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Article

Evaluation of effectiveness of an enriched curriculum prepared using Geogebra software

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Abstract

The purpose of this research is evaluation of effectiveness of enriched curriculum prepared using GeoGebra software and covers squares and rectangles subjects. In the study pre-test post-tests control group design was used. Firstly, pre-test was applied for the creation the experimental and control group in the study. Because no significant difference between pre-test scores groups were randomly assigned as experimental and control groups. After selection of the group, experimental material was applied to the experimental groups over two weeks. The control group did not receive any action. Post-test were applied to the experimental and control groups after the experimental application. Obtained post-test results were compared using t-test technique. According to comparison, significant differences between experimental and control groups was found in favour of the experimental group.

Keywords: Curriculum evaluation, Geometry, GeoGeb, experimental and control groups

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INTRODUCTION

It is a condition generally regarded that teachers are the most critical element in the educational process. Innovation in the educational system, whether content, technology or methods, can only be effective to the extent that they can help teachers. However, the information technology-based audio-visual media such as televisions, films, computers, have resulted in that teachers are not currently the essential sources of information in the teaching-learning process (Tutkun, Öztürk & Demirtas, 2011). Now, the teacher's duties are to monitor learning and to provide guidance to develop learners (Arslan, 2008). Technological software is not to replace the teacher in the classroom, but to facilitate visualization and calculations, to provide opportunity to do accurate experiments easily again and again. Teachers can create richer learning environments for students by using mathematical software. Within this context, every innovation in the educational system reaches its goal/s as long as it helps learners and teachers. Basaran (2005) purports "… computers are tools in education, that is; they are not targets themselves, but they are a media of technology that reduce the curves of the road on the way to the target goal. It is unimaginable to expect that they will replace teachers." According to him, a teacher is required for the use and implementation of any technological tool (Basaran, 2005).

Mathematical software allow students to create models, associations and develop generalizable inferences. The visualization area of interest to mathematics educators began as the history of the mathematics concepts appeared, and the number of educators interested in this area has increased after visualization is realized thanks to computer technology (Isik & Konyalıoğlu, 2005). Computers used in the learning process mediate learning by providing students a language and notation system they have to use it while performing their activities, (Kose, 2008). Information technologies make students willing to learn complex topics. They help them be prepare as future problem-solving and technology users.

Technological tools play an effective role in concreting abstract mathematical concepts. Especially young children, because they are at the concrete operational stage, have difficulties in understanding and internalizing abstract concepts. Therefore, if these children at this developmental stage are taught using appropriate technological tools, they can accelerate their mathematical development and thus be eager to learn advanced mathematical concepts themselves. In this way, the likelihood of experiencing learning difficulties in mathematics topics in the later age periods will be reduced to a minimum. The technologies used in mathematics education can be grouped under three main headings (Kose and Yavuzsoy, 2008):

1- General technological tools: They are tools that cover all technology, not only the requirements in math education.
2- Technological tools to make math: They cover technologies that have been developed to make easy and accurate mathematical operations.
3- Technological tools for teaching mathematics: They are software developed in order to help students improve math learning.

Math software, on the one hand, teach the use of mathematical knowledge and how to use it in learning and, on the other hand, they contribute to the mathematical understanding and knowledge. The software used in mathematics education is of two kinds:

1- Computer Algebra Systems (CAS): Computer algebra systems are software tools that can effectively be used for teaching mathematics. These software packages can be used for experimental applications or learning through discovery in the classrooms. Because of their visual features, they are effective in achieving the desired learning objectives in education (Hohenwarter, Hohenwarter, Kreisler, & Lavicz, 2008).
2- Dynamic Geometry Software (DGS): Dynamic geometry software is the common name the geometry software developed especially for teaching geometry. Dynamic Geometry Software which fall into geometry education, 'rescue' geometry from the paper-and-pencil process with a static structure, make it dynamic on computer screen, and allow students estimate, discover relationships and theorems and test them (Guven & Karatas, 2003).

