GEOMETERS' SKETCHPAD SOFTWARE FOR NON-THESIS GRADUATE STUDENTS: A CASE STUDY IN TURKEY

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The purpose of this paper is to determine mathematics teachers' views about Geometers' Sketchpads Software (GSP) and to analyze the effects of training sessions on prospective teachers' ability to integrate instructional technology in the teaching of geometry. For that purpose, two graduate student teachers were selected; they investigated GSP activities. They followed training sessions about using GSP. The data come from interviews with them and GSP activities improved by them. The results of this study indicate that their awareness level about GSP was increased.

Keywords: *Teacher Education, Secondary Mathematics Education, Non-thesis Graduate Program, Integrating Technology, Geometers' Sketchpad Software.*

INTRODUCTION

Today's use of technology as a learning tool supplies the students with gaining the mathematics skills in their lessons. According to Newman (2000), the use of technology in learning arouses curiosity and thinking, and challenges students' intellectual abilities. Kerrigan (2002) state that using mathematics software promote students' higher order thinking skills, develop and maintain their computational skills. For this reason, teacher training is crucial in order to use technology in mathematics education.

Computers could be used in school for teaching geometry, and since then a lot of work has been done that discusses many aspects of using Dynamic Geometry Software (DGS) in education (Kortenkamp, 1999). In this study, it was concerned with DGS activities developed by non-thesis graduate student teachers. Non thesis graduate program is in Turkey was opened for the purpose of educating future teachers. The secondary school (grade 9-11) mathematics teacher training program made up of two different programs. The Five-Year Integrated Programs (3.5+1.5) in Faculty of Education and Non Thesis Graduate Program (4+1.5) in Faculty of Science. Last 1.5 year part is the same for both 3.5+1.5 and 4+1.5 programs. Of these programs 3.5 and 4 year are spent on taking the mathematics courses and remainder years on pedagogical courses. After graduation, they can be secondary school mathematics teacher. This program is described in more detail in YOK (1998). The aim of this study was to investigate whether their views changed after the education process and to determine the outcomes about student teachers' proficiency.

THEORETICAL FRAMEWORK

In geometry, teachers are expected to provide "well-designed activities, appropriate tools, and teachers' support, students can make and explore conjectures about geometry and can learn to reason carefully about geometric ideas from the earliest years of schooling" (NCTM, 2000). Mathematics teachers can help students compose their learning by using geometry sketching software. Geometer's Sketchpad allows younger students to develop the concrete foundation to progress into more advanced levels of study (Key Curriculum Press, 2001).

Reys et al. (2006) point out young learners of mathematics need to

- experience hands-on (concrete) use of manipulative for geometry such as geoboards, pattern blocks and tangrams,
- connect the hands-on to visuals or semi concrete models such as drawings or use the sketching software on a computer,
- comprehend the abstract understanding of the concepts by seeing and operating with the picture or symbol of the mathematical concept (cited in Furner and Marinas, 2007).

GSP is an excellent tool for students to understand the properties of geometric shapes and to model for them mentally manipulating objects. GSP can also provide students to visualize the solid in their mind. In literature, McClintock, Jiang and July (2002) found GSP provides opportunities to have a distinct positive effect on students' learning of three dimensional geometry. In another study, Yu (2004) stated that the students' concurrent construction of figurative, operative and relational prototypes was facilitated by dynamic geometric environment. That's why, the knowledge about which DGS and DGS activities how prepared should be given the student teachers.

METHOD

Participants

Case study was used in this paper. This research was conducted during the spring term of 2007–2008 academic years in spring term. The study was conducted with two secondary school preservice teachers attending the 4+1.5 Integrated Secondary Mathematics Teacher Education Program at Dokuz Eylul University in Turkey. Of the ten students in this program there were two volunteers. In this process, they took the courses about mathematics content knowledge, pedagogical content knowledge and general pedagogical knowledge. All participants had basic computational skills but none of them knew how to use DGS.

Data Collection

The data were collected from interviews and the activities which are prepared by the student teachers. The interviews were semi-structured in nature. In the beginning of the research, the opinions of the participants towards GSP software are taken with semi-constructed interview form. Each interview took approximately 15-20 minutes and recorded with a tape. Then the participants attended a six-hour GSP training sessions which is given by the researchers. After the program, it was demanded that

the participants developed the GSP activities. Finally, the participants` opinions towards GSP software are taken again.

