THE EFFECT OF BASIC GEOMETRIC DRAWING-CONSTRUCTION ACTIVITIES ON 7TH GRADE STUDENTS' SELF-EFFICACY BELIEFS ABOUT GEOMETRY[i]

Fatmanur Tortop[1][ii],
Elif Bahadır[2]
[1]PhD Student,
Institute of Educational Science,
Marmara University,
Türkiye
orcid.org/0000-0003-1314-2983
[2]Assoc. Prof. Dr.,
Faculty of Education,
Yildiz Technical University,
Türkiye
orcid.org/0000-0002-1154-5853

Abstract:

In this study, it was aimed to determine the effects of geometric drawing-construction activities on the self-efficacy beliefs of 7th grade students toward geometry. The study was carried out using the quasi-experimental pre-test-post-test research model. The participants of the research are 30 7th grade students in a secondary school in Istanbul. It is based on the fact that the students have seen all the geometry gains and their volunteering. The data were collected in the classroom environment for 4 weeks, the first week was the "Self-efficacy Scale for Geometry" pre-test, and the second and third weeks were 9 activities including basic geometric drawing-construction, a total of 26 open-ended questions consisting of progressive questions in each activity, and the "Geometry-oriented Self-efficacy Scale" in the fourth week. Self-efficacy Scale was collected in 21 hours by applying the post-test. When the data obtained from the pre-test and post-test were analyzed with the dependent sample t-test, the results were found to be significant. This shows that geometric drawing-construction activity practices affect students' geometry self-efficacy beliefs positively. In line with the findings, suggestions were developed for the application of drawing-construction activities in geometry teaching.

Keywords: geometry teaching, 7th grade, drawing-construction activities, self-efficacy belief

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[ii] Correspondence: email fnurtortop@gmail.com

1. Introduction

Geometry is one of the abstract fields of mathematics that takes its subjects from life and nature, makes sense of the world by associating it with daily life, and has a universal language. The concepts and rules of geometry have an important place in our lives as they are used in all other fields of mathematics as well as in different branches of science and art (Duatepe & Ersoy, 2001). It is important to learn and teach geometry, which is used in every aspect of our lives, to solve the problems we encounter in our daily lives, and to recognize and understand the world (Altun, 2004). Geometry teaching, starting with games in childhood, constitutes the fun and interesting part of mathematics in learning geometric knowledge and concepts in a way to affects mental processes (Gür, 2005). However, since geometry consists of abstract concepts due to its structure, it is seen as a difficult course to achieve by students at later education levels. Since geometry teaching is a cumulative course, it takes place according to a certain systematic process. In this systematic process, it is understood that it is necessary to teach geometry not only at the level of knowledge but also through geometric drawing-construction activities to provide students with geometric thinking skills. It has been emphasized that if teachers use only the lecture method in geometry teaching, students may think of geometry as an abstract science, and therefore their interest in geometry may decrease and their academic achievement may be negatively affected (Başer et al., 2002).

The main purpose of geometry teaching is closely related to students' thinking, exploring, and finding a solution to a problem by proving by drawing and constructing in geometry. Drawing-constructions are a tool used to advance students' discovery skills (Cheung, 2011). The aim of geometric drawing-constructions is to solve problems by developing strategies instead of creating geometric shapes using compasses and rulers (Erduran & Yeşildere, 2010; Napitupulu, 2001). In drawing-construction activity applications, students' problem-posing and solving skills can be improved by enabling them to understand the relationship between different geometric shapes and their properties and to draw them (Posamentier, 2000; Napitupulu, 2001). In order to ensure meaningful learning in geometry, it is clearly stated that students' geometric thinking skills can be improved by including drawing-construction activity practices (Napitupulu, 2001; Erduran & Yeşildere, 2010). Geometry teaching should not be limited to textbooks, and many different activities that can be applied in classroom environments should be planned and implemented (Olkun & Aydoğdu, 2003).

In geometry learning, it is important to develop students' drawing-construction skills through activity-based practices (Napitupulu, 2001). Since the activity applications are student-centered, students should be helped to become aware of their own abilities, thus improving their self-confidence and increasing their positive attitudes and interests toward the course.

- With geometric drawing-construction activities, students can make abstract concepts concrete by visualizing them.

