependent sample t-test, a statistically significant difference was observed in the post-test direction [t_{22}=-3,205, p<0,05]. Here, the effect size was found to be 0,318. Therefore, it can be said that the education carried out according to the textbook greatly increased the geometry achievement of the control group.

Fourthly, it is necessary to determine whether the post-test scores of the study groups are statistically significant. Since there is no significant difference between the pre-test scores of the study groups, it will be sufficient to compare the post-test scores with the independent sample t-test. This test result is presented in Table 6.

Table 6.

The T-Test Results of the Post-Test Scores

Groups	*n*	$\bar{X}$	*s*	*sd*	*t*	*p*
Experimental	24	13,75	5,399			
Control	23	10,43	5,151	45	2,152	0,037

Table 6 shows that while the mean of the post-test score of the experimental group students was 13,75 and the standard deviation was 5,399, the mean of the post-test score of the control group students was 10,43 and the standard deviation was 5,151. As a result of comparing the post-test scores of the study groups with the t-test, a statistically significant difference was found in the direction of the experimental group [t_{45}=2,152, p<0,05]. Here, the effect size was found to be 0,0948. Based on this, it was interpreted that the worksheets developed by following the steps of the 5E model using Cabri 3D and the instruction applied

to the experimental group had a moderately positive effect on increasing the geometry achievement compared to the teaching applied to the control group using the textbook.

Fifthly, the opinions of the experimental group students on the teaching of geometry with Cabri 3D were examined. Below are the findings about the questions used in this interview and their answers. The first question of the students in the interview was: "How were geometry lessons taught before?". The answers to this question were categorized and coded, and the frequency distribution is presented in Table 7.

Table 7.

Category, Coding, and Frequency Distribution of the Answers to the First Question of the Interview

Category	Subcategory	Coding	Frequency
Period	Method	Book	3
		Teacher Lecture	2
	Environment	Class	4
Tools	Technology	Writing Board	6
	Concrete model	Geometric Object	3
Course Content	Clutch	Not understanding	3
	Permanence	Don't forget	3

As listed in Table 7, the student's opinions on the teaching of geometry lessons before the application are grouped into three different categories. The first of the categories, the period category, was divided into sub-categories as environment and method according to student opinions. Opinions of the experimental group about the handling of geometry subjects before the use of Cabri 3D were divided into two in the method subcategory. Based on the opinions, three students stated that they processed the lesson from the textbook and two students stated that they processed the lesson with the teacher's explanation. When the environmental subcategory was examined, four students stated that they processed the courses in the classroom.

The equipment category, which is the second of the categories, is divided into subcategories as technology and concrete model. Before using Cabri 3D, students' views about the handling of geometry subjects were coded with one item each. It was seen that six students stated that they used the whiteboard as a technological tool and three students stated that they used geometric objects as concrete models.

In the third category, the course content category, two sub-categories emerged comprehension and permanence. Before using Cabri 3D, the experimental group's views on the handling of geometry subjects were coded with one item each. It was determined that three students did not fully understand the subject and three students forgot the subject quickly.

A few examples of the student's opinions regarding the first question are given below:

-" …we used to write from books and notebooks."

-"The teacher was teaching the lesson and we were listening."

-"…we used to work in the classroom environment."

-"…we used to process it from the smart board."

- "…we couldn't understand very well."

When the experimental group's views on the handling of geometry subjects before using Cabri 3D were generalized, it can be said that the students are in a passive position and the permanence of the learning is low by transferring the lessons from the blackboard to the notebook mostly in the classroom.

The second question of students in the interview: "Did you have positive thoughts about Cabri 3D during the process of using it in the lessons? What are these thoughts?". The answers to this question were categorized and coded, and the frequency distribution is listed in Table 8.

Table 8.

