The Efficacy of Using GeoGebra in Teaching Eighth Grade Mathematics

The Case of Two Nabatieh Area (Lebanon) Schools

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Abstract—**The objective of this study is to investigate the effect of the use of the GeoGebra program and the educational aids on the achievement of both types of direct and deferred learning in mathematics in the parallelogram and circle unit for the eighth grade students. The study also compared the results of the students who studied the parallelogram and circle units of the eighth grade in the traditional method and those who studied using the GeoGebra program and teaching aids, in order to find out if there are statistically significant differences in favor of the use of the GeoGebra program in teaching. The study showed that the use of GeoGebra has led to an increase in the level of students' achievement in mathematics, in light of the studies that confirm the low level of achievement in the subject of geometry, especially the parallelogram and the circle units when taught in traditional methods. The study also showed that the use of specialized software contributes to the consolidation of concepts, facts and generalizations in the long-term memory of the learner.**

Keywords-GeoGebra; efficacy; mathematics; Lebanon.

I. INTRODUCTION

The educational process aims to educate the members of society according to its values, principles and philosophy. The process of education is essentially a process of communication, whose components are the sender or teacher, the receiver or the student, the message or the mathematical content, the means or the tool or variables used to convey the message to the learners, and finally, the feedback or action that the learner produces to reflect his/her acceptance and understanding of the message [1].

Mathematics is one of the most difficult subjects learned by students, because of its abstract nature. At the same time, mathematics is becoming increasingly important as it is the language of science. In order for a greater proportion of learners to understand different mathematics subjects and acquire mathematical skills, reducing their level of abstraction makes them attractive and understandable. Educational tools, in their different and varied forms, offer mankind this great service that makes mathematics more realistic and close to everyday life [2].

Most students believe that mathematics is not important in their lives, and this led to the formation of negative tendencies towards the study of the subject, in addition to the lack of teachers' use of teaching aids in teaching mathematical concepts [3]. Students at a global level suffer from difficulties in learning abstract concepts. The most important of these is the emphasis on descriptive aspects and formal proof without attention to new mathematical processes such as geometrical sense and the use of technology in teaching geometry [4].

The middle schools in Nabatiyeh governorate lack the use of technology-based teaching aids and computer software in teaching mathematics, especially geometry topics. Mathematics concepts, in general, and in the mathematics of the eighth grade – specifically the units of the parallelogram and the circle – in particular, are showing more confusion, because of the emphasis on the abstract side of teaching, without trying to engage educational tools and computer software to simplify the students' understanding of these concepts and instill them in their minds. Such obstacles can only be overcome through educational means and appropriate computer software designed to achieve the objectives of education.

Based on the recommendations of educational studies related to this subject, and due to the lack of studies and research on the use of GeoGebra and teaching aids in the teaching of mathematics in grade eight, the study investigated the effectiveness of such a teaching aid on the direct and deferred achievement of students in mathematics, probed by a specific student sample and specific topics: the parallelogram unit and the circle unit.

This paper is organized into four sections as follows: Section 2 contains the literature review of the study. Section 3 investigates the methodology of the study. Section 4 discusses the findings and analyzes the data. We conclude the paper in Section 5.

II. LITERATURE REVIEW

The call for the use of teaching aids in education began long time ago, and this is manifested through the role of educators in advocating the use of educational means. Plato considers that the role of the teacher is not based on the imposition of science on students through external pressure, but rather directing the latter with the discussion and the

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questions he mentions. The Platonian educational system has a significant educational status and emphasizes that its use in the educational process achieves the educational goals envisaged. Roso has demanded that the child's access to reasonable things be via the means of concrete things, which is known as experiential learning [3].

A. Reasons for low student achievement in mathematics

Sbeitan reported that the world-renowned educational scientist Kline highlighted in his famous book (Why Johnny Cannot Add) his criticism of the traditional curriculum in mathematics and the drawbacks that lead to low achievement of students in mathematics. The most important points are [5]:

- Focusing on automation training and memorization, since the goal of the traditional curriculum was to teach arithmetic skills and the memorization of rules and theories and providing them through training and repetition without focusing on understanding and application.
- The emergence of concepts, facts and processes separate from each other.
- Lack of consideration of accuracy and clarity of expression, and lack of mathematical precision to be provided in curricula and textbooks.
- Inclusion of traditional curricula and books of some useless topics that had lost its importance and value.
- Avoidance of curricula, books and traditional books of mentioning the mathematical proof except in geometry.
- Lack of curriculum and textbooks to the element of motivation and suspense.
- Lack of books and curricula to keep abreast of modern developments that meet the requirements of the times and the needs of individuals and society.
- The use of old methods that proved ineffective in the teaching of mathematics, and the reluctance to use alternative methods.
- Poor professional preparation of the teacher, so the weakness of the teacher professionally is reflected on the low level and achievement of the students in mathematics.