- They can reach the solutions to problems more easily by paying attention to concepts such as angle, length, and equality in geometric shapes.
- Doing geometric drawing-construction activities directs students to use metacognitive skills such as thinking, thinking, visualizing, analyzing, reasoning as a whole at the same time, and in this way, students gain many cognitive skills at the same time by drawing.
- Developing students' drawing-construction skills is a prerequisite for students to learn by making sense of the hierarchical relationships between geometric shapes and their properties (Hoffer, 1981).

In addition to cognitive skills, affective characteristics such as self-efficacy beliefs are also important in students' meaningful learning of geometric topics and concepts. In many studies examining mathematics and self-efficacy beliefs, it has been observed that there is a significant relationship between students f-efficacy beliefs and mathematics achievement levels (Kloosterman, 1991; Chn. 2002; Migray, 2002; Moore, 2005; Hacket & Betz, 1989). It is quite obvious that geometry, one of the important sub-branches of mathematics, will also be affected by self-efficacy beliefs. When the studies investigating the relationship between teaching methods-techniques and self-efficacy beliefs are examined, it is stated that there is a strong correlation between students' self-efficacy beliefs and the use of teaching materials and activities (Woolfok & Hoy, 2002; as cited in Zengin, 2003).

The concept of self-efficacy refers to an individual's belief that he/she can be successful in overcoming difficulties and solving problems in life (Senemoğlu, 1997). "Self-efficacy theory", whose importance has been more understood in recent years, was first developed by Bandura to provide control in behavioral changes toward individuals' fears (Chao, 2003). The concept of self-efficacy belief in the theorem is expressed as individual judgments about how well and correctly individuals can perform their actions in order to overcome the negativities they may encounter (Blake & Lesser, 2006). Self-efficacy beliefs are related to individuals' beliefs about what they can achieve with their skills, not their apparent skills. Even if an individual has enough knowledge and skills to accomplish a task, he/she will fail if he/she does not have the confidence that he/she can do it (Gawith, 1995). Self-efficacy belief is a belief that develops over time with the individual's experiences, observing other individuals, and listening to their comments (Lee, 2005). In studies on self-efficacy, it has been observed that individuals with high self-efficacy beliefs make more effort to succeed, persistent work harder by not giving up when faced with negative situations, and are patient (Gibson & Dembo, 1984; Pajares, 1996; Aşkar & Umay, 2001; Ritter et al., 2001).

Self-efficacy belief is based on positive and negative experiences of the individual. It is not the same as unrealistic thoughts and dreams. Since self-confident individuals evaluate their knowledge and skills more objectively, they do not take risks that are unlikely to be successful (Keskin & Orgun, 2006). In education, there are students who are not aware of their own abilities and do not believe in what they can do or whose belief is destroyed by the negativities they experience. Since these students have a high belief

that they cannot succeed, they see learning by making an effort as unnecessary (Kotaman, 2008). For this reason, it is important to conduct studies to determine students' self-efficacy beliefs. which play an important role in ensuring success in their academic and daily lives.

2. Purpose and Importance of the Research

In this study, it was aimed to investigate the effects of geometric drawing-construction activity practices on the geometry self-efficacy beliefs of 7th grade students. By implementing basic geometric drawing-construction activities in the classroom environment, students are given the opportunity to be active in the lessons, they are given the opportunity to realize their abilities, and thus their self-confidence is formed, and by implementing activity applications in lessons where attitude, interest, and motivation are lacking, it is to help increase affective gains as well as cognitive skills. In order for students to be successful in lessons, they need to have beliefs that they will succeed as well as knowledge (Gawith, 1995).

2.1 Research Problem
What are the effects of basic geometric drawing-construction activity practices on 7th grade students' self-efficacy beliefs toward geometry?

2.2 Research Sub-problems
1) How are students' self-efficacy belief levels towards geometry before and after geometric drawing-construction activity practices?
2) Do geometric drawing-construction activity practices have a significant effect on students' geometry self-efficacy beliefs?
3) When the geometry self-efficacy belief scale is analyzed according to its sub-dimensions, is there a significant effect of drawing-construction activity practices?