Category, Coding, and Frequency Distribution of the Answers to the Second Question of the Interview

Category	Subcategory	Coding	Frequency
Learning	Achievement	Understanding	4
	Time	Speed	1
	Course content	Permanence	3
Cabri 3D Environment	Participation	Activity	4
	Attitude	Enjoyable	3
		interest- curiosity	1
	Usefulness	Ease of software application	2
		Possibility of repeat	3
	Visuality	Rich visual content	3

As it is presented in Table 8, the positive views of the students about Cabri 3D are divided into two categories as learning and Cabri 3D environment. The learning category, which is the first positive opinion of the experimental group about Cabri 3D, was divided into three sub-categories as achievement, time, and course content. In the achievement sub-category, four students expressed their opinion that they made sense of the topics with Cabri 3D, and in the time sub-category, one student said that they could solve questions faster with Cabri 3D. And in the sub-category of course content, it is seen that three students stated that their learning with Cabri 3D is permanent.

The second category, Cabri 3D environment category is divided into subcategories as participation, attitude, usability, and visuality. While four of the experimental group students were actively involved in the lesson in the participation subcategory, in the attitude subcategory, three students found Cabri 3D environment enjoyable and one student stated that Cabri 3D attracted their attention. In the usability subcategory, two students stated that the software application was easy and three students stated that they had the opportunity to repeat the activities. In the visuality sub-category, it is seen that three students think that Cabri 3D environment offers rich visual content.

A few examples of the student's opinions about the second question are given below:

-"…I learned new things."

-"…I got to know geometry better."

-"…because we both had fun and learned."

-"…people enter a fun environment."

-"…it was nice to teach in the computer environment."

-"…we could take it back and fix it when we made a mistake."

When the positive opinions of the experimental group about Cabri 3D were generalized, the students stated that Cabri 3D increased the achievement of geometry, positively affected retention, and accelerated problem-solving. In addition, it can be said that Cabri 3D is practical and reinforcing, it is a fun environment and it allows active participation of students.

The third question of the experimental group in the interview: "Did you have negative thoughts while learning geometry using Cabri 3D? What are these thoughts?" The data obtained from the answers given to this question were categorized and coded, and the frequency distribution is presented in Table 9.

Table 9.

Category, Coding, and Frequency Distribution of the Answers to the Third Question of the Interview

Categories	Sub Categories	Codes	Frequency
Having negative thoughts	Difficulty	I had difficulties at the beginning of the application, then I got used to it.	6
		I don't have a computer.	3
	Language of the software application	The software application's environment is not in Turkish.	3

When the experimental group was asked about their negative opinion of Cabri 3D, it was seen that 12 students answered that they did not have a negative opinion. As listed in Table 9, in the experimental group, six students stated that they had difficulties at the beginning of the activities, three students had negative thoughts because they did not know how to use computers very well, and three students stated that the language of Cabri 3D could be Turkish.

A few examples of the student's opinions about the third question are given below:

-"…I'm not very good at using computers."

-"…no, at first it was just…"

-"…no, because it was fun."

-"…it was a bit of a complicated program."

When asked about the negative thoughts of the experimental group about Cabri 3D, it can be said that most of them did not have negative thoughts, and some of the students stated that they had difficulties at the beginning of the activities and then got used to it. It is seen that some students stated that the source of their negative thoughts is the lack of experience in using computers and the language of Cabri 3D is not Turkish.

The fourth question of the experimental group in the interview was: "Did you encounter any difficulties while you were teaching using Cabri 3D? What are these?". The data obtained from the answers to this question were categorized and coded, and the frequency distribution is presented in Table 10.

Table 10.

Category, Coding, and Frequency Distribution of the Answers to the Fourth Question of the Interview

Categories	Sub Categories	Codes	Frequency
Technical problem	Computer sourced	Reinstalling when the program did not open.	5
Cabri 3D environment	Working environment	The program was closing by itself.	4

When asked about the difficulties encountered by the experimental group while using Cabri 3D, 15 students said that they did not encounter any difficulties. However, some students said they encountered difficulties and they were categorized as a technical issue and Cabri 3D environment. In Table 10, five students stated that they had problems with the computer that required them to reload the program, four students stated that Cabri 3D sometimes shut down by itself, causing them to lag, and 15 students did not experience any difficulties while using Cabri 3D.