The most powerful and widely accepted instructive aspect of the dynamic geometry software is their ability to be visible and interactive. All operations made on the chalkboard can be made in DGS. For example, the geometric structures may be presented to be more effective in two or three dimensional figures or displayed graphically. Mathematical legends-symbols can be presented fully-accurately (Kokol-Voljc, November 2007). Dynamic Geometry Software (DGS) offer innovation in geometry teaching-learning process thanks to their properties to support experience in teaching geometry and to teach geometry through research. In this way, students have opportunities to explore, estimate, test, refuse, formulate and describe things, by freely entering the research environment (Guven, 2002). GeoGebra software packages, as offered free of charge to users, are widely used in mathematics teaching-learning process all over the world. So, GeoGebra software are translated into many of languages are allowed to use in both multi-cultural environments and in local languages (Hohanwarter & Lavicza, 2007-a).

Those features that characterize Dynamic Geometry Software are as follows:

1- Geometric shapes can be created very easily.
2- The resulting shapes can be measured to determine their properties.
3- Shapes can be dragged, expanded, collapsed and rotated on the screen. This is the most important feature of Dynamic Geometry Software. Thanks to this feature, students can discover the invariant features by observing when changing a number of the characteristics.
4- The quantity measured before changes dynamically when the structure is moved. With the help of this feature, hypotheses can be set up about the structure, hypotheses can be tested and some generalizations are possible.
5- All subjects in transformational geometry can be studied.
6- These software include no built-in subjects and information.

In this study, a teaching program prepared to present issues of square and rectangular in a geometry lesson enriched by GeoGebra software, everyday experiences and concrete materials, was implemented and the following questions were sought answers:

1. Is there any significant difference between the post-test scores of the experimental and control groups after the teaching program prepared to present issues of square and rectangular in a geometry lesson enriched by GeoGebra software, everyday experiences and concrete materials, was implemented?
2. What do students think about the use of GeoGebra software in geometry lessons?

METHODOLOGY

This paper is an experimental one since it strives to determine the effect of a teaching program enriched by the use of GeoGebra software on student achievement by comparing learners' pretest and post-tests scores. In the study were utilized Erturk's (2013) Output-oriented Program Evaluation approach and Tyler's Objectives-based Program Evaluation, out of program evaluation approaches. Tyler, in his Objectives-based Program Evaluation model, aims to eliminate deficiencies in the program by determining the difference between the actual student performance and the expected objectives (Yüksel & Saglam, 2014). In this model, generally used with experimental research designs, can be used achievement tests to measure cognitive behavior, observation form and performance tests for the measurement of kinetic behavior, and finally attitude scales to measures emotional behaviors (Erden 1998). Achievement tests were used in this study.

Experimental Design

In this study aiming to determine the effect of a curriculum enriched by the use of GeoGebra software on students' achievement was utilized a pretest – post-test, control group experimental group design. In the experimental group was implemented a curriculum developed for the subjects "Square" and "Rectangle" while the control group was not made any intervention in the teaching process. Both groups were administered pretest and post-tests.

Participants

Two Math's-Sciences classes studying in Kocaköy Multi-Program High School in 2014-2015 Academic year were included in the study as experimental and control groups. As for ensuring the equivalence of experimental and control groups, both groups were administered a pretest. The results indicated that both groups are equivalent. The experimental and control groups were assigned randomly. The quantitative information on the experimental and control groups are presented in Table 1.