3. Method

3.1 Research Design
In the study, a quasi-experimental pretest-posttest research model was used to investigate the effects of geometric drawing-construction activities on 7th grade students' self-efficacy beliefs towards geometry courses. In the study, the control group was not needed since the basic geometric drawing-construction activities were to be applied after the geometry topics and achievements that the students saw at the end of the second semester of the 7th grade. The independent variable of the study was geometric drawing-construction activities and the dependent variable was students' self-efficacy belief levels towards geometry. In experimental studies, clearer results are obtained compared to other research designs. Because in experimental studies, comparable procedures are

applied and their effects are examined, the results obtained from the study are expected to lead the researcher to correct interpretations (Büyüköztürk, Çakmak, & Akgün, 2008).

3.2 Participants

Our research is a process aimed at students' basic geometric knowledge and drawing-construction skills in geometry teaching. In this process, the fact that the geometric subjects and acquisitions related to the study we intensive in the 7th grade determined the grade level of the participants. The participants of the study consisted of 30 students studying at the 7th grade level in a middle school in Istanbul by using convenience sampling (Yıldırım & Şimşek, 2005). The study was based on the students' having seen all previous geometry acquisitions including the 7th grade and their volunteering.

3.3 Data Collection Tools

In our study, data were collected in two stages: the implementation of geometric drawing-construction activities and the administration of the self-efficacy scale for geometry.

3.3.1 Basic Geometric Drawing-construction Activities

In geometry teaching, drawing-construction activities were prepared to enable students to draw lines, angles, types of triangles, types of triangles, types of quadrilaterals, circles, and regular polygons correctly by establishing the relationship between shapes and their properties. Within the scope of the research, 9 activities were prepared from easy to difficult, and each activity consisted of a total of 26 open-ended questions in stages ranging from 1-5. At the end of the basic geometric drawing activities, students were given homework to make their own designs by associating geometric shapes with daily life.

3.3.2 Geometry Self-efficacy Scale

The self-efficacy belief scale or geometry was developed by Cantürk-Günhan and Başer (2007). Twelve of the items of the scale, which consists of 25 items on a 5-point Likert scale, are related to "Positive Self-efficacy Beliefs", six are related to "Using Geometry Knowledge". and seven are related to "Negative Self-efficacy Beliefs".

3.4 Data Collection Process

At the end of the spring semester of the 2021-2022 semester, basic geometric drawing activity applications were applied to 30 students selected from among all 7th grade students in the classroom environment for a total of 21 hours for 4 weeks, including the geometry self-efficacy belief scale pre-test in the first week, 9 activities consisting of progressive questions and including basic geometric drawing-construction in the second and third weeks, and the geometry self-efficacy belief scale post-test in the fourth week. In the first week, the self-efficacy belief scale was applied as a pre-test in one class hour on Monday. In the 2nd week, geometric drawing-construction activities prepared from

easy to difficult were practiced for 10 hours for 2 hours each day with breaks in each activity for five days during the week, in the 3rd week, 8 hours for 2 hours each day with breaks in each activity for the first four days of the week, and on the 5th day of the 3rd week, the general evaluation of the activities was made for 2 hours and the students were given homework to make a design by adding what they learned in geometric drawing-construction activities and their own knowledge. On Monday of the 4th week, homework assignments were collected and the self-efficacy belief scale was applied as a post-test in one class hour on the same day.

Table 1: Data Collection Process of the Study

Week	Day	Data Collection Tools	Duration
1st week	Mon	Self-efficacy Scale for Geometry Pre-test Application	30 min
2nd week	Mon	**Activity 1:** Drawing straight lines from the point (3 stages)	2 h
	Tue	**Activity 2:** Developing different strategies to find the midpoint of the line and drawing the circle (3 stages)	2 h
	Wed	**Activity 3:** Learning the types of triangles and forming them in circles (3 stages)	2 h
	Thu	**Activity 4:** Learning the types of rectangles and forming them in circles (5 stages)	2 h
	Fri	**Activity 5:** Learning equilateral, equiangular, and regular polygon concepts and drawing hexagons as examples (3 stages)	2 h
3rd week	Mon	**Activity 6:** Making appropriate drawings by learning the types and properties of polygons by adapting the 'polygons table' in the 7th grade MEB mathematics textbook as a 'learning polygons by drawing-building activity' table (3 stages)	2 h
	Tue	**Activity 7:** Developing drawing strategies on how to create regular polygons with many circles (3 stages)	2 h
	Wed	**Activity 8:** Giving examples of geometric shapes in our life and in nature, creating a flower motif in nature with geometric shapes (2 stages)	2 h
	Thu	**Activity 9:** Drawing geometric design by applying drawing strategies for circles and polygons learned in drawing-construction activities (1 stage)	2 h
	Fri	At the end of the activities, evaluations were made about the activities, and the students were given as homework to create their own designs with geometric shapes.	2 h
4th week	Mon	Collection of homework Self-efficacy Scale for Geometry Post-test Application	30 min

