EFFECTS OF USING CALCULATORS (TI-92) ON LEARNING TRANSFORMATIONAL GEOMETRY

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ABSTRACT

The present study aims at finding out the effects of using the advanced calculator TI-92/Cabri in teaching transformational geometry on teacher students' attitudes, geometric thinking levels and achievement. The subject of study, i.e. the participants in the introduction to geometry course, were 78 students from freshmen elementary school mathematics education students at Hacettepe University, Ankara, Turkey. Three instruments were used in the present study to find out the relevant factors and effects of TI-92/Cabri aided/supported geometry teaching. The data were gathered by means of the designed instruments and analyzed by using PC-SPSS. In the analysis, several tests were used in order to understand the effects of various factors on the attitudes and achievement. This statistical analysis compares the mean scores of each group and reveals whether this differences significant or not.

Key words: Transformational geometry, TI-92/Cabri, Geometric thinking levels, Attitudes

Introduction

Among geometry topics, transformational geometry is the most interesting one, and it is one of the cores that support students' creativity in geometry courses. In this topic, students are expected to learn how to transform any regular or non-regular geometric shapes in 2-D space, and discover some features of shapes, rules, etc. Flipping, sliding, rotating, translating, and reflecting can occur transformation. Representations in this area of the geometry make an abstract interpretation, which can be easily understood in the real life applications. Students can have the opportunity to see connections within mathematics, between mathematics and the various areas of human activity and can develop an understanding of the types of reasoning that form the basis of mathematical thought (Natsoulas, 2000). They can also make connections between mathematics and art which makes the life livable. Furthermore, six mathematical activities all cultures participated in the past and today are counting, locating, measuring, designing, playing and explaining. Among all these activities, designing results in richest and most diverse outcomes, which is an outcome of transformational geometry. For example, in the pattern of a Turkish rug, one can see repeated, reflected, translated or rotated objects. Understanding those beautiful patterns by the help of transformational geometry make students gain positive attitudes towards both this topic and mathematics.

The main purpose of this study is how to teach an extracurricular geometry topic to the freshmen grade teacher students by the help of the advanced calculator TI-92/Cabri. Since the instruction of transformational geometry is almost impossible by just using blackboard and chalk, planning the help of an instructional technology and mathematical tools is essential. But we should be aware of the results of the introduction of the technology and the implementation. Therefore, at the end of the implementation, we tried to find out the effects of using TI-92 in teaching transformational geometry on students' attitudes and geometric thinking levels. Thus, the research question of this study is *"What are the effects of using TI-92 in teaching transformational geometry on teacher students attitudes, geometric thinking levels and achievement?"* One of the results of the investigation might be finding out the more effective ways of teaching geometry and the discussion of the implementation of the technology. Since the presentation of geometry topics in Turkish schools is far from the visual activities, which are vitally important in teaching geometry, the instruction should change. Although such instruction may not meet the requirements, students are expected to develop their spatial sense and geometric thinking levels.

2. Background: A Short Overview of Teaching Geometry in Schools and Use of Technology

Geometry is an interesting area of mathematics and can enhance the students understanding level in the other areas of mathematics. However, students generally do not like the geometry and are unsuccessful at it. There might be many reasons of this negative attitudes and underachievement. Here we review the issue very briefly and notice the use of technology in teaching geometry.

2.1. Teaching Geometry in Schools

Although the national mathematics curriculum of USA and UK strongly recommend that students should study transformational geometry, this topic is not offered in Turkish National Mathematics Curriculum (TNMC). Actually whether a topic exists in the curriculum or not, the most important criteria for gaining an attention for a topic is the university entrance examination in Turkey. This examination determines which topics are taught at the schools, what aspects of topic are emphasized and de-emphasized, and the instruction method in general. The topics, which are evaluated at the university entrance examination, have the great emphasize while the others are mentioned superficially, even sometimes skipped. Since transformational geometry neither exists in the TNMC nor is asked at the university entrance examination, this unit is totally undermined. Since the TNMC is so loaded, at first glance it is not seemed reasonable to teach that 'struggled' topic. However, mathematical reasoning is not isolated for every topic. The mathematical reasoning is a process rather than a product. This means if a person can reason in one mathematical concept, he/she can use that way of thinking in the other area of mathematics. Therefore, the progress a student makes in transformational geometry would affect his/her perception, attitude and achievement of both geometry and mathematics. Another possible reason why we do not offer this topic might be the difficulties of presentation of this topic in the classroom environment. In order to teach this topic by traditional method, the teacher has to draw the objects very clearly and carefully on the blackboard, which makes the presentation of this topic is so difficult and requires an additional skill from the teacher. As an additional help, some instructional technology like educational software or graphing calculator can be helpful for this situation.

