

WCES-2010

The effects of using geometry software supported by digital daily life photographs on geometry learning

Zeynep Gecü^a, Nesrin Özden^b *

^aMarmara University Institute of Educational Sciences, Istanbul 34722, Turkey

^bMarmara University Atatürk Faculty of Education, Istanbul 34722, Turkey

Received October 23, 2009; revised December 1, 2009; accepted January 13, 2010

Abstract

Dynamic geometry software has a significant place in geometry instruction, which has been confirmed by many research findings. This study aims to investigate the effects of using geometry software supported by digital photographs that exemplify daily life, upon achievement and permanence of knowledge. The findings of this research demonstrate that using Geometer's Sketchpad (GSP) supported by digital photographs results in improvements in achievement, permanence of knowledge and relating mathematics subjects to daily life.

© 2010 Elsevier Ltd. All rights reserved.

Keywords: Geometry instruction; dynamic geometry software; digital photograph; daily life.

1. Introduction

Many studies (Mitchelmore, 1997; Mullis et al., 2000; Prescott, Mitchelmore & White, 2002) have showed that students have difficulties in learning geometry, and in thinking geometrically. Research on technology integration in education has demonstrated that using computers in the classroom benefits student learning in mathematics (Işıksal & Aşkar, 2005; Olkun, Altun, & Smith, 2005).

The term 'dynamic geometry', originally coined by Nick Jackiw and Steve Rasmussen, has quickly entered the literature as a generic term. Dynamic geometry describes software packages such as Geometer's Sketchpad (Jackiw 1991, 1995), Cabri (Baulac, Bellemain, & J.M. Laborde, 1992, 1994) and Geometry Inventor (Brock, Cappo, Dromi, Rosin, & Shenkerman, 1994), which were designed for geometry instruction (Goldenberg & Cuoco, 1998).

Geometer's Sketchpad (GSP) is one of the powerful tools for geometry education. Sinclair, Bruyn, Hanna and Harrison (2004) reported that GSP offers students the opportunity to investigate geometric objects without learning traditional procedures. Moreover, Sinclair (2004) found that using GSP activities helped students notice geometric details, explore relationships and develop reasoning skills related to geometric proof (as cited in Lin, 2008). GSP is

* Nesrin Özden.

E-mail address: nozden@marmara.edu.tr.

also effective in helping students develop three-dimensional visualization, and achieve a conceptual understanding of geometrical content (McClintock, Jiang, & July 2002).

The study reported by Vatansever (2007) determined that students, who learn geometric concepts with GSP by drawing, and try to research by exploring, are more successful. Similarly, Üstün & Ubuz (2004) compared traditional and dynamic instructional environments (based on the use of GSP). Their results indicate that students who learned geometry with GSP and Sketchsheets showed higher performance levels in learning geometric concepts than students who received instruction by traditional methods. Akuysal (2007) suggests that while teaching geometric concepts, there should be a conducive learning environment for students to discover these by themselves. A number of studies (Baki, 2001; Belfort & Guimarães, 2004; Toumasis, 2006) have showed that dynamic geometry software can help students to learn concepts by discovering, without memorizing.

Afzal, Clark-Jeavons and Oldknow (2004) mentioned that dynamic software such as GSP allows access to a wealth of digital images in a variety of common formats. These enable teachers and students to bring images easily from the outside world into the mathematics classroom. As a matter of fact, some studies (Arsal, 2002; Chung, 2009; Kayaaslan, 2006) have showed that using daily life examples and activities during instruction, and relating these to the subject have positive effects upon student achievement.

Oldknow (2003) mentioned that the property of importing photographs into dynamic geometry software can be used for algebraic and geometric modeling. Moreover, Tanner (2005) described using digital images in dynamic geometry software during her lessons, and showed that use of digital photography attracted the attention of students and increased their motivation.

This following research has been conducted to examine the effects of using digital photographs in dynamic geometry software GSP upon student achievement, and upon permanence of knowledge. This study also aims to realize abstract geometric concepts using digital photographs that exemplify daily life, and can act as direct educators about the use of dynamic geometry software, in line with the demands of the new curriculum.

1.1. Aim of Research

The aim of this research is to examine the effects of using digital photographs in dynamic geometry software GSP upon student achievement, and upon permanence of knowledge. The effects of the method used, which related mathematics to daily life, were also investigated. In this research it is hypothesized that:

- The experiment group which uses GSP supported by digital photographs exhibits significantly higher achievement than the control group which uses GSP.
- The experiment group is more successful than the control group in terms of permanence of knowledge.
- The experiment group is more successful than the control group in terms of relating mathematics subjects to daily life.