3.5 Analysis of Data

In order to determine the effect of geometric drawing-construction activity practices on students' geometry self-efficacy beliefs, firstly, the normality of the data distributions was tested in order to determine the significance of the difference between the pretest-posttest mean scores. According to the results of the normality test, the pre-test and post-test data

of the research were analyzed by applying the dependent sample t-test. Self-efficacy belief towards geometry was determined by examining the significance of the pre-test-posttest mean score difference, its significance to its sub-dimensions, and students' geometry self-efficacy belief levels. Self-efficacy belief levels towards geometry were determined according to the average score ranges indicated in Table 2.

Table 2: Mean Score Ranges and Levels of Self-efficacy Beliefs towards Geometry

Average score ranges	Levels
1-1,80	Lowest
1,81-2,60	Low
2,61-3,40	Middle
3,41-4,20	High
4,21-5,00	Highest

4. Findings

In the study, the pre-test results of the data formed by the application of the 'Self-efficacy Belief Scale for Geometry' before and after the basic geometric drawing-construction activity applications are given in Table 3.

Table 3: Geometry Self-efficacy Belief Scale Pre-test Descriptive Statistics

	Number of Students (N)	Minimum	Maximum	Average (X)	Standard Deviation (SS)
Pre-test	30	2,44	4,88	3,7187	0,57607

As seen in Table 3, the average of the scores the students got from the pre-test application of the scale was calculated as 3,7187. From this, it is concluded that the geometry self-efficacy belief levels of the students participating in the study are at "high" (3,41 – 4,20). The lowest score obtained from the pre-test was 2,44; The highest score being 4,88 indicates that the lower limit is "low" and the upper limit is "highest".

In the study, the post-test findings formed by the application of geometric drawing-construction activities are given in Table 4.

Table 4: Geometry Self-efficacy Belief Scale Post-test Descriptive Statistics

	Number of Students (N)	Minimum	Maximum	Average (X)	Standard Deviation (SS)
Post-test	30	2,84	5	3,9733	0,56239

In Table 4, the average of the scores obtained from the post-test application of the scale was calculated as 3,9733 and it is seen that there is an increase of 0,2546 compared to the pre-test average. It is understood that the students participating in the study were at the "high" (3,41 – 4,20) level in the post-test application. The lowest score from the post-test

was 2,84; The highest score being 5 indicates that the lower limit is "medium" and the upper limit is "highest".

When the data in Table 3 and Table 4 are compared, it can be seen that the minimum values of the students participating in the study increased, they went from "low" to "medium" level; although there is an increase in the maximum scores, it is seen that there is no change in their levels and they are at the "highest" level. When the students' geometry self-efficacy belief pre-test and post-test data are evaluated, it is concluded that the average score increases. In order to understand whether the increase in the students' self-efficacy belief average scores was significant or not, the sample t-test dependent on the pre-test and post-test values was applied.

The findings obtained from the dependent sample t-test applied for the analysis of the pre-test and post-test results of the students participating in the study are presented in Table 5.

Table 5: Descriptive Statistics of Dependent Sample t-Test Applied to
Geometry Self-efficacy Belief Scale Pre-test and Post-test Scores

	Number of Students (N)	Average (X)	Standard Deviation (SS)	Degrees of Freedom (sd)	Test Statistics (t)	Significance Level (p)
Pre-test	30	3,7187	0,57607	29	-3,313	0,002
Post-test	30	3,9733	0,56239			

In line with the data in Table 5, it is seen that the pre-test and post-test mean score differences of the students are significant (t = -3,313; p = 0,002<0,05). It is concluded that geometric drawing-construction activity practices affect students' self-efficacy beliefs positively.

