

Impact of Using Geogebra Software on Students' Achievement in Geometry: A Study at Secondary Level

Abstract

The rapid growth of technology for teaching and learning includes the introduction of educational softwares. However, a few reports have found that provides evidence on the effectiveness of these softwares. The purpose of this study is to determine the effect of using dynamic mathematics software Geogebra geometry teaching on geometry achievement of students. This study involved students from a CBSE affiliated English medium school of Bilaspur (C.G.). The quasi-experimental study with equivalent group post-test only design was conducted to examine the effect. A total of 23 students were employed in the experimental group and 22 students in control group. The experimental group was subjected to the group taught by using Geogebra software while control group taught by traditional teaching method. The data were collected after 3 weeks of application and analyzed by employing Mann-Whitney U test. The finding of the study showed significant difference between experimental and control group's achievement in geometry. The difference is in favor of experimental group which had taught by using Geogebra. The finding present implications in the field of education that promote the use of Geogebra as a means of improving geometry teaching at secondary level.

Keywords: Educational Software, Geogebra Software, Geometry Achievement.

Introduction

Education is a systematic process through which a man acquires knowledge, experience, skill, and sound attitude. It makes an individual civilized, refined, cultured and educated. According to Gandhi jee –“By education I mean an all-round drawing out of the best in child and man-‘body, mind and spirit’.” In this context education is certainly a means of all-round development of man. The formal system of secondary education has mainly three components i.e. teacher, students and curriculum. The curriculum of secondary education exits mainly five subjects i.e. Languages (L1 & L2), social science, science and mathematics. Mathematics has an important place in school education at secondary level. It is the numerical and computation part of men's life and knowledge. It helps people to give exact interpretations to their various ideas and conclusions. According to Webster dictionary-“The science of numbers and their operations, interrelations, combinations, generalizations and abstractions and of space configurations is called mathematics”. Kothari commission (1964-66) suggested that every student should study mathematics compulsory up to class X level (as cited in Kulshrestha, 2014). So, the knowledge of mathematics is helpful in day- today life. At this level mathematics divided into various branches such as algebra, trigonometry, geometry, statistics, set theory and calculus etc. Geometry has an important place in mathematics curriculum of secondary education. According to Webster dictionary –“Geometry is a branch of mathematics that deals with points, lines, angles, surfaces and solids”. Geometry is visual and dynamic in nature. Therefore, it requires visualizing abilities in teaching-learning process. Thus, it is important for students learning geometry, to be able to imagine, construct and understand construction of shape in order to connect them with related facts. It can relevant that the use of information and communication technology (ICT) to visualize the teaching learning process. The success of using ICT in teaching-learning is depending on the use of appropriate technology tools. A number of mathematics teaching learning tools are available such as: interactive white board, mathematics

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calculator, geometers, sketchpad and Geogebra etc. among these one of the interactive and dynamic mathematic software for teaching learning geometry is Geogebra. By using Geogebra construction can be made with points, vectors, segments, lines, polygons, conic-sections, inequalities, implicit polygons and functions. All of them can be changed dynamically afterwards. Elements can be entered and modified directly via a mouse and touch through impact bar. So the software concurrently gives the algebraic, graphic and spreadsheet representation of mathematical objects. Any changes made to one of these aspects are directly related to others.

Rationale of the Study

Students at secondary level perceive the study of geometry a challenging one. They have also psychological tendency that geometry is very difficult to study due to the nature of the subject. They have fear of being failed in this subject. On the one hand this subject is interesting for some students, where as many students face difficulties in solving the problem. Here the question arises that "how this subject can be made interesting to the majority of students". There are various ways by which this subject can be made interesting and one of them is to use the ICT in teaching-learning. Teaching and learning with the use of technology has many advantages such as greater opportunities for students (Robert, 2012) and encouraging discovering learning (Binet, 1999). ICT adds new dimensions to the teaching and learning of mathematics, by helping a student to visualize certain mathematics concept (Voorst, 1999). Van Voorst (1999) and Hohnwater (2000) claimed that the visualization and exploration of mathematical objects and concept in multimedia environments can foster understanding in new ways. So, in the teaching and learning mathematics, especially geometry it is important for a student to understand the construction of shapes and the effect of changing in shapes by the use of ICT. The success of using ICT in teaching and learning depends on the use of appropriate software. In this context Geogebra is one of the interactive and dynamic software for teaching and learning mathematics.