2. Method

In this study, an experimental research model was used that involved a control group, an experiment group and a post-test given to both groups. The research group consisted of two 7th grade classes, and experiment and control groups were determined by lot. The equivalence of the groups in terms of mathematical knowledge was determined by utilizing a pre knowledge test. After lectures performed with different teaching methods (control group: with GSP; experiment group: with GSP supported by digital photographs), group comparisons were made. After three weeks following the application, the effects of the teaching methods on permanence of knowledge were examined in each group, using a permanence test. According to the results of sampling forms that were filled out by the students, the ability of experiment and control groups to associate subjects with daily life were compared.

The control group consisted of 17 students; the experiment group consisted of 15 students. The application was performed in the “Coordinate System and Graphing Linear Equations” module, given by the same teacher in 3 days for 2 lesson hours per day. The first 2 hours of the teaching process for both experiment and control groups were conducted as theoretical in the classroom. The remaining four hours were performed in the laboratory with GSP software. Samples of the GSP screenshots used for each group are given in Figure 1 and Figure 2. After the second day, the experiment group was asked to take photographs that contained relevant daily-life examples, and to bring these to the next lesson. In the last lesson the experiment group studied using the photographs they had taken.

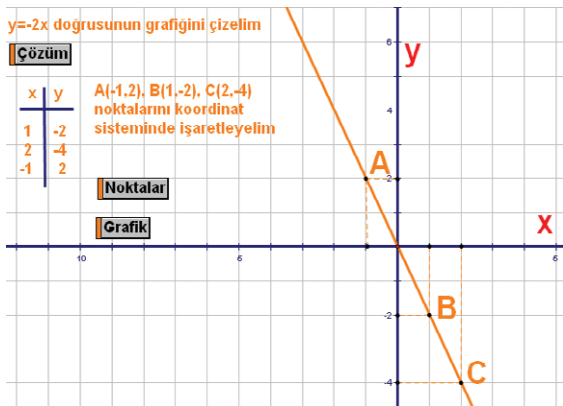


Figure1. GSP Screenshot for control group

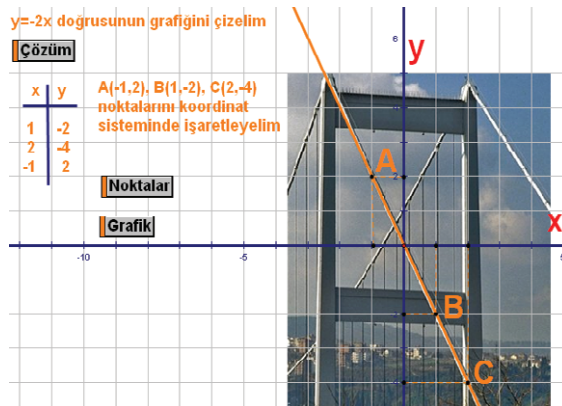


Figure 2. GSP Screenshot for experiment group

2.1. Data Collection

Pre Knowledge Test: Each student sat a pre knowledge test containing 25 mathematics questions taken from a Government Scholarship Examination in Turkey for 6th grade primary school students, for the 2006–2007 academic year. Pre knowledge test results were used to determine whether the groups were equivalent or not in terms of their level of mathematical knowledge.

Achievement Test: In order to assess the success of students and determine the impact of the different teaching methods, an achievement test was developed by the researchers. The research for the reliability of the test was done in a different school with 81 students; the Cronbach's Alpha statistic was 0,715. Three weeks following the application, the same achievement test was used as permanence test.

Sampling Form: A sampling form, which consists of four open-ended questions, was developed by the researchers. Through this form, students were asked to give examples from daily life associated with the prisms, symmetry, similarity and congruency, and polygons.

3. Results

In this research, a Mann Whitney U test was used to compare the study groups' pre knowledge test results in order to determine whether they were equivalent or not in terms of their level of mathematical knowledge before the application. The results showed that there was no significant difference between the groups in terms of their mathematics achievement. [U=113,50; p=0,60>0,05].

3.1. Hypothesis 1

In order to test the first hypothesis and compare the control group, which used GSP, with the experiment group, which used GSP supported by digital photographs, in terms of achievement, a Mann Whitney U test was used. According to the achievement test results given in Table1, there was a statistically significant difference between the groups (U=67,00; p<0,05). When the mean ranks are taken into consideration, it can be seen that achievement scores of the experiment group students are higher than the scores of the control group students.