A few examples of the student's opinions about the fourth question are given below:

-“….the software application was closing sometimes.”

-"….the software application was closing sometimes, we were opening it again, but since everything was deleted, we had to do it from the beginning and we were lagging."

-“….I didn't have much difficulty.”

Based on the answers to the question about the difficulties encountered by the experimental group while using Cabri 3D, the majority of the students stated that they did not encounter any difficulties. It has been observed that some students have difficulties due to the computer and Cabri 3D environment.

The fifth question of the experimental group in the interview: “Would you like to use computers in teaching other subjects? Why?". The answers to this question were categorized and coded, and the frequency distribution is presented in Table 11.

Table 11.

Category, Coding, and Frequency Distribution of the Answers to the Fifth Question of the Interview

Category	Sub Category	Coding	Frequency
Those who want the computer environment	Attitude	Enjoyable	4
	Achievement	Instructive	1
		Understandable	4
	Course content	Permanence	1
	Visuality	Visual richness	2
	Usefulness	Ease	5
		Possibility of software application	1
	Team work	Team work	2
		Communication with different people	2
Those who do not want the computer environment	Method	Teacher lecture	1
	Experience	Can't use the computer	1

When the experimental group was asked for their opinions on computer use in other courses and subjects, as it is presented in Table 11, the majority of them expressed a positive opinion. Positive opinions are divided into sub-categories such as attitude, achievement, content, visuality, usefulness, and group work. Among the students who had opinions about using computers in other lessons, four students stated that this environment was fun, one student said that Cabri 3D was instructive, and four students said that the program was understandable were observed. Similarly, one student stated that Cabri 3D provides permanence, two students expressed the richness of the visual content of Cabri 3D, five students stated that Cabri 3D is useful, and one student stated that it is possible to practice in the lessons. Some of the experimental group associated the worksheets with group work and stated that they had a positive opinion as it allowed teamwork and cooperation with people they had not communicated with before. Two of the experimental group students stated that they did not want to use the computer. One of the students explained that they could not use the computer well and the other stated that they found the subject more understandable with the teacher's explanation.

A few examples of the student's opinions about the fifth question are given below:

-“…yes I would, because it was very nice to use it together with my friend.”

-"…that was so fun…"

-“…the lessons were more understandable and more enjoyable.”

-“…it was easier to draw, when we made a mistake, we could easily correct it.”

-“…it is better understood with visual elements.”

Most of the students expressed positive opinions about the use of computers in teaching other courses. It was found out that Cabri 3D provides an increase in achievement and permanence, is easy to use, adds visual richness, positively affects friendships, and is an entertaining environment.

4. DISCUSSION and CONCLUSION

Considering the pre-test and post-test scores of both groups, there is a statistically significant difference in the direction of the post-test scores for both groups. Therefore, it can be claimed that the teaching methods applied to the experimental and control groups greatly increased the achievement of geometry in both groups. On the other hand, when the post-test scores of the study groups were taken into account, a statistically significant difference in the direction of the experimental group emerged. Hence, it can be claimed that geometry teaching with the experimental group has moderately more effect on increasing the achievement of geometry compared to the teaching performed with the control group.

When the literature is examined, it is observed that similar studies have been conducted. Büyükkarcı (2019) concluded that according to the 5E model enriched with coding, teaching positively affects the success of geometry and the permanence of this success. Keskin and Tapan-Broutin (2019) concluded that activities with Cabri, developed following the 5E model, contributed positively to learning the circle subject. Çetin et al. (2015) observed that the activities developed following the 5E model supported by Geogebra software positively affect the increase in geometry success. There are studies in the literature in which dynamic geometry software-supported teaching applications have a positive effect on student achievement, and the results of the relevant studies show similarities with these research results (Çalışkan, 2016; Dur, 2016; Karataş & Güven, 2015; Kösa & Kalay, 2018; Özmen, 2019; Uğur et al., 2016; Yanık, 2015). The conclusion that the 5E model has a positive effect on academic achievement was also reached in the studies conducted by Saka (2006), Lawson (2001), Balcı (2005), Bleicher (2001), Akar (2005) and Özsevgeç (2007). As a result, the studies mentioned above support the results of this research, namely the use of Cabri software and the 5E model, which positively affects success.