2.2.Use of Technology in Learning/Teaching Geometry

In geometry lessons, students do the activities of constructing and drawing patterns and relationships. Many times these constructing and drawing activities are so difficult without any technological help. They need software programs for computers or advanced graphing calculators. Physical aspects such as speed, color, screen resolution etc. make the software programs preferable for individual use, but compromises have to be made when providing mass education. In addition to this computer programs and computers are generally much more expensive than calculators. Small size and easy usage are the other important preferable aspects of calculators over computers. They could be viewed as computers available to all students because of their low cost, ease of use, and portability (Waits & Demana, 2000). Calculators can play an important role in students' construction of mathematical relationships (Wheatley, 1990). Increased used of calculators in school, ensures that students' experiences in mathematics match the realities of everyday life, develops their reasoning skills, and promotes the understanding and application of mathematics.

There is growing evidence that paper-pencil manipulation skills or just blackboard instruction do not lead to better understanding of mathematical concepts. Indeed use of hand-held calculators can provide more classroom time for the development of better understanding of mathematical concepts by eliminating the time spent on 'mindless manipulations.' As Podlesni (1999) stated they remove the unnecessary, tedious and time consuming tasks, thereby allowing students to 'see the forest for the trees.' Therefore, the main advantage of using calculators during instruction is to help reduce the load on students working memory so those more significant problems can be enhanced. The use of calculators creates a computational advantage as well as helps them to improve their selections of appropriate problem solving strategies. Learning is fun and the changing technology gives students a change to watch their teachers share in that joyous adventure (Usnick, Lamphere, Bright, 1995).

3. Method and Implementation

Here short information about the method of the research and the instruments used in the present study are given.

3.1. Purpose, Problem and Hypothesis

Purpose: This study aims at to find out the effects of using advanced graphing calculator, namely TI-92/Cabri, in teaching transformational geometry on the freshman teacher students' attitudes, geometric thinking levels and achievement.

Problem: The research question is stated as "What are the effects of using TI-92/Cabri in teaching transformational geometry on teacher students attitudes, and geometric thinking levels.

Hypothesis: From this research question, we hypothesized the following two statements:

- **H0(1):** The mean score difference pre and post implementation of attitude scale of the group are not significantly different;
- **H0(2):** The mean score difference of pre and post implementation van Hiele geometric thinking level test of each group are not significantly different.

3.2. Instruments Adapted and Developed

Three instruments were used in this study. They are van Hiele Geometric thinking level test (VHL), Geometry attitude scale (GAS), and the instructional materials.

Van Hiele Geometric Thinking Level Test (VHL) (Usiskin, 1982): In order to determine students' geometric thinking levels 25-item VHL will be used. The items represent the five geometric thinking levels proposed by van Hiele[1]. Teacher students' total score will be considered out of 25 for this test. The content validity of the Turkish version of van Hiele geometric thinking level test were confirmed by a group of a mathematician and mathematics educators. A pilot implementation on 31 seniors of mathematics department and 61 freshman and sophomore of department of computer education and instructional technology was ensured its construct validity[2]. Reliability measures of the levels of the original VHL and the Turkish version of it ranged between 0.79-0.88, 0.51-0.88, 0.70-0.88, 0.69-0.72, and 0.59-0.65, respectively.

Geometry Attitude Scale (GAS): This scale will be used in order to determine the teacher students' attitudes toward mathematics. It consists of 37, 5 point Likert type items. These items represent 4 dimensions of attitude: interest, anxiety, importance and enjoyment. Factor analyses revealed that these 4 dimensions are valid and reliability coefficient of this scale is 0,89 for the first administration and 0,90 for the post administration.

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[1] First five items represent level 1, second five item represent level 2, the items number 11-15 represent level 3, the item number 16-20 represent level 4 and the last 5 items represent level 5. This instrument was translated into Turkish in during a master thesis study (Duatepe, 2000).