Table1. Comparison of Experiment and Control Groups' Achievement Test Scores after Application

	Groups	n	Mean Rank	Sum of Ranks	U	p
Achievement Scores	Control	17	12,94	220,00	67,00	,021
	Experiment	15	20,53	308,00		

3.2. Hypothesis 2

In order to test the second hypothesis, and compare the control group, with the experiment group, in terms of permanence of knowledge, a Mann Whitney U test was used. Three weeks following the application, according to

the permanence test results, which are given in Table2, there was a statistically significant difference between the groups ($U=69,50; p<0,05$). The experiment group, which used GSP software supported by digital photographs, showed a higher level of permanence of knowledge.

Table2. Comparison of Experiment and Control Groups in terms of Permanence of Knowledge

	Groups	n	Mean Rank	Sum of Ranks	U	p
Permanence Test Scores	Control	17	13,09	222,50	69,50	,027
	Experiment	15	20,37	305,50		

3.3. Hypothesis 3

Frequency analysis was conducted by evaluating the sampling forms that were filled by the students. As shown in Table3, when the frequencies of examples given by students were examined, it can be seen that the experiment group was more successful than the control group in terms of relating mathematics to daily life ($T=64$ for experiment group, $T=29$ for control group). In addition, comparison of the number of students who could not give examples in the categories, it can be seen that the number of students in the control group is higher than the number of students in the experiment group (Prisms $B=9$, Similarity & Congruency $B=13$, Polygons $B=12$ for control group).

Table 3. Distribution of Samples of Relating Mathematics to Daily Life

Categories	Given Samples	T Frequency		W Frequency		B Frequency	
		E	C	E	C	E(n=15)	C(n=17)
Prisms	Speaker, buildings, aquarium, roof, tent	25	9				
	Pyramids, cone, prism, stairs			7	2	0	9
Symmetry	Mirror, butterfly wings, glasses, leaf	12	13				
	Window, table, house			2	3	3	1
Similarity & Congruency	Electric pole, Matryoshka doll, wardrobe doors	5	2				
	Book, triangle			1	3	10	13
Polygons	Honeycomb, door, sidewalk, car glass	22	5				
	Box, pyramids			3	1	0	12
Total		64	29	13	9		

T: Number of true samples W: Number of wrong samples B: Number of students who left it blank E: Experiment C: Control

Moreover, when the sampling forms were examined, it was observed that students in the experiment group gave more and different kinds of examples compared with the students in the control group for the categories of prisms, symmetry, similarity and congruency, and polygons.

4. Conclusion and Recommendations

This study examined the effects of using GSP supported by digital photographs in geometry education upon student achievement, permanence of knowledge and the ability to relate subject to daily life. These findings demonstrate that there is significant differences in terms of achievement test results in favor of the experiment group which used GSP supported by digital photographs that exemplify daily life, compared to the control group which used GSP. This supports some previous studies (Arsal, 2002; Chung, 2009; Kayaaslan, 2006), which emphasized that using daily life examples and activities, and relating them to subjects has a positive impact upon student achievement in the process of education.

These results also show that the experiment group, which used GSP supported by digital photographs that exemplify daily life, is more successful in terms of permanence of knowledge, compared to the control group. These results support the study by Chung (2009) which emphasized the importance of using concrete materials for abstract concepts in mathematics lessons and a study by Arsal (2002), which indicated the effects of using concrete experiences on achievement and permanence of knowledge.

Analysis of the sampling forms revealed that most of the students in the experiment group gave true examples. However, in the category of 'symmetry' the students in the control group gave more true examples than the students

in the experiment group. The reason of this result might be that, the subject ‘symmetry’ was taught both in mathematics, and science and technology lessons in the 6th grade. In both groups, the number of samples given for the subject ‘similarity and congruency’ was less than for any other subject; this suggests that this subject from the 6th grade curriculum is poorly understood by students. Also comparison of the number of students who could not give examples in the categories of prisms, similarity and congruency, and polygons, it can be seen that the number of students in the control group is higher than the number of students in the experiment group.

Due to the limited sizes of the groups in this study, future studies should be undertaken with larger groups of students. In addition, further studies could assess more comprehensive subjects, which take more lesson hours. In this way, the effects of teaching methods on permanence of knowledge, student motivation and continuity of interest could be examined in long term studies. Moreover, students faced difficulties during the applications because they encountered the software for the first time, and the language of the software is English. Thus the researchers suggest constituting groups with students who are familiar with this software and have higher abilities. In this way further study showing higher and more permanent results can be used to support the use of GSP supported by digital photographs in learning.