With the help of Cabri 3D used in this research, the students were able to create geometric shapes themselves and have the opportunity to rotate, shift, change, and measure these shapes. With these features, Cabri 3D supports students' learning by doing and experiencing and helps to realize meaningful learning. While the 5E model used in the worksheets ensures the active participation of the students in each stage, Cabri 3D also helps the students to test their knowledge and create their concepts. The higher achievement rate of the students in the experimental group can be attributed to the above reasons.

According to the interviews with the students in the experimental group after the use of Cabri 3D in geometry teaching, it was determined that teaching with Cabri 3D improved the positive opinions of the students in many ways. When the students' opinions about the teaching of geometry lessons are considered, it can be claimed that the geometry lesson is mostly taught in the classroom using the blackboard, the lessons are continued with the teacher's explanation and the student remains passive. It is one of the results obtained from these interviews that the students have difficulties in making sense of geometry and keeping it in mind.

Considering the positive opinions of the students about Cabri 3D, it can be stated that Cabri 3D increases the achievement of the students and accelerates the students in the solution of the questions and the drawing phase. In addition, it can be said that Cabri 3D has an effect on keeping students' learning in mind, provides active participation of students, and is beneficial to students with its rich visual content.

Considering the negative opinions of the students about Cabri 3D, it was seen that half of the students did not have negative thoughts. Despite this, it can be said that some of the students had difficulty using Cabri 3D at first, and some of them had difficulties due to the language of its environment.

Considering the opinions of the students about the difficulties encountered while using Cabri 3D, it is seen that although it is observed that the majority of the students do not have any problems while applying the activities, some of the students have encountered problems with the computer or Cabri 3D environment.

Considering the students' views on using computer-assisted environments in other courses, it was determined that students mostly expressed positive opinions. It is seen that students who want to use computer-assisted environments in other lessons describe this environment as fun, instructive, visually rich, and easy to use. It can be said that students find the information they learn in the computer-assisted environment more permanent and understandable.

As a result, it was determined that the students saw the geometry teaching in the traditional classroom environment, in which they followed the activities in the textbook, as rote-based, boring, difficult to understand, and low permanence. However, it has been observed that they tend to see geometry teaching in a computer environment supported by Cabri 3D as enjoyable, active participation, visually rich, experience, and high permanence.

The studies that support the results of this research and have similar results are as follows. Güven and Karataş (2003) proved that the students found it useful to use dynamic geometry software applications, and the result of the positive change in their views on geometry is similar to the result of this study. As a result of action research by Yavuzsoy-Köse and Özdaş (2009), they found that the use of Cabri 3D in learning the subject of symmetry was effective in students' reasoning and creating their unique mathematical structures. In the study of Okumuş (2011), similar to the results of this study, it was determined that the use of Cabri 3D in teaching the subject of quadrilaterals was effective in increasing success. Gürbüz and Gülburnu (2013) concluded that geometry education supported by Cabri 3D facilitates students' conceptual understanding. They also stated that students have positive opinions about the environments where Cabri 3D is used. In the study of Uğur et al. (2016), it was shown that the students expressed the positive aspects of the activities as interesting, time-saving, and active reuse outside the classroom. As a result of Keskin and Tapan-Broutin's (2019) study investigating the effectiveness of the 5E model in teaching the circle subject, they found that the 5E model contributed to the teaching of the circle subject, similar to the results of this study. They observed that the students actively participated in the teaching process in which the E5 model was used in their studies, and this increased their motivation. As a result of the study by Demir and Kurtuluş (2019), in which they examined the effect of the 5E model on the transformation geometry thinking levels, they concluded that the 5E model increased the thinking levels, similar to the results of this study.

Based on the results of this study, the following can be recommended.