[2] The mathematics majors got significantly higher score than the other students.

Instructional Materials for Calculator Aided/Supported Geometry Teaching (IMCA/SGT): They are a pile of lecture notes and worksheets which were either adopted and translated into Turkish from English and designed by the researchers.

3.3. Design of Research and Procedures

Sample: Participants were 78 teacher students from the freshmen grade level at the Department of Elementary School Mathematics Education, Hacettepe University (HU), Ankara, Turkey. Because of some missing data, data from 67 students (45 female, 22 male) were taken into consideration.

Procedure: In order to test the hypotheses stated above, a pre-experimental research design was implemented and the study lasted 3 weeks in a month. The freshmen teacher students from the HU in Beytepe Campus, Ankara were taught 3 transformational units: translation, rotation and reflection in 3 hours a week, totally 9 hours. Instruction was done by the use of the teacher unit of TI-92, i.e. calculator, view-screen and OHP and sample of IMCA/SGT. In order to do this, each teacher student was given TI-92 and followed the instruction with this powerful device while one of the researcher who was the instructor guiding them. The instructor gave the directions and the teacher students tried to follow these directions with the help of TI-92 and were worked as a group of three or four. The instructor reflected the right answer on the screen placed in the room by means of an OHP so that the teacher students could see what are they expected to see on the screen of their calculators. By this way they were going to be responsible for their own progresses.

The instructor accepted the students' autonomy and initiative as in the constructivist approach so that the teacher students were encouraged to engage in dialogue both with their classmates and the instructor, and they ask questions to each other frequently. The instructor encouraged them to think by asking thoughtful, open-ended questions and reflect their thinking on the subject. During the implementation they were received some worksheets to help them clear their ideas related with what they did by the use of calculator. These worksheets were prepared by the researchers to help the teacher students on discovering some important features, aspects and rules of transformational geometry.

To evaluate the success of the introduction and integration of TI-92, both instruments, i.e. GAS and VHL were implemented at the beginning of the semester, i.e. before the teacher students were received any instruction in order to determine their prior attitude and geometric thinking level and after the treatment.

4. Analyses of Data and Discussion of Results

The data were gathered by means of the designed instruments and analyzed by using PC-SPSS. In the analysis, t-test was used in order to understand whether the hypotheses are true or not. This statistical analysis compares the mean scores of each group and reveals whether this differences significant or not.

Table 1. Descriptive Statistical Analysis of Data about VHL and GAS

Variable	N	mean	mode	min	max	Std Deviation
PreGAS	67	131.67	145	98	169	44.64
PosGAS	67	145.10	150	116	177	17.87
PreVHL	67	14.04	15	10	22	5.05
PosVHL	67	15.96	17	12	22	2.57

As it is seen from Table 1, student teachers got higher scores from the post implementation of the measures. In order to see whether this differences are significant or not, t test was used. Independent t-test result revealed that post implementation of GAS (posGAS) (M = 145.10; SD = 17.86) is significantly higher than pre implementation of the GAS (preGAS) (M = 131.67; SD = 44.64). The t test result can be seen from Table 2. As it is seen from that table, this difference was significant at $\alpha = .05$, ($t(67) = 2.723$; $p<.08$).Therefore, the first hypothesis was rejected. In other words, there is a significant difference between pre and post implementation of Geometry Attitude Scale.

Table 2. The t- test Results of Student Teachers' Scores

Paired Difference	PDM*	Standard Deviation	Std Error Mean	95% Confi. Interval	t	df	Sig. (2-tailed)
PosGAS- PreGAS	13.433	48.034	-25.149	-25.15/-1.72	2.289	66	.025
PosVHL-PreVHL	1.910	5.744	-3.312	-3.31/-.51	2.723	66	.008

*PDM: Paired difference mean

On the other hand, independent t-test result also showed that post implementation of VHL (posVHL) (M = 15.96; SD =2.57) is significantly higher than pre implementation of VHL (preVHL) (M = 14.04; SD = 5.05). According to Table 2, this difference was significant at $\alpha = .05$, ($t(67) = 2.289$; $p< .05$). This means that hypothesis H02 was also rejected. In other words, there is a significant difference between pre and post implementation of van Hiele Geometric Thinking Level test.