Review of Literature

The researcher has seen many researches to find out the answer of the question that arouse in his mind. The descriptions of related studies are following-

Kepceoglu & Yavuz (2016) conducted a study with the aim to investigate the effect of GeoGebra in the teaching of the concept of the periodicity of trigonometric functions. The aim of the study is to analyze and to compare the effect of the traditional teaching and the computer assisted mathematics teaching on students' conceptual learning about the periodicity of trigonometric functions. The design of this study is chosen as a quasi-experimental, and the working group is 36 tenth grade high school students from a public high school in Istanbul. 15 days after the instruction period, participants filled in a 5 questions test. The answers of students are analyzed using descriptive statistics.

According to the results of the study, with the aid of computer mathematics education is more effective on students' learning than traditional mathematics education.

Arbain & Shukor (2015) performed a quasi-experimental study to see the effectiveness of using Geogebra software on mathematics achievement among 62 students in Malaysia. Students were divided into two groups of the experimental group and control group. The experimental group is the group of students was taught about how to use the Geogebra software to solve statistics problem while control group was without using Geogebra. Results shows that students have positive perception towards learning and have better learning achievement using Geogebra.

Bhagat & Chang (2015) conducted a study with the aim to examine the impact of using the Geogebra on 9th grade students' mathematics achievement in learning geometry. A total of 50 students were selected from a government school located in the eastern part of India. The experimental group (25) was taught theorem on circles using Geogebra while the control group (25) was taught utilizing traditional teaching methods. At the end of the treatment, students' mathematics achievements were measured using a post-test. The result indicated that Geogebra is effective tool for teaching and learning geometry in middle school.

Hutkemri & Zarkria (2014) performed a study to see the effectiveness of using Geogebra on students' conceptual and procedural knowledge of limit function. In this study quasi-experimental method was used. A total of 138 students were involved in the experimental and 146 students were involved in control group for the study. Data were collected by using the conceptual and procedural test of limit function. The finding shows that the use of Geogebra has succeeded in increasing students' conceptual and procedural knowledge of limit function.

Zegin, Furkan & Kuttaca (2012) performed a study to determine the effects of dynamic mathematics software Geogebra on student achievement in teaching of trigonometry. The sample of study consists of 51 students. The experimental group was subjected to the lessons arranged with Geogebra software in computer assisted teaching method while control group was subjected to the lessons shaped with constructivist instruction. The data were collected after 5 weeks of treatment. Finding shows a meaningful difference between experimental and control groups' achievement in trigonometry. This difference indicates a positive impact of utilizing Geogebra in enhancing students learning and understanding trigonometry.

Akkaya, Tatar & Kagizmanli (2011) studied with aim to prepare materials about symmetry which is one the subject of analytic geometry lesson in secondary education. For this purpose materials had been formed, which can assist students in taking symmetry of point and line in accordance with coordinate axes, origin, $y=x$ and $y=-x$ lines by paying attention to the directions on the given worksheet and

as a result, internalizing the basic logic of the concept of symmetry.

Dogan&Icel (2011) performed a study with the aim to observe effects of dynamic mathematics software Geogebra on eight grade students for the subjects of triangles. The results showed that dynamic software Geogebra has positive effects on students' learning and achievements. It had also been observed that it improves students' motivation with positive impact.

Reis (2010) performed a case study to show the increase relation of knowledge and success with computer supported mathematics with Geogebra. In this study, the subject of integers has been taught with different methods to two homogenous classes. One of the classes was taught by traditional teaching techniques whereas the other was taught by Geogebra. In the finding, it is found that making more use of Geogebra in teaching is an important factor in an effective mathematics teaching and a permanent learning.

Saha, Ayub&Tardini (2010) performed a quasi-experimental study with non-equivalent control group post-test only designed was conducted to examine the effects of using Geogebra in the learning of co-ordinate geometry among students classified as high visual-spatial ability students (HV) and low visual-spatial ability students (LV). The results of the study showed that there is a significant difference in the mean mathematical achievement between the Geogebra group and traditional teaching group. Finding showed that the use of Geogebra enhanced the performance in learning co-ordinate geometry.