- Materials using dynamic geometry software applications that students can learn by doing and experiencing with their active participation should be used in teaching different subjects in mathematics.
- Sample activities that can be implemented using dynamic geometry software applications should be included in the textbooks.
- This research is limited to 7th-grade geometry topics. For subjects at other grade levels, the effects of using Cabri 3D on students can be investigated from different aspects.

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GENİŞLETİLMİŞ ÖZET

1. GİRİŞ

Ulusal Matematik Öğretmenleri Konseyi (NCTM), geometrik düşünme becerisini geliştirmesi için geometri alanında etkin öğretim yöntemlerinin kullanılmasını önermektedir. Teknoloji destekli ortamlarda öğretim yapılmadığında geometrik kavramları öğrenciler anlamlandıramayacak ve geometriye yönelik kavramlar ezbere öğrenme ile sınırlı kalacaktır. Bu sebeple bilginin öğrenciler tarafından öğrenilmesine imkân veren öğrenme ortamları yapılandırılırken teknolojiden etkin biçimde yararlanılması önerilmektedir. Bilgisayar teknolojisindeki ilerlemeler sonucunda matematik öğretiminde kullanılabilecek öğretim yazılımları geliştirilmektedir. Bunlardan biri olan dinamik geometri yazılımları öğrencilerin geometrik çizimleri oluşturmasına fırsat vermektedir. Öğrencilerin matematiksel ilişkileri keşfetmesinde, ilişkilendirmesinde ve genelleme elde etmesinde bu yazılımlardan etkin biçimde yararlanılabilmektedir.

Bu çalışmada Cabri 3D dinamik geometri yazılımı kullanılmıştır. Cabri 3D yazılımı geometrik cisimlerin görselleştirilmesinde ve üç boyut algısını kavratmada fayda sağlamaktadır. Geleneksel ortamda oluşturulması ve görülmesi zor olabilen şekiller Cabri 3D yazılımı ile kolaylıkla inşa edilebilmekte ve cisim açılımları yapılabilmekte, farklı açılardan incelenebilmektedir. Bu çalışma Cabri 3D dinamik geometri yazılımı kullanılarak 5E modeline göre hazırlanmış etkinlikler doğrultusunda öğretim yapılan yedinci sınıf öğrencileri ile ders kitaplarındaki etkinlikler çerçevesinde öğretim yapılan yedinci sınıf öğrencilerinin geometri öğrenmelerini kıyaslamak amacıyla gerçekleştirilmiştir. Çalışmanın bir başka amacı, Cabri 3D yazılımı hakkında öğrenci görüşlerini incelemektir.

2. YÖNTEM

Bu araştırmada karma araştırma yöntemi tercih edilmiştir. Nicel araştırma yöntemlerinden yarı deneysel desen, nitel araştırma yöntemlerinden ise görüşme kullanılmıştır. Cabri 3D yazılımı destekli 5E modeline göre etkinlikler hazırlanarak öğretim yapılan deney grubu ile ders kitaplarındaki etkinliklere göre öğretim yapılan kontrol grubu arasında geometri başarı farkının belirlenmesi amacıyla kontrol gruplu yarı deneysel yöntem kullanılmıştır. Bu araştırmada ayrıca deney grubu öğrencilerinin, geometri öğretimi esnasında kullanılan Cabri 3D yazılımına yönelik görüşlerini incelemek için yarı yapılandırılmış görüşme formu kullanılmıştır.

Bu çalışmada deney ve kontrol grubunun seçiminde ön ölçüm ve kriterler kullanılmıştır. Gruplar seçilmeden önce uygulamanın yapıldığı okuldaki üç şubenin birinci dönem matematik not ortalamaları incelenmiştir. Matematik not ortalamalarına göre kontrol ve deney grupları birbirine yakın üç şubeden rastgele seçilmiştir. Çalışmanın örneklemini yedinci sınıfta öğrenim gören toplam 47 öğrenci oluşturmaktadır. Akademik Başarı Testi hem deney grubuna hem de kontrol grubuna uygulanırken, Görüşme Formu sadece deney grubundaki tüm öğrencilere uygulanmıştır.

