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The effects of using digital photographs with Geometer's Sketchpad at 4th Grade

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Abstract

Research findings have showed that students have difficulties in learning geometry. Physical and virtual manipulatives might help primary students to learn and understand geometry easily. In this research, we have investigated the effects of using digital photographs with Geometer's Sketchpad (GSP) on students' academic achievement at 4th grade. In this regards, instructional materials, achievement tests and worksheets were prepared in accordance with 4th grade curriculum and applied on the students. This quasi-experimental study was conducted in an elementary school with 50 students at 4th grade. The findings of this study demonstrated that using GSP as a virtual manipulative facilitates students learning. Also, according to the interviews with students, the students have both positive and negative thoughts towards instructional software and GSP as a virtual manipulative.

Keywords: Geometer's Sketchpad, digital photographs, geometry instruction, achievement;

1. Introduction

Research findings (Mitchelmore, 1997; Mullis et al, 2000; Prescott, Mitchelmore & White, 2002) have showed that students have difficulties in learning geometry. At the same time, according to the TIMSS (Trends in International Mathematics and Science Study) results, it is obvious that the geometry scores of Turkish students are below the international average (Mullis et al, 2008).

It is very important to find the better way for teaching mathematics & geometry to students in order to increase their achievements. According to Clements' (1999) physical and virtual manipulatives might help students to learn mathematics. In the process of teaching, especially mathematics, the concretization of abstract concepts and relations is gaining importance with the development of computer software which is called "virtual manipulative" (Karakırık, 2008). Also Clements (1999) stated that, good manipulatives are those that should be meaningful to the learner, provide control and flexibility to the learner, be consistent with cognitive and mathematics structures and help the learner in making connections between various pieces and types of knowledge.

Virtual manipulatives offer new and improved approaches for teaching and learning mathematics by using manipulatives and using computers (Moyer, Bolyard & Spikell, 2001). Geometer's Sketchpad (GSP) as a virtual manipulative is one of the dynamic geometry software that can be used in mathematics and geometry classes. GSP is a powerful tool for visually representing geometric concepts to students and also it provides students with the

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capability to draw, measure, calculate and script geometric shapes and figures (Liu & Cummings, 2001). Another feature of the GSP is that digital images in different formats can be imported. Nowadays cameras, scanners and various formats of digital images can easily be accessed via the Internet. This feature enables teachers and students to bring images easily from the outside world into the classroom (Afzal, Clark-Jeavons & Oldknow, 2004). Also according to Weinthal (2005) photographs can be powerful teaching tools.

Some of the studies (Almeqdadi, 2000; Budak, 2010; Vatansever, 2007) have showed that using GSP have positive effects on students' geometry achievement. Also other studies (Garofalo & Bell, 2003; Pierce & Stacey, 2005; Schumann, 2004; Oldknow, 2008) have stated that using digital photographs with dynamic geometry software such as GSP could change the way of students' thinking and could increase the interest of students.

This research has been conducted to investigate the effects of using digital photographs with GSP on students' academic achievement at 4th grade. This study also aims to determine how to prepare and apply more effective classroom activities by using GSP as a virtual manipulative.

1.1. Aim of Research

The purpose of this research is to examine the effects of using digital photographs with GSP on students' academic achievement at 4th grade and to determine students' views on these applications. The study will answers for the following questions:

- Is there a statistically significant difference between experimental and comparison group students' academic achievement after the application?
- What is the experimental and comparison group students' views towards applied instruction?

2. Method

This quasi-experimental study with nonequivalent comparative groups was conducted in an elementary school in an urban area with 50 students at 4th grades. Quantitative and qualitative approaches were adopted in this research. It was aimed to examine how to apply computer assisted instruction activities through dynamic geometry software more effectively. In this context, while students in the experimental group were taught "Triangle, Square & Rectangle", "Perimeter" and "Area" subjects by using digital photographs with GSP (Figure 1), students in the comparison group were taught the same subject by using just GSP (Figure 2). The experimental group consisted of 24 students; the comparison group consisted of 26 students. The equivalence of the groups in terms of mathematical knowledge was determined by utilizing a pretest. The application was performed by the same teacher in five weeks for two lesson hours per week. At the end of the treatment, both groups of students completed Geometry Achievement Test. Later, semi structured interviews are conducted to gather data on students' thoughts about geometry learning with virtual manipulatives.