Table 1. Quantitative information about experimental and control groups

Group	**N**
Experimental	27

Control	25
Total	52

Data Collection Tools and Their Development

The measurement tool used to ensure the equivalence of the groups and to determine their prior learning was developed to cover the issues to be investigated. In the development process of the test, the subjects prior to the 'Square' and 'Rectangle' were taken into consideration and students were tested in terms of their prior learning they can benefit while they are being taught these subjects. Questions were organized according to the developmental characteristics of Grade 11 students. In order to validate the test, the questions prepared were examined by two experts in the field. As for the content validity, questions related to the subject to be taught were included in the test and a test of 15 items was prepared. Trial form was administered to 50 students studying in Grade 11 in the same school, and KR-20 reliability coefficient was determined to be 0.92. The post-test developed to test the students' achievement regarding the subjects 'Square' and 'Rectangle' after application of the group was prepared according to the table of specifications created during the writing of the objectives. Regarding the subjects 'Square' and 'Rectangle', a total of 34 questions, namely 14 true-false, 10 classic essay and 10 multiple-choice questions, was prepared. In order to ensure the content validity and construct validity of the test, the units were delivered to 2 experts and the questions were revised by virtue of this expert opinion. Trial form for post-test in the form of a total of 34 questions was administered to 65 students at the same school, in different classes. KR-20 reliability coefficient after this application was calculated as 0.80. K-20 values and opinions for validity and reliability of the test show that this post-test can be used to measure these contents. Tyler (2013) draws attention to the reliability of the measurement instruments to be utilized in program evaluation. According to him, the validity and reliability analyses of the measurement tools to be used in program evaluation should be carried out very carefully.

Data Collection and Analysis

The pretest developed for the subjects 'Square' and 'Rectangle' in the Grade 11 curriculum was administered in both group before the main experimental application. After the experimental procedure, however, a post-test was administered in both groups. T-test was utilized to determine if there is a significant difference in achievement levels between the control and experimental groups after the post-test.

FINDINGS and DISCUSSION

The findings obtained from the pretest, which was used to ensure the equivalence of the experimental and control groups, are presented below. The measurement tool used here includes learning required for the unit to conduct research. While developing the tool were considered the earlier lessons before the subjects "square" and "rectangular" and students were tested in terms of their previous learning. The pretest was administered in two classes selected out of classrooms in Kocaköy Multi-Program High School in order to ensure the equivalence of experimental and control groups and determine the extent of their prior learning. Findings obtained are presented in the following table. According to this table, it does not seem to be a significant difference between the two groups (p> .05). The arithmetic mean of Group is 38.2, while the mean value of the second group is determined to be 38.8. Thus, these two groups can be randomly assigned as experimental and control groups.

Table 2: Pretest results of the groups

Groups	N	X	SD	F	P
1st Group	27	38,2	22	-1,365	0,185
2nd Group	25	38,8	21		

Findings: Procedure Steps

In this study aiming to determine the effect of a curriculum developed for the subjects 'Square' and ''Rectangle' enriched by the use of GeoGebra software on students' achievement are followed the following experimental procedures:

1. Two Maths-Sciences classes, Grade 11, studying in Kocaköy Multi-Program High School in 2014-2015 Academic year were administered a pretest to ensure the equivalence of experimental and control groups. Groups determined to be equivalent in accordance with the pretest results were randomly selected as the control group and experimental group each.
2. In the process of research, the curriculum developed was administered in the experimental group in collaboration with the course teachers during 2014-2015 academic year in December. The control group was not made any intervention in this process. As long as this study is limited to the subjects 'Square' and 'Rectangle', two weeks were allotted for each subject and each subject was taught for 4 hours in the experimental group.
3. A post-test developed based on the objectives of the subjects covered by this study was administered to experimental and control groups separately.

Findings: Procedure Material

In order to increase the effectiveness of the curriculums followed in high schools and to reveal the effect of a curriculum specifically designed by the use of information and communication technologies, a curriculum was developed in partnership with course teachers by using the GeoGebra software. GeoGebra is an open-source dynamic mathematics software, previously prepared by Markus Hohenwarter as a master's thesis in University of Salzburg in

2001, and then developed by an international group. It has a single interface allowing all geometry and algebra analysis and can be used at every stage from primary to higher education (Hohanwart & Lavicz is a 2007-b). As the objectives of the curriculum developed as the experimental procedure material in this study were considered to be based on those of the curriculum designed by the Ministry of National Education (MoNE). Tyler (2013) emphasized that objectives, while being determined, should be clear and understandable, and assist in the selection of the contents and provide guidance for the testing conditions.