Bu çalışmada ön-test ve son-test uygulamasında kullanılan Akademik Başarı Testi ve etkinlikler sonunda uygulanan Görüşme Formu veri toplama aracı olarak belirlenmiştir. Akademik Başarı Testi ilk aşamada 75 soruluk çoktan seçmeli test olarak hazırlanmış ve pilot uygulama sonrasında madde analizi yapılmıştır. Bu analizden sonra 75 sorudan 45'i madde güçlük indeksinin ve madde ayırt ediciliğinin ölçütlerini sağlamadığından elenmiştir. Testin güvenirliği için Cronbach's Alpha güvenirlik katsayısı hesaplanarak 0,912 bulunmuştur. Geçerlik ve güvenirlik analizleri tamamlandıktan sonra 30 soruluk çoktan seçmeli Akademik Başarı Testi ön-test ve son-test olarak uygulanmıştır. Cabri 3D dinamik geometri yazılımı destekli geometri öğretimi hakkında deney grubu öğrencilerinin yorumlarını almak için beş açık uçlu sorudan oluşan yarı yapılandırılmış Görüşme Formu hazırlanmış ve uygulanmıştır.

Deney grubundaki öğrencilere bilişim sınıfında ikili gruplar oluşturmak suretiyle Cabri 3D dinamik geometri yazılımıyla desteklenen 5E modeline göre hazırlanmış etkinlikler 7 hafta boyunca araştırmacı

rehberliğinde uygulanmıştır. Kontrol grubu öğrencilerine ders kitabındaki etkinlikler uygulanarak dersler sürdürülmüştür.

Nicel verilerin analizi için SPSS 26.0 paket programından faydalanılmıştır. Kullanılan testlerde istatistiksel olarak anlamlılık değeri 0,05'ten küçük çıkma şartı aranmıştır. Nitel verilerin analizi için betimsel analiz yöntemi uygulanmıştır.

3. BULGULAR

Deney ve kontrol grubu öğrencilerinin başarı ön-test puanları ilişkisiz örneklemler t-testi kullanılarak analiz edilmiş ve istatistiksel açıdan anlamlı farklılık tespit edilememiştir. Buradan çalışma öncesi deney ve kontrol grubu öğrencilerinin geometri başarılarının birbirine denk oldukları ifade edilebilir.

Deney grubu öğrencilerinin ön-test puanları ile son-test puanlarının analizinde ilişkili örneklemler t-testinden yararlanılmış ve son-test yönünde istatistiksel açıdan anlamlı farklılık tespit edilmiştir. Buradan yola çıkarak, Cabri 3D yazılımı destekli 5E modeline göre hazırlanan etkinliklerin deney grubuna uygulanması öğrencilerde geometri başarısının artışını sağladığı sonucuna varılabilir.

Kontrol grubu öğrencilerinin ön-test puanları ile son-test puanlarının analizinde ilişkili örneklemler t-testinden faydalanılmış ve son-test yönünde istatistiksel açıdan anlamlı farklılık olduğu görülmüştür. Buradan ders kitabı etkinliklerine göre sürdürülen öğretimin kontrol grubu öğrencilerinin geometri başarısında artış sağladığı sonucuna ulaşılabilir.

Deney ve kontrol grubu öğrencilerinin son-test puanlarını kıyaslarken ilişkisiz örneklemler t-testine başvurulmuş ve deney grubu öğrencileri yönünde istatistiksel açıdan anlamlı farklılık belirlenmiştir. Buradan yola çıkarak, Cabri 3D yazılımı ile desteklenen 5E modeline göre hazırlanmış etkinlikler kullanılarak deney grubuna uygulanan öğretimin ders kitabındaki etkinlikler kullanılarak kontrol grubuna uygulanan öğretime kıyasla öğrencilerin geometri başarını artırmada olumlu etkisinin olduğu sonucuna varılabilir.