B. Features and characteristics of the GeoGebra software

GeoGebra [6] is a program based on the scientific standards of mathematics and the curricula adopted by most Ministries of Education around the world, not a substitute for them. Markus Hohenwarter developed the program along with an international team of programmers (University of Florida, Atlantic). It is designed in a way that enables the student to develop a deep understanding of mathematical theories and realities through practical application, and the discovery of concepts himself. It is a collection of tools that contribute to the achievement of the student's mathematical skills, and includes all the aids necessary to make the learning process easy and interesting, as the student builds on his previous learning [7][8].

The themes common to GeoGebra and the Lebanese curriculum are:

1- Plane and space Geometry plan
2- Statistics
3- Algebra
4- Coordinate systems
5- Lines in the coordinate plane
6- Functions
7- Polynomials.

III. METHODOLOGY

A. Design of the study

The study is classified as descriptive quazi-analytical and experimental approach. A commercially available statistical package (SPSS, version 21 [9]) was used to analyze the data.

B. Participants

The study sample consists of 34 students. The sample is divided into two groups: the first group (A) consists of the eighth grade students in one public school and the second group (B) consists of the eighth grade students in another public school, plus some 41 instructors of mathematics in the schools of Nabatiyeh area. The researcher chose the sample in a deliberate manner, so that the sample of the study is in schools equipped with the means and tools necessary for the study, such as educational tools, display screen and computer laboratory that are well equipped and appropriate.

C. Instrument

The researcher used the training material of the Circle Unit and the Parallelogram Unit, the GeoGebra application, a computer and a projector, tests of comprehension – both direct and delayed – and a teachers' survey.

D. Experiments

The researcher used the training material of the Circle Unit and the Parallelogram Unit, the GeoGebra application, a computer and a projector, tests of comprehension – both direct and delayed – and a teachers' survey.

IV. RESULTS AND DISCUSSION

The current study aims to identify the effectiveness of the use of the GeoGebra program in the direct and deferred educational achievement of the eighth grade students in Nabatieh Governorate, the extent of the use of the GeoGebra program, and the compatibility of the curriculum and the approved textbook with the use of the program and teaching aids. To achieve this goal, the researcher prepared educational tools and the use of the GeoGebra software, where two groups of students were taught. The first one studied the material using the GeoGebra program and the

TABLE I. THE RESULTS OF THE DIRECT TEST ON THE PARALLELOGRAM UNIT

Section (A) – GeoGebra		**Section (B) – Traditional Method**	
Mean	***Standard Deviation***	***Mean***	***Standard Deviation***
12.88	3.71	10.00	3.98

second studied the same material in the traditional way. Then the first group studied the rest of the experimental material using the traditional method, and the second group studied the same lesson using GeoGebra. Two tests (direct and deferred) about the lessons that were explained to the students were administered. After collecting the data and processing it statistically using a commercially-available program, the following results were drawn:

TABLE II. A COMPARISON BETWEEN THE DIFFERENT TEACHING VARIABLES OF THE LESSON ON THE PARALLELOGRAM UNIT

Variable	Section (A) - GeoGebra	Section (B) – Traditional Method
Nb of hours of explanation	2	3
Nb of hours of lesson preparation	3	1
% of students who identified the lesson properties during explanation	73	<10
% of students who passed the test of learning outcomes	81.25	55
Drawing competency	Weak	Good
Teaching method	Active and stimulating, for the student is a partner in the teaching-learning process	Slow and dull, for the teacher is the focus of the process, rather than the student

The results of the direct test of the two groups, after explaining the parallelogram unit in Section (A) using the GeoGebra and explaining the same lesson in Section (B) using the traditional method, are shown in Table I.