When Table 6, is examined according to the sub-dimensions of the Geometry Self-efficacy Belief Scale, it is seen that the pre-test - post-test mean score differences regarding students' positive self-efficacy beliefs, use of geometry knowledge, and negative self-efficacy beliefs are significant (p<0,05). From this, it is understood that drawing-construction activities affect students' positive and negative self-efficacy beliefs and their ability to use their geometric knowledge positively.

Table 6: Descriptive Statistics of the Pre-test and Post-test Dependent Sample
t-Test According to the Sub-dimensions of the Geometry Self-efficacy Belief Scale

		Number of Students (N)	Average (X)	Standard Deviation (SS)	Degrees of Freedom (sd)	Test Statistics (t)	Significance Level (p)
Positive Self-efficacy Beliefs	Pre-test	30	3,8000	0,64757	29	-2,849	0,008
	Pos-test	30	4,0361	0,57096			

Using Geometry Knowledge	Pre-test	30	3,3222	0,84637	29	-2,275	0,030
	Pos-test	30	3,6333	0,88344			
Negative Self-efficacy Beliefs	Pre-test	30	2,0810	0,50984	29	2,737	0,010
	Pos-test	30	1,8429	0,49679			

5. Discussion, Conclusion and Recommendations

Considering that people with high self-efficacy beliefs do not give up despite all the negativities they face and work hard to be successful, it is thought that geometric drawing-construction activity practices will increase students' self-confidence by making them aware of their abilities and thus have a positive effect on their success in geometry course. In addition to cognitive skills, affective characteristics gain importance in increasing students' attitudes and interests toward the course. Since geometry teaching generally uses lecture methods, students see it as a difficult course because they cannot concretize abstract geometric concepts. In today's education system, the teaching method in which the teacher is the guide and the student is active is adopted. With the implementation of geometric drawing-construction activities in the classroom environment, students are given the opportunity to be active in the lessons, they are given the opportunity to realize their abilities and thus their self-confidence is formed, and an increase in both cognitive and affective gains can be achieved by implementing activities in lessons where attitude, interest, and motivation are lacking. In our study, it was concluded that the implementation of activities involving basic geometric drawing-construction significantly increased the geometry self-efficacy beliefs of 7th grade students. These results show that drawing-construction activity applications positively affect students' attitudes, interests, and motivation toward the course by increasing their self-confidence. In our study, during the process of drawing-construction activity practices, students found geometry fun with the activities and stated that they started to like the lesson and understood the subjects better.

When the literature is examined, it is seen that there are no studies investigating the effect of basic geometric drawing-construction activity practices on middle school students' self-efficacy towards geometry, but there are not many studies investigating the effect of different activity-based instruction on students' self-efficacy beliefs. In this context, there are studies involving problem-based instruction (Cantürk-Günhan, 2006), creative drama (Yenilmez & Uygan, 2010), computer-assisted instruction (Orçanlı & Orçanlı, 2016), and writing activities (Contay & Duatepe-Paksu, 2018). In these studies, it was stated that students' geometry self-efficacy beliefs were positively affected. In one study, activities were prepared for the circle and circle subjects with GeoGebra software with 9th grade students by utilizing technology and it was stated that the applied method increased success and self-efficacy (Balcı-Şeker & Erdoğan, 2017).

Some suggestions are presented in line with the findings obtained from the research:

In order to increase students' attitudes, interest, and self-confidence towards the course in geometry teaching, activities can be designed and implemented in which students can discover and construct the information themselves by thinking and researching.

Since it is understood that drawing-construction activities will increase students' cognitive and affective skills, teachers should be informed about including drawing-construction activities in their lesson plans.

In addition to theoretical knowledge in geometry teaching, mathematics textbooks can include more activities involving drawing-construction.

In our study, it was observed that geometric drawing-construction activities positively affected the self-efficacy of 7th grade students at a high level. Research can be conducted by applying the self-efficacy scale to low and middle-level students.

In our study, the self-efficacy belief scale was applied to 7th grade students. Similar research can be conducted by applying it to 5th, 6th, and 8th grade students.