Deney grubunun Cabri 3D etkinliklerinden önce geometri konularının işlenişine ilişkin görüşleri değerlendirildiğinde, derslerin genelde sınıf ortamında, yazı tahtasından deftere aktarma şeklinde, öğrencilerin pasif olduğu ve öğrenmelerin kalıcılığının düşük olduğu söylenebilir. Bu süreçlerde teknolojik araç gereç kullanımının öğrenci etkileşimi olmaksızın kullanılan akıllı tahta ile sınırlı kaldığı belirlenmiştir.

Deney grubunun Cabri 3D yazılımı hakkındaki olumlu görüşleri incelendiğinde, geometri başarılarını artırdığı, kalıcılığı olumlu etkilediği, soru çözümünde hız kazandırdığı, pratik olması, eğlenceli bir ortam olması ve öğrencilerin aktif katılımına imkân vermesi yönünde düşünceleri olduğu söylenebilir.

Deney grubunun Cabri 3D yazılımına yönelik olumsuz düşünceleri olup olmadığı sorulduğunda, çoğunun olumsuz düşüncesinin olmadığını, bazılarının olumsuz düşüncesinin kaynağının bilgisayar kullanımındaki deneyim yetersizliği ve yazılımın dilinin Türkçe olmayışı olarak ifade ettikleri görülmektedir. Deney grubunun Cabri 3D yazılımıyla etkinlikleri uygularken karşılaştıkları zorlukların belirlenmesine yönelik soruya verdikleri cevaplardan yola çıkarak, öğrencilerin çoğunun herhangi bir zorlukla karşılaşmadığını ifade ettiği görülmüştür.

Deney grubunun diğer konuların öğretiminde bilgisayar destekli ortamdan yararlanılması yönünde çoğunluğunun olumlu görüş belirttiği görülmektedir. Cabri 3D dinamik geometri yazılımının, başarı ve kalıcılık artışı sağladığı, kolay kullanılabilir olduğu, görsel zenginlik kattığı, arkadaş ilişkilerini olumlu etkileyen ve eğlendiren bilgisayar destekli bir ortam olduğu gözlemlenmektedir.

4. TARTIŞMA VE SONUÇ

Deney ve kontrol grubu öğrencilerinin ön-test ve son-test puanları kıyaslandığında grupların ikisinde de son-test puanları yönünde istatistiksel açıdan anlamlı farklılık belirlenmiştir. Buradan deney ve kontrol gruplarında uygulanan öğretim etkinliklerinin geometri başarısını artırdığı sonucuna varılabilir.

Deney ve kontrol grubunun son-test puanları kıyaslandığında, deney grubu son-test puanı yönünde istatistiksel açıdan anlamlı farklılık bulunması sonucuna dayanarak deney grubu ile yürütülen öğretim etkinliklerinin yani Cabri 3D destekli 5E modeline göre geometri öğretiminin geometri başarısını artırmada kontrol grubuyla yürütülen öğretim etkinliklerinden yani geleneksel öğretimden daha fazla etkisi olduğu söylenebilir.

Cabri 3D dinamik geometri yazılımının geometri öğretiminde kullanımı sonrasında deney grubundaki öğrencilerle görüşmeler yapılmıştır. Öğrencilerin ders kitabındaki etkinlikleri takip ettikleri geleneksel sınıf ortamında yapılan geometri öğretimini ezbere dayalı, sıkıcı, anlaşılması güç ve kalıcılığı düşük olarak görmekte iken Cabri 3D yazılımı destekli bilgisayar ortamında yapılan geometri öğretimini eğlenceli, aktif katılım sağlayabildikleri, görsel açıdan zengin, deneyim imkânı buldukları ve kalıcılığı yüksek olarak görme eğiliminde oldukları gözlenmiştir.

ETHICAL APPROVAL

In this study, all rules stated to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions specified under the title of "Actions Violating Scientific Research and Publication Ethics," which is the second part of the directive, have not been carried out.

Ethics Committee Approval Information:

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CONTRIBUTION OF RESEARCHERS

The contribution rate of the 1st and 2nd authors to the research is 50%.

Author 1: Research design, data analysis, reporting.

Author 2: Determination of the method, consultancy, critical comment.

CONFLICT OF INTEREST

There is no conflict of interest between the authors or any institution in the study.