The Geometer's Sketchpad Training Sessions

The training sessions allowed the instructor to prepare the non-thesis graduate student teachers to enter their future mathematics classrooms not only knowledgeable about the capabilities of instructional technology, but also experienced enough to appropriately integrate their selected software. The GSP training sessions' content is given Table 1.

	Training Sessions	Topics	Duration
DAY 1	Introductory *(Guided & Discussed)*	• major concepts of mathematics education • the aim of the involved Software • introduction to dynamic geometry environment with GSP • introduction to tools and menus of the Software	1 hour
	Constructing Geometrical Concepts *(Guided & Discussed)*	• to construct basic concepts of geometry • to transform the rotation, reflection, and dilation of the figures • to construct regular and non-regular polygons, and its interiors • to measure in geometry (length, distance, perimeter, area, circumference, arc angle, arc length, radius, etc.) • to graph various functions and its derivative	1 hour
DAY 2	Animation and Presentation (*Guided & Discussed)*	• to use action and hide/show buttons • to tabulate the data • to prepare presentations	2 hours
	Activity Planning *(Guided & Individual)*	• to plan activities and practice it	2 hours

Table 1: Training Sessions

DAY 1 included two sessions. Each session lasts an hour.

Introductory Session: The introductory session contained the major concepts of mathematics education, introduction to dynamic geometry environment with GSP and the aim of the involved Software.

In the beginning of the session, the participants discussed the major concepts - conceptual development, problem solving, modelling verbal problems, creative

thinking, analytical thinking etc.- in order to determine their readiness with researcher. Then, they argued the aim of the involved Software. Afterwards, the participants introduced Dynamic Geometry Environment, the menus, sub-menus and tools of the GSP Software. When the participants get information about tool box, text palette, file menu, edit menu, display menu, construct menu etc., the researcher advanced next session.

Constructing Geometrical Concepts: In this session, the participants find out how to construct the basic concepts of geometry; such as ray, line, segment, paralel line, perpendicular line, angle bisector, median of triangle, altitude of triangle, arc etc.

When the participants learned how to use the menus, sub-menus and tools, the researcher showed them some operations. The participants learned about constructing regular and non-regular polygons, and its interiors. After that, they learned to change the color and width of the lines and figures.

Then, they transformed the rotation, reflection, and dilation of the figures. Subsequently, they measured length, distance, perimeter, area, circumference, arc angle, arc length, radius, etc. with using GSP.

When they reached the graph menu, they defined coordinate system, chose grid form and they draw some graphs with GSP, such as sinus, cosinus, tangent, etc. Afterwards, they graphed various functions and its derivatives. During this session, the participants discussed the functions of GSP each other if it was necessary or it was forgotten.

DAY 2 comprised two sessions. Each session is made up of two hours.

Animation and Presentation: In this session, the participants found out text palette on advanced level. Next they learned motion controller, how to paste picture and then passed animation and hide/show buttons. They learned how to utilize animations and change it's speed. Then they learned to trace points, segments, rays and lines. Afterwards they focused on tabulate the data on tables in order to arrange them regularly.

After they learned animation and presentation clues, they started to organize page set-up and document options in order to prepare excellent presentations.

Activity Planning: This session includes all of the applications learned. The researchers wanted the participants to prepare activities. And they also wanted to apply all the operations learned in their activity. In the preparation period, if the participants needed to be supported, the researchers could be guiding them.

Data Analyses

In the interview, four open-ended questions were asked to the participants and the interview guide was used in this stage. During the interview, the questions like "What are the GSP aims in mathematics learning environment?" "Which students' skills are able to improve by GSP activities?", "What do you take into account while

the GSP activities are composed?" and "How can you assess the students with the GSP activities?" were answered by the students.

The evaluating criteria were determined in order to assess the activities improved by the student teachers. These criteria were adapted from Roblyer (2003).