Table II shows that the use of the GeoGebra program is more activating and stimulating for the students than the traditional method. This was demonstrated by the interaction of the students with the teacher during the explanation. The percentage of students who discovered the characteristics of the lesson was 73% compared with less than 10 percent when using the traditional method. Learning using the GeoGebra program takes less time to communicate the concept and objectives that the student is supposed to learn than in the traditional way.

After the same direct evaluation of the two sections, the success rate in Section A was 13 out of 16 (81.25 %), compared with Section B (10 out of 18, or 55 %). This shows that the result of the students' achievement in Section (A), in which the lesson was explained by the use of the GeoGebra program, is better than the result of the students' achievement in Section B, in which the lesson was explained using the traditional method.

TABLE III. THE RESULTS OF THE DIRECT TEST ON THE CIRCLE UNIT

Section (A) – Traditional Method		Section (B) – GeoGebra	
Mean	***Standard Deviation***	***Mean***	***Standard Deviation***
9.66	4.11	11.74	3.52

In contrast, the amount of time it takes to prepare a lesson with the use of the GeoGebra program is more than the amount of time it takes to prepare the lesson without it. The preparation of the lesson in Section (A) took three hours versus one hour to prepare the lesson in Section B.

The observations during the experiment also revealed a weakness in the skill of manual drawing of the students who learned using the GeoGebra program (Section A), compared with the students who learned without using the GeoGebra program (Section B).

The results of the direct tests of the two sections, after explaining the circle unit in Section (B) using GeoGebra, and explain the same lesson in Section (A) in the traditional way, are shown in Table III.

The results shown in Table IV prove that the use of the GeoGebra program is more activating and stimulating for the students than the traditional method. This was demonstrated by the students' interaction with the teacher. The percentage of students who discovered the characteristics of the lesson was 65% (15 % when using the traditional method), as well as learning using the program GeoGebra takes less time to communicate the concept and objectives intended to provide the student of education in the traditional way, where lesson took one lesson with the use of the program GeoGebra compared to two hours using the traditional method.

TABLE IV. A COMPARISON BETWEEN THE DIFFERENT TEACHING VARIABLES OF THE LESSON ON THE CIRCLE UNIT

Variable	Section (A) - Traditional Method	Section (B) – GeoGebra
Nb of hours of explanation	2	1
Nb of hours of lesson preparation	1	2
% of students who identified the lesson properties during explanation	15	65
% of students who passed the test of learning outcomes	56.25	72.22
Drawing competency	Good	Weak
Teaching method	Slow and dull, for the teacher is the focus of the process, rather than the student	Active and stimulating, for the student is a partner in the teaching-learning process

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After the same direct evaluation of the two sections, the success rate in Section (A) was 9 out of 16 (56.25 %), compared to Section (B) 13 out of 18 (72.22 %).

This shows that the result of the students' achievement in Section (B) in which the lesson was explained by using the GeoGebra program is better than that of the students in Section A, in which the lesson was explained using the traditional method.

In contrast, the amount of time it takes to prepare a lesson with the use of the GeoGebra program is more than the amount of time it takes to prepare the lesson without it. The preparation of the lesson in Section A took one hour, compared to two hours to prepare the lesson in Section B.

Two weeks after the completion of the either unit explanation, another test was carried out to assess the level of achievement of the two sections in order to compare the results of this test with the results of the direct test conducted immediately upon completion of the unit explanation. This is to determine whether education using the GeoGebra program has a positive effect on deferred comprehension. The experiment clearly proved (data not shown) the marked superiority of the marks obtained by the students who studied the material using GeoGebra, over their peers who studied the same material – either unit – by the traditional method. The mean of deferred parallelogram test was 12.98, even higher than the average of the direct test of 12.88. The increase of 0.115 indicates – however modest – that teaching using the GeoGebra program has a positive effect on deferred learning.

V. CONCLUSION

The paper sheds light on the use of a specific computer application as a teaching aid in mathematics, in order to ameliorate the students' understanding of the parallelogram and circle units, taught in grade eight in the Lebanese curriculum. There was a clear difference in the learning statistics between the students who studied the units of the circle and the parallelogram using the GeoGebra program and the students who studied the same units using the traditional method, both on the scale of direct and deferred testing, in favor of the GeoGebra. This indicated that the use of technology made it easier on the students to grasp otherwise hard concepts. This was manifested by the test results based on the learning outcomes.

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