Arithmetic means of the post-test mean scores of the experimental and control groups are presented in Table 3. Accordingly, the post-test mean scores were calculated as 54.39 for the control group and 39.80 for the experimental group.

Table 3: Descriptive statistics According to the Posttest Score of Experimental and Control Groups

Group	***N***	***X***
Experimental	27	54,39
Control	25	39,80

According to Table 3, it is observed that the average score of the experimental group is higher than that of the control group; therefore, it can be inferred that the applied experimental procedure material has been effective. However, it is needed to check whether there is a significant difference between the mean scores. T-test results are given in Table 4.

Table 4: t-test results according to posttest score of group

<table>
<tr><th>Group</th><th>N</th><th>X</th><th>SD</th><th>F</th><th>P</th></tr>
<tr><td>Experimental</td><td>27</td><td>54,39</td><td>25,956</td><td rowspan="2">1,517</td><td rowspan="2">0,03</td></tr>
<tr><td>Control</td><td>25</td><td>39,80</td><td>21,673</td></tr>
</table>

According to findings in Table 4, it was found to be a significant difference between mean scores for pretest and post-test scores of the experimental and control groups ($p <.05$). That is to say, the experimental procedure has been effective to create a significant difference on the achievement of the experimental group.

The results obtained by comparing the post-test scores of experimental groups and control group indicate that the achievement of the experimental group increased significantly when compared to the control group. According to the findings, there was no significant difference between pretest mean scores prior the experimental procedures. So, groups were equivalent. However, the significant difference, in favor of the experimental group, between the mean scores regarding the post-test in both groups after the experimental procedures can be regarded or considered as proof of effectiveness of the curriculum followed and implemented in the experimental group during the teaching process. It is seen that the literature includes similar findings. GeoGebra software has a positive impact on student achievement (Karaaslan, Karaaslan, & Delice, 2012; Selçik & Bilgici, 2011; Zengin & Tatar, 2014). Tyler (2013) defines the evaluation process as "…a process in which how much the target behaviours are realized in the application by means of educational programs and teaching is determined." Erturk (2013) regards the identity of target behaviours and output behaviours as a proof of the program's full qualification. When compared the evaluation process and outputs in this study, it is concluded that the program has succeeded.

CONCLUSION and RECOMMENDATIONS

The study suggested that between the experimental and control group differences in effectiveness was imminent within the GeoGrebra software implementation. The GeoGebra software was also found to be effective amongst student's achievement, which supported with the findings of previous study. Innovation in classroom through technology and teacher's administrations enhanced the practice of technological know-how benefited to the end users, which in this study reflects the growth of both teachers and students using the GeoGebra software. The application of GeoGebra software in classroom enabled the student's interest which the findings of this study suggests to bring forward the achievement of student.

In the light of research findings, some recommendations were developed for teachers, students and officials of the Ministry of National Education regarding the use of GeoGebra software, a dynamic algebra and geometry software, in mathematics and Math education.

- Mathematics and Geometry curricula in high schools must be carried out within the framework of computer assisted instruction. The necessary infrastructure for this was prepared and provided by "FATIH Project in Education."
- Smart board systems installed in classrooms and tablets distributed to schools this project provides run this program. Tablet computers to be distributed to students must be designed by considering the system requirements of such software.
- The Ministry of National Education is known to provide in-service courses for teaching teachers about such types of software. However, these courses should be expanded to include all middle and high school math teacher gradually.
- In order to remove the material lacking in this field, both The Ministry of National Education and relevant departments in universities should contribute to field by a joint study, materials that can be used by teachers and students should be increased in number, and guidelines should be prepared about how to use the program.
- The use of dynamic geometry software and incentives should not be limited only by GeoGebra, research about other software such as Cabri 3D, Cabri 2D and Geometer's Sketchpad should be done.
- The software considered to be effective in Turkey should be recommended to teachers by the Ministry of National Education.

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