Zerrin&Sebnam (2010) studied to see the effectiveness of Geogebra on students' success at 12th grade mathematics subject parabola. In this study quasi-experimental method of control group of 102 students of class 12 and experimental group of 102 students of class 12 was used. The study found that the teaching with materials, which prepared with Geogebra are more successful than traditional method.

Dogan (2010) conducted a quasi-experimental study to evaluate the success of students learning using the Geogebra software. It was a twelve hour course held for a period of two weeks involving two eight classes. The study found that the computer based activities with Geogebra software encouraged higher order thinking skills. The software was also found that having a positive effect in motivating students towards learning and retains their knowledge for a longer period. This was proving based on a recall test conducted a month later.

Research Questions

On the basis of above facts some questions arose in researcher's mind-

1. Is the use of Geogebra in geometry teaching effective for improving student achievement?
2. Is there difference between the achievement of boys and girls by using Geogebra in teaching geometry?

Objectives of the Study

For the fulfillment of above problem researcher has formulated the following objectives:-

1. To study the effect of Geogebra on students' achievement in geometry of class IX.
2. To study the difference between the achievement of boys and girls by using Geogebra in teaching geometry of class IX.

Research Hypothesis

After formulating the objectives of study researcher needs to formulate the hypothesis for the process of study. Basically scientific research keeps scientific approach which is based on the hypothesis. For this study researcher has formulated the following hypothesis-

1. There is significant difference between the achievement of students taught by Geogebra-used-teaching and traditional teaching method.
2. There is significant difference between the achievement of male and female students taught by Geogebra-used-teaching method.

Research Methodology

The applied type research conducted a quantitative method for the empirical study. On the basis of objective and hypothesis of study, the present study was conducted by using quasi-experimental procedure. The quasi-experimental study with equivalent group post-test only design was conducted to examine the effect.

Population

In this research, researcher has constituted the male and female students of class IX of CBSE affiliated English medium school of Bilaspur, (C.G.). There are 15 CBSE affiliated English medium school in Bilaspur, (C.G.), but it is very difficult for researcher to identify the whole population that is the total number of male and female students studying in IX class of these schools.

Sample & Sampling Procedure

In the study, a sample of 45 students are selected from a CBSE English medium school. The sample has selected by the simple random sampling technique. The sample of 45 students consists of 22 male students and 23 female students which are divided into two groups- control and experimental group. Control group consist of 23 students and experimental group consists of 22 students (see table-1) with controlling the extraneous variables- locality, computer literacy and visual spatial ability.

Table 1: Sample

Group	Male students	Female students	Total
Experimental group	10	12	22
Control group	13	10	23
TOTAL	23	22	45

Procedure of Conducting Experiment

For the experiment, two groups of students had been selected - one is control group and another is experimental group. Experimental group taught by using geogebra and Control group taught by traditional teaching method (See table-2). For the teaching of Experimental group the lesson material is

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prepared by using geogebra. The content of teaching has constituted from the Euclidian geometry, Lines and Angles and Triangle of NCERT book of class IX. After 21 days of teaching activities a post-test has conducted for both the groups.

Table-2: Experimental group and process

Group	Experimental process	No. of students
Experimental group	Teaching by using geogebra	22
Control group	Teaching by traditional method	23

Tool

A geometry achievement test has constructed to observe the students achievement in geometry of class IX. From this test researcher want to observe students' knowledge, understanding and application level of geometry. So this test consists of 30 questions from knowledge, understanding and application level of geometry.

Statistics Used

In this study, Mann Whitney U Test was used for analyzing the data and testing of hypothesis by using SPSS.

Analysis and Discussion

Analysis of Data for First Objective Objective

To study the effect of Geogebra on students' achievement in geometry of class IX.

Research Hypothesis

There is significant difference between the achievement of students taught by Geogebra-used-teaching and traditional teaching method.

Null Hypothesis

There is no significant difference between the achievement score of students taught by Geogebra-used-teaching and traditional teaching method.