References

- Afzal, A., Clark-Jeavons, A. & Oldknow, A. (2004). How can teaching aids improve the quality of mathematics education. *Educational Studies in Mathematics*, v56, n2–3, p313-328.
- Akuysal, N. (2007). Seventh grade students' misconceptions about geometrical concepts. *Unpublished Master Thesis*, Selçuk University, Graduate School of Natural and Applied Sciences, Konya.
- Arsal, Z. (2002). The Effectiveness of teaching division operations through concrete experiences in primary school mathematics course. *Unpublished Doctoral Dissertation*, Abant İzzet Baysal University, Social Sciences Institute, Bolu.
- Baki, A. (2001). Bilişim teknolojisi ışığı altında matematik eğitiminin değerlendirilmesi [Evaluation of mathematics education in the light of information technology]. *The Journal of National Education*, 1, 149–154.
- Belfort, E. & Guimaraes, C.L. (2004). Teacher's practices and dynamic geometry. *International Group for the Psychology of Mathematics Education*, 28th, Bergen, Norway, July 14-18, 2004. 8 pp.
- Chung, I. (2009). Korean teachers' perceptions of student success in mathematics: Concept versus procedure. *The Montana Mathematics Enthusiast*. Vol. 6, nos. 1&2, pp.239- 256.
- Goldenberg, E.P. & Cuoco, A. (1998). What is dynamic geometry? R. Lehrer, D. Chazan (Eds.), *Designing Learning Environments for Developing Understanding of Geometry and Space*, Lawrence Erlbaum Associates, 351-367.
- Işıksal, M. & Aşkar, P. (2005). The Effects of Spreadsheet and Dynamic Geometry Software on the Achievement and Self-Efficacy of 7th Grade Students, *Educational Research*, 47 (3), 333-350.
- Kayaaslan, A. (2006). 4th and 5th grade elementary school students' beliefs about the nature of mathematics and the teaching of mathematics. *Unpublished Master Thesis*, Gazi University, Institute of Educational Sciences, Ankara.
- Lin, C.Y. (2008). Preservice teachers' beliefs about using technology in the mathematics classroom. *The Journal of Computers in Mathematics and Science Teaching*; 27, 3; Academic Research Library pg. 341.
- McClintock, E., Z. Jiang, & July, R. (2002). Students' development of three-dimensional visualization in the *Geometer's Sketchpad* environment. *PME-NA XXIV: Proceedings of the 24th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, ERIC 739–54.
- Mitchelmore, M. C. (1997). Children's informal knowledge of physical angle situations. *Learning and Instruction*, 7, 1-19.
- Mullis I. V.S., Martin M. O., Gonzalez E. J., Gregory K. D, Garden R. A., O'Connor K. M., Chrostowski S.J., & Smith T. A. (2000). *TIMSS 1999 International mathematics report: findings from IEA's repeat of the third international mathematics and science study at the eighth grade*, Chestnut Hill, MA: Boston College.
- Oldknow, A. (2003). Geometric and algebraic modelling with dynamic geometry software. *Micromath*. 19(2), 16-19.
- Olkun, S.; Altun, A. & Smith, G. G. (2005). Computers and 2D geometric learning of Turkish fourth and fifth graders. *British Journal of Educational Technology*, 36(2), 317-326.
- Prescott, A., Mitchelmore, M., & White, P. (2002). Students' difficulties in abstracting angle concepts from physical activities with concrete material. *Proceedings of the Annual Conference of the Mathematics Education Research Group of Australia* Incorporated ED 472950.
- Sinclair, M., Bruyn, Y., Hanna, G., & Harrison, P. (2004). Cinderella and the Geometer's Sketchpad. *Canadian Journal of Science, Mathematics, & Technology Education*, Vol. 4 Issue 3, p423-437.
- Tanner, R. (2005). Bearings using *Geometer's Sketchpad*. *Micromath*, Vol. 21(1) 22–23.
- Toumasis, C. (2006). Expanding in-service mathematics teachers' horizons in creative work using technology. *International Journal of Mathematical Education in Science and Technology*, Vol. 37, No. 8, 15, 901–912.
- Üstün, I. & Ubuz, B. (2004). Geometrik kavramların Geometer's Sketchpad yazılımı ile geliştirilmesi [The development of geometric concepts through a Geometer's Sketchpad software]. *Best Practices in Education Conference 2004*. (17 January 2004). İstanbul: Sabancı University.
- Vatansever, S. (2007). The effect of learning the seventh grade primary geometry subjects with dynamic geometry software geometers sketchpad on success and permanence and the students' opinions. *Unpublished Master Thesis*, Dokuz Eylül University, Institute of Educational Sciences, İzmir.