5. Concluding Remarks

As it is seen from the previous part, both hypotheses, H0(1) and H0(2) of the present study were rejected. In other words, using TI-92/Cabri in teaching transformational geometry has a significant positive effect on student teacher' attitudes, and geometric thinking levels.

Related with hypothesis H0(1) it is observed that classroom became a real learning environment. Student teachers were more active and problem solvers. Learning was fun and more exciting in that environment. Therefore attitude toward what is learned by calculator was increased as the previous researches (Dunham, 2000).

As hypothesis H0(2) rejected, it was stated that student teacher got significantly higher scores on VHL after the instruction. It means that the calculator has a positive effect on the VHL test score. However, if the result is investigated deeply, this significant effect will be meaningless to some extents. Table 3 shows the detail of the analysis of scores that the student teachers got on the pre and post implementation of VHL.

Table 3. Descriptive Statistical Analysis of Data about VHL

Variable	N	mean	mode	min	max	Std Deviation
PreLevel	67	2.134	2	0	3	1.028
PostLevel	67	2.433	3	1	3	0.783

It can be seen in that table that student teacherss' van Hiele Geometric thinking level is somewhere between 2nd and the 3rd level on both pre and post implementation of the VHL. So it can be said that the scores on van Hiele Level Test increased significantly during instruction, but this increase is nor enough to get next van Hiele Geometric Thinking Level.

Moreover, it can be also concluded from the present study that teaching geometry by TI-92/Cabri technology is more effective. On the other hand, the presentation of topics in transformational geometry in the classroom environment was easier than by traditional method. The instructor/teacher did not have to draw the objects very clearly and carefully on the blackboard. Hence, this struggled topic can easily be taught in classroom environment in Turkey and elsewhere.

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APPENDIX. ACTIVITY ON TRANSLATION

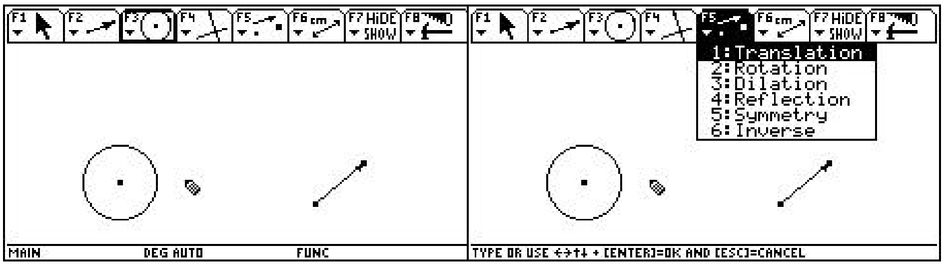
Aim: At the end of this activity series, students will be able to translate triangle, quadrilateral and circle by means of calculator.

A: Translating a Circle

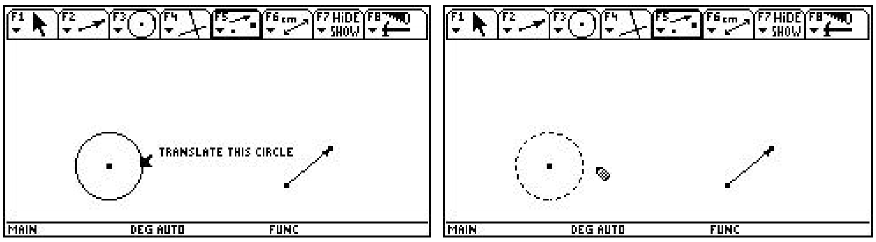
Objective: At the end of this activity series, students will be able to translate circle by means of calculator.

Script:

1. Construct a vector ***(F2, 7:vector)*** and a circle ***(F3, 1: Circle***). Determine the radius of a circle by pressing the arrowsof the big blues button. Then select ***Translation*** by pressing F5.



2. Select the circle as an object of translation. Move cursor to see 'Translate this ***circle***' on the screen. When you see this on the screen press '***enter***'. By this way you can select the circle as an object of translation. If you have done this correctly, the sides of the circle would turn into rounding dots.



3. Construct the vector which determine the direction and the magnitude of the translation. (Move cursor till seeing ***'by this vector'*** on the screen then press '***enter***') After that you can see the translated circle and your original circle in the screen as you see from below figure.