For analyze the testing hypothesis, the data has calculated by Mann-Whitney U Test by using SPSS. The mean rank and sum of the ranks of post test scores of the control group and experimental group is tabulated in table-3.

Table-3: Mean Rank and Sum of Ranks for Mann-Whitney Test

Group	Sample size (N)	Mean Rank	Sum of Ranks
Experimental group	22	28.20	620.50
Control group	23	18.20	414.50

Table 3 indicates that the mean rank and sum of the ranks of post test scores of the experimental group is higher than control group. To test the significance of difference in the mean rank and sum of the ranks of post test scores of the control group and experimental group, data were analyzed by Mann-Whitney U test and tabulated in table-4.

Table-4: Significant Different in the Achievement Scores of Control Group and Experimental Group

Test Statistics	Score
Mann Whitney U	138.500
Wilcoxon W	414.500
Z	2.613
Assumption significant (2-tailed)	0.009

Table- 4 indicates that the Mann Whitney U score is 138.500 and Wilcoxon W score is 414.500. It also indicates that the Z score is -2.613, which is greater than 1.96 (critical Z score at significance level 0.05). Hence, this indicates that: There is significant difference between the achievement score of control group and experimental group.

Analysis of Data for Second Objective Objective

To study the difference between the achievement of male and female student by using Geogebra in teaching geometry of class IX.

Research Hypothesis

There is significant difference between the achievement of male and female students taught by Geogebra-used-teaching method.

Null Hypothesis

There is no significant difference between the achievement score of male and female students taught by Geogebra-used-teaching method.

For analyze the testing hypothesis, the data has calculated by Mann-Whitney U Test. The mean rank, sum of the ranks and U value of post test scores of the male student and female student of control group are tabulated in table-5.

Table-5: Sum of Ranks, Mean rank and U value for Mann-Whitney Test

	Sample size(N)	Sum of ranks	Mean rank	U-value
Male students	10	123	12.3	62
Female students	12	131.5	10.96	76.5

Table-5 indicates that the mean rank and sum of the ranks of post test scores of male students is higher than female students. To test the significance of difference in the mean rank and sum of the ranks of post test scores of male students and female students, data were analyzed by Mann-Whitney U test and tabulated in table-6.

Table-6: Significant different in the achievement scores of control group and experimental group

U _{calculated} value	U _{table} value
62	29

Table-6 indicates that the Mann Whitney U score is 62, which is greater than 29 (critical U value at significance level 0.05). Hence, this indicates that: There is no significant difference between the achievement score of male students and female students.

Conclusion

It is quite obvious in learning mathematics that we cannot ensure the full learning just by lecturing the subject. As this is totally a teacher-centered instruction, it cannot attract the attention of the students. According to Gagne, we have to attract the attention of the students first for involving in learning. For this we need materials that attract their attention. The fact that Geogebra is a computer software and students are somewhat interested in learning process. As the finding of the study, we can see that the success of teaching with Geogebra is higher compared with that of conventional teaching

without any gender biasness. Naturally, there is another reason for this, we can attribute it to Gardner's theory of multiple intelligences. Gardner states that a human being is born with 8 types of intelligences but some are dominant. Starting this study, with the application of Geogebra, more intelligences of students are aimed to be reached at, thus success is to be higher. Besides these, according to Edgar Dale's Cone of Experience, we remember 30% of what we hear but remember 80% of what we see, hear and utter. The results of the study exactly shows the application of these. With Geogebra, students are more involved in the teaching-learning process and more sense organs are appealed to, thus higher success is found. Therefore we can say 'Making more use of Geogebra in geometry teaching will be an important factor in an effective teaching and a successful learning'.

Educational Implications

On the basis of above finding, we can say that Geogebra is effective tool for classroom teaching to improve student achievement. First of all, Geogebra can include practical contribution to mathematics education with proves a reality that computer based classroom activities can be effectively used in the teaching-learning environments. Secondly, Geometric facts, figures, shapes and their properties with actual conditions of constructions were observed by using the geogebra. Thus, the students have the chance to verify the condition by observing the geometric properties of shapes with all sufficient conditions.

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