1.	Connection to mathematics standards.
2.	Appropriate approach to mathematics topics with respect to grade, ability.
3.	Presence of conceptual development, problem solving/higher order thinking skills.
4.	Use of practical applications and interdisciplinary connections.
5.	Suitability of activities (interesting, motivating, clear, etc.)

Table 2: Evaluation Criteria adapted from Roblyer (2003)

RESULT

In this section, the analysis of data obtained from two preservice teachers' view transcripts and activities which they prepared are presented.

Handan's Case

Handan is working as an assistant teacher in private teaching institution for a year. During the pre-interview, four questions were asked her. She made explanations as follows:

Researcher : What are the GSP aims in mathematics learning environment?
Handan : It supplies the students with learning and visualizing in math lessons and preparing animations.
Researcher : Which students' skills are able to improve by GSP activities?
Handan : The students' spatial thinking skills are improved.
Researcher : What do you take into account while the GSP activities are composed?
Handan : It should be appropriate the students' cognitive level.
Researcher : How can you assess the students with the GSP activities?
Handan : I don't know because of lacking knowledge about GSP.

As can be seen in her statements, although she mentioned that she did not know GSP, she could be able to estimate its aims, skills to be improved and rules taken into account when the activities had done.

After training sessions, the researcher wanted her to prepare GSP activities whatever topics she wished. She chose the congruence as a subject of geometry instruction. Her activity is given Figure 1.