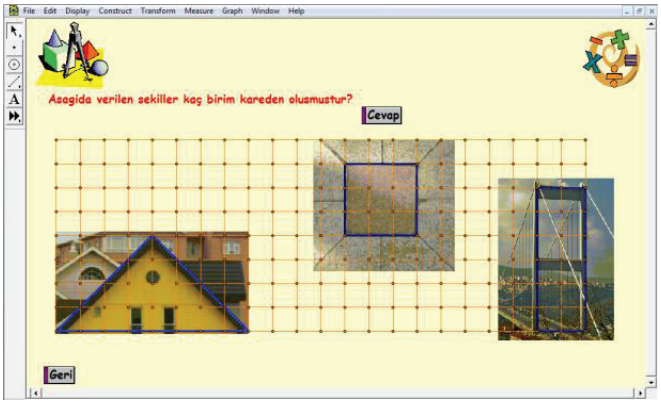

Figure 1. GSP Screenshot for the experimental group

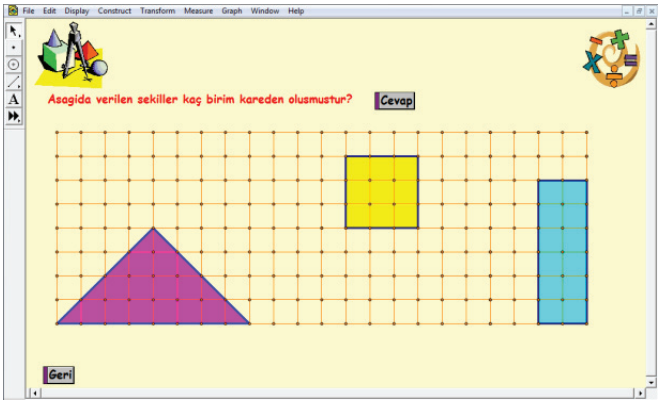

Figure 2. GSP Screenshot for the comparison group

2.1. Data Collection

Geometry Achievement Test: In order to assess the success of students and determine the impact of the instruction, an achievement test was developed by the researchers. The content validity of the test was determined by experts. The research for the reliability of the test was done in a different school with 114 students; the Cronbach's Alpha statistic was 0,790. This geometry achievement test was also used as a pretest in order to determine whether the groups were equivalent or not in terms of their level of mathematical knowledge.

Interview Form: Semi structured interview forms were developed by the researchers. Through the interviews students' views about the treatment and GSP were gathered.

3. Results

In this research, the data of pretest and posttest is normally distributed so the independent *t*-test is used to test the difference between groups' test scores and also the dependent *t*-test is used to compare groups' pretest and posttest scores. According to the pretest results given in Table 1, there was no significant difference between the experimental and comparison groups ($t_{(48)}$=-0,68; p>0,05). In this case, it can be said that the achievement levels of experimental and comparison groups are equal.

Table 1. Experimental and Comparison Groups' Pretest Scores

Groups	N	Pretest Mean	SD	df	t	p
Experimental Group	24	9,95	4,06	48	-0,68	0,500
Comparison Group	26	9,19	3,89			

In order to compare the experimental group students who were taught by using digital photographs with GSP, with the comparison group students who were taught by using just GSP in terms of achievement, an independent *t*-test was used. According to the geometry achievement test results given in Table 2, there was a statistically significant difference between the experimental and comparison groups ($t_{(48)}$=-2,19; p<0,05). This difference is in favor of the students in the experimental group. Also, the effect size of 0,62 is clearly interpreted as a medium effect size.

Table 2. Experimental and Comparison Groups' Posttest Scores

Groups	N	Posttest Mean	SD	df	t	p	d
Experimental Group	24	17,29	4,15	48	-2,19	0,034	0,62
Comparison Group	26	14,53	4,71				

In order to compare experimental and comparison groups' pretest and posttest scores, dependent *t*-test was used. In Table 3, test scores of groups are given. Significant differences were found between students' pretest and posttest scores. These differences were in favor of the students in both experimental ($t_{(23)}$=-10,24; p<0,05) and comparison ($t_{(25)}$=-7,15; p<0,05) groups.

Table 3. Experimental and Comparison Groups' Pretest & Posttest Scores

Groups	Tests	N	Test Mean	SD	df	t	p
Experimental Group	Pretest	24	9,95	4,06	23	-10,24	0,000
	Posttest	24	17,29	4,15			
Comparison Group	Pretest	26	9,19	3,89	25	-7,15	0,000
	Posttest	26	14,53	4,71			

In order to investigate the views of students on applied instruction, short interviews were carried out with eight students from 4th grade. Semi-structured interview questions were asked to investigate the students' views' on applied instruction and dynamic geometry software. 87,5% of the students stated that they liked using dynamic geometry software during the instruction. The students in both groups have never used such dynamic geometry software before and also, 75% of the students said that they did not have any difficulties while they were using GSP. However one student from each group stated that they had difficulties because of the language of the software (instruction in the schools are Turkish while the interface of software is in English). 87,5% of the students found software useful; also some of them mentioned that because of the dynamic feature of the software they understood the subject more deeply. Furthermore, 75% of students in the experimental group stated that they liked the way they were taught by using digital photograph with GSP, some of them said that with the help of photographs they comprehended better. Lastly, all of the students interviewed said that the GSP contributed to their achievements.

4. Conclusion and Recommendations

This research aimed to examine the effects of using digital photographs with GSP on students' academic achievement at 4th grade and to determine students' perspectives on these applications. The data gathered with geometry achievement tests was analyzed, it was found that using dynamic geometry software GSP as a virtual manipulative facilitated students' learning for 4th grade level. This result supports the studies that (Almeqdadi, 2000; Budak, 2010; Clements, 1999; Vatansever, 2007) which have showed that using GSP have positive effect on students' geometry learning. According to this result we might say that using dynamic geometry software GSP can increase students' academic achievement levels.

Also using digital photographs with GSP improved academic achievement of students even further. This result supports the studies (Garofalo & Bell, 2003; Pierce & Stacey, 2005; Schumann, 2004; Oldknow, 2008) which have stated that using digital photographs with dynamic geometry software such as GSP could change the way of students' thinking, and could increase the interest of students.

Also, as indicated by the results, most of the students interviewed agree that using dynamic geometry software during the instruction is effective and beneficial. Some of the students mentioned that using GSP was easy and useful and also facilitated learning. This result supports the studies (Liu & Cumming, 2001; Pierce & Stacey, 2005) which emphasized that using dynamic geometry software facilitates learning.

In the light of this study, it can be deduced that future studies need to be conducted to see the effects of using digital photograph with GSP as virtual manipulatives on academic achievement for different content areas and grade levels. In order to increase the use of dynamic geometry software as a virtual manipulative, it is suggested that

educators should educate themselves and new activities containing dynamic geometry software applications should be developed.

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