At the end of the activity practices for basic geometric drawing-construction, students were given homework to create their own designs with geometric shapes. When the designs prepared were examined, it was seen that the students made meaningful drawings by establishing the relationship between geometric shapes and their properties in the light of the information they learned during the activity process and associating them with daily life. A few examples of students' homework assignments are presented below.
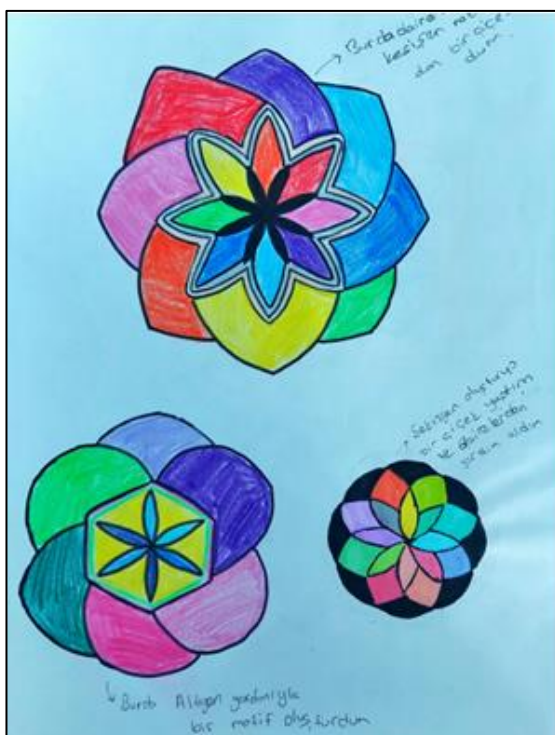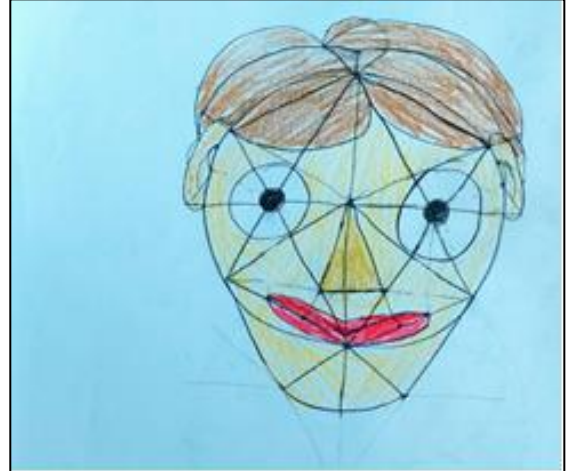
| Drawing of S12 coded student | Drawing of S30 coded student |
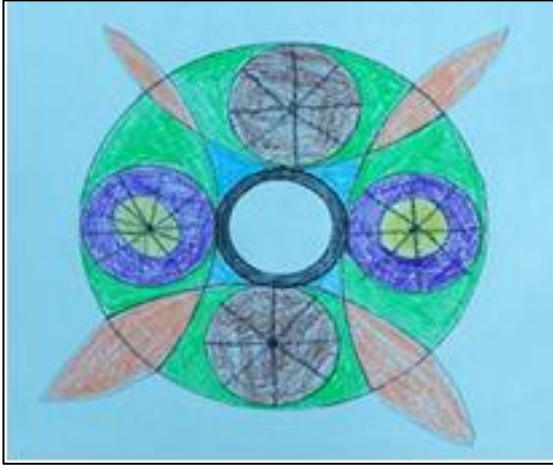
Drawing of S17 coded student

Drawing of S8 coded student

Drawing of S2 coded student

Drawing of S20 coded student

Conflict of Interest Statement
The authors declare no conflicts of interest.

About the Author(s)
Fatmanur Tortop is a graduate of Yildiz Technical University, Faculty of Education, Mathematics Teaching, and a graduate with a Master of Mathematics Education at Institute of Science. She is pursuing his doctorate in mathematics teaching at Marmara University. She has articles and papers on mathematics education in international peer-reviewed journals.

Assoc. Prof. Dr. Elif Bahadır works at Yildiz Technical University, Faculty of Education, Department of Mathematics and Science Education, Mathematics Education. She has many articles published in national and international journals in the fields of social and human sciences, primary and secondary education mathematics teaching.

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