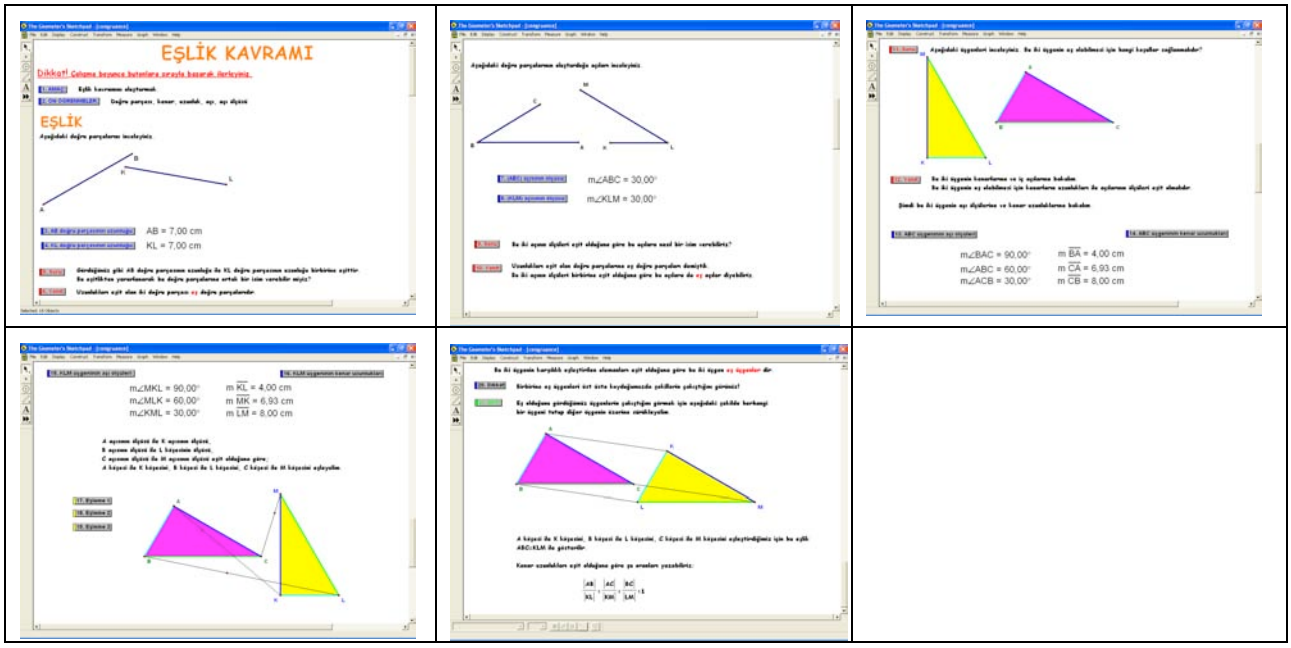

Figure 1: Handan's Activity

The content of her activity was about congruence. She decided to plan her activity for constructing the concept of congruence. As regards to the activity, the student knows the aim of the subject (step 1) and the concepts related to the subject (step 2). Handan gave directions to the students in her activity, in general. Therefore the student follows the instructions and carries on step by step. Afterwards, she gave two segments as AB and KL. She demonstrated the length of AB and KL segments (step 3-4). In the next step of the activity, she wanted students to compare the length of AB segment with KL segment. She asked whether the students call a common name to these segments (step 5) and explained it simply (step 6). Subsequently, she gave two angles and its measurements (step 7-8). She told the angles have the same measurement (step 9) and asked what the common name of the angles is (step 10). Later she constructed two triangles (ABC and KLM) and asked the students in what conditions they are congruent (step 11). Later on she showed the conditions of the congruence (step 12) and measurements of the triangles (step 13-14-15-16). In following steps, she paired each corners of the triangles and animated them (step 17-18-19). Finally, she drew the students' attention for the coincidence of triangles and demonstrated this (step 20-21).

When her activity arranged was assessed via the so-called evaluation criteria in Table 2, it was seen that the activity was connected to mathematics standards organized by Ministry of National Education (MNE) in Turkey, suited approach to mathematics topics -to explain congruence of triangle- with respect to 10^{th} grade but it was too simple and like 8^{th} grade level. It was provided conceptual development, also clear but not engaged the students in real life situations and interdisciplinary connections. It is useful for constructing the concept of congruence but not provide satisfactory knowledge. It wasn't prepared for improving the students' problem solving skills also. Handan utilized the mathematical language adequately. In respect of

technicality, the activity is good. Each step's button is made as hide/show button. The 17th and 19th steps' button have the same function, so one of them is needless. The activity hasn't got any other technical problem.

Afterwards she had done activity; the post-interview was carried out with her and it was given her comments as follows:

Researcher : What are the GSP aims in mathematics learning environment?
Handan : It provides the students learn geometrical concepts…their problem solving skills are improved and the concepts are visualized.
Researcher : Which students' skills are able to improve by GSP activities?
Handan : The students' spatial thinking…. and problem solving skills are improved.
Researcher : What do you take into account while the GSP activities are composed?
Handan : It should be interesting…. appropriate for the students' cognitive level and the students' opinions can be taken while the activities are prepared.
Researcher : How can you assess the students with the GSP activities?
Handan : The students can be able to do the applications involved in GSP and these are evaluated.

Considering her statements, it is seen that her views changed after training sessions and her activity. She has primarily information about GSP and she awakes of what taking into account while the GSP activities are composed.

Mualla's Case

Mualla is also working as an assistant teacher in private teaching institution for a year. In time of the pre-interview, she gave responses as follows:

Researcher : What are the GSP aims in mathematics learning environment?
Mualla : …It constitutes long lasting learning in math lessons and provides the teachers and the student drawing figures, preparing animations.
Researcher : Which students' skills are able to improve by GSP activities?
Mualla : GSP improves the students' spatial thinking skills.
Researcher : What do you take into account while the GSP activities are composed?
Mualla : It should be interesting…
Researcher : How can you assess the students with the GSP activities?
Mualla : I don't know…

In the analysis of this interview, she determined which skills improved and what she pays attention during the GSP activities are composed. Besides it is seen that Mualla's responses are similar to the Handan's statements.

After training sessions, the researcher wanted her to prepare GSP activities whatever topics she wished. She chose the similarity as a subject of geometry instruction. The activity involved is given Figure 2.

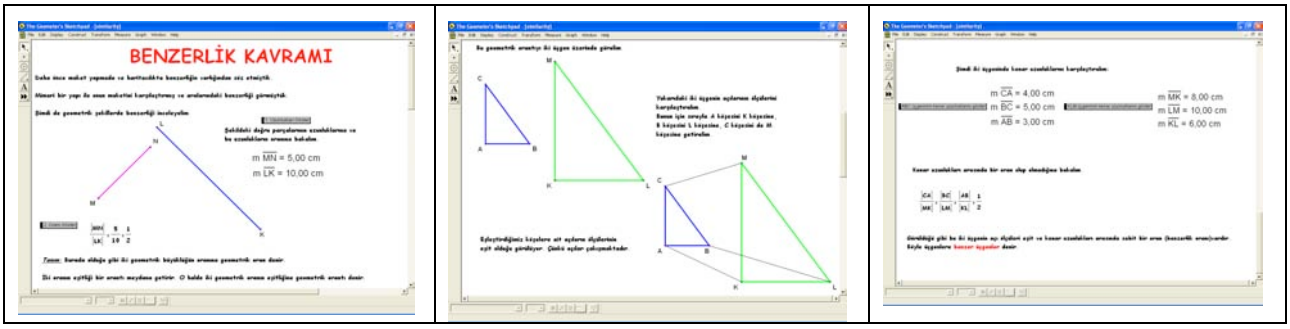

Figure 2: Mualla's Activity

Mualla's activity deals with similarity of triangles. She tried to carry out her activity for constructing the concept of similarity. According to her activity, she acknowledged that the students have little knowledge about the subject. Mualla generally gave directions to the students in her activity, as Handan did. However, her activity didn't similar to in terms of following the instructions step by step. In the beginning of the activity, she mentioned few real-life examples to the students about similarity and then she passed the similarity between geometrical concepts. She gave two segments, like Handan, and she compared the length of them under the first button. The second button shows the students the ratio of the lengths of the segments. After that, the definition -geometrical ratio and geometrical proportion- was given, and demonstrated. Then, she compared the measures of each angle of the triangles and mentioned the coincidence of each angle. Afterwards, she showed and compared the length of sides of the triangle and stated whether the sides of both triangles have a ratio or not. Lastly, she defined a stable ratio, as the ratio of similarity.

When her activity organized was assessed by means of the evaluation criteria in Table 2, it was seen that the activity was overlapped mathematics standards organized by MNE in Turkey, partly suited approach to mathematics topics -to explain similarity of triangle- with respect to 10^{th} grade. It was provided conceptual development, but not connected to the students in real life situations and interdisciplinary connections. Her activity was clear and understandable but it was also towards 8th grade and too simple. It wasn't also provides sufficient knowledge. It wasn't prepared for improving the students' problem solving skills also. Mualla used the mathematical language few adequately. In respect of technicality, the activity is not bad. Each step's button was made as hide/show button, as Handan did. It didn't include enough animation and demonstration. Finally it was said that, the activity hasn't got any technical problem.

After she had done activity; her comments during the post-interview was given as follows:

Researcher : What are the GSP aims in mathematics learning environment?

Mualla : It provides the students learn geometrical concepts and problem solving, proof geometrical theorems. In addition to, it can be long lasting learning.

Researcher : Which students' skills are able to improve by GSP activities?
Mualla : The students' spatial thinking was improved.
Researcher : What do you take into account while the GSP activities are composed?
Mualla : It should be appropriate the students' cognitive level and the mathematics standards
Researcher : How can you assess the students with the GSP activities?
Mualla : It can be ask some question in GSP aiming at determining whether they learned the geometric concepts. We expect that the students reveal the relationships between geometric concepts.

As her statements, she increases information about GSP. It follows from her responses that her point of view enlarged after training sessions. She encouraged and determined carefully what she does with GSP in mathematics learning environment after she prepared activities herself.

DISCUSSION AND CONCLUSION

In this study, the data indicated that Dynamic Geometry Software (DGS) is important in geometry education. Generally speaking, Handan and Mualla learned some properties of GSP. At the end of the study, they realized how they can use GSP to prepare the activities. Handan gave detailed directives in her activity. She expected that the students to mention the concept of congruence; but this concept was given by her at the beginning of the study. In the other case, Mualla set out the similarity proportion when she prepared her activity. Both of them did not mention the kinds of congruence and similarity. They perhaps fostered the finding of these kinds by the students. As Key Curriculum Press (2001) mentioned, teachers can use GSP to create worksheets, exams, and reports by exporting GSP figures and measurements to spreadsheets, word processors, other drawing programs, and the Web. These results indicate that DGS is important in teacher education and DGS training must be present in non-thesis graduate education.

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