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Using Geometer's Sketchpad To Teach Senior High School Trigonometry: It's Effect On Students' Achievement Performance

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Abstract: ***This research compared the effect of the use of Geometer's Sketchpad (GSP) and that of the conventional teaching strategy on students' learning of trigonometry in senior high schools in Ghana.***

The pretest – posttest nonequivalent - groups design was used. Two schools were purposively selected in the Accra Metropolis. In all, 83 students were involved, 37 in the experimental group and 46 in the control group. Students in the experimental group underwent learning trigonometry using GSP technology while students in the control group were taught using a conventional instruction strategy. A one – way analysis of covariance (ANCOVA) was used to test the stated hypotheses.

The study found no significance difference at the 0.05 significance level in the performance scores for the two groups [F (1, 81) = 0.004, P> 0.05]. However, it has been found that Geometer's Sketchpad has the ability to improve upon the achievement of low achievers within a class. Geometer's Sketchpad enables the experimental group to retain trigonometrical concepts at a significantly high level than did the conventional group.

I. INTRODUCTION

One of the aspirations of most developing countries such as Ghana is the desire to build an academically strong, united, prosperous, and economically vibrant society. The desire for economic viability depends on industrialisation, the basis of which is science and technology. Science and technology, also depend on the indispensable tools of mathematics. Perhaps, it is the desire for those tools that mathematics is now the focus in the community of school subjects of almost all countries, the world over. In Ghana, mathematics is a compulsory subject at all pre- university levels. Due to its importance the government is committed to ensuring the provision of high quality mathematics education. Various attempts have been made in the past to improve upon the quality of teaching and learning of mathematics. Example is in-service training for mathematics teachers.

Mathematics is learned because of many reasons. Firstly, the mastery of basic mathematical skills is needed in order to cope with the demands of life. Such demands include being numerically literate, gaining tools for future employment, developing the prerequisite for further education, and appreciating the relationship between mathematics and technology. Secondly, mathematics is the language of the sciences, and many disciplines depend on this subject as a symbolic means of communication. Another justification for learning mathematics is the need for students to use the subject as an important means of discovering truth. The discipline clearly and precisely presents aspect of knowledge which are helpful in finding out truth about the structure and patterns of the environment. The learning of mathematics concepts and skills students encounter shapes their understanding, their ability to solve problems and their confidence in, and disposition toward mathematics (Too, 2007). Mathematics, the world over, plays a pivotal role in student's lives. It is the foundation of science and technology and the functional role of mathematics to science and technology is multifaceted and multi farious that no area of science, technology and business enterprise escapes its application (Okigbo &Osuafer, 2008). The reason is that mathematics is composed of intellectual skills and not very much verbal.

While it is true that mathematics serves as an important tool in all aspect of human endeavour, it is equally true that most students find it difficult to learn mathematics, to the point of eventually disliking the subject. In the study of Rizalvo (as cited by Orteza, 2006) it was observed that students encountered difficulty in mathematics because of their lack of the computational skills in the fundamental operations on whole numbers, fractions, decimals, radicals, analysis in solving problem and logical thinking. In order to overcome this weakness Rizalvo suggests that students should have a good foundation in fundamental operation in mathematics in their early years of schooling. Felipe (as cited in Foronda, 1995) noted that every person must have corresponding growth in desirable degree and types of mathematical concept in order to orient himself satisfactorily during these changing times.

Trigonometry is one of the topics in the senior high school core mathematics in Ghana.

Understanding trigonometric function is a pre – requisite for understanding topics in Newtonian physics, architecture, surveying, and many branches of engineering. It can also serve as an important precursor towards understanding pre- calculus and calculus. Fields that use trigonometry or trigonometric functions include astronomy, music theory, acoustics, optics, analysis of financial markets, electronics, probability theory, statistics, biology, medical imagines, pharmacy, chemistry, number theory, meteorology, oceanography, many physical science, land surveying and architecture, phonetics, economics, electrical engineering, mechanical engineering, civil engineering, computer graphics, cartography, crystallography and game development.

With these numerous benefit of trigonometry, Gür (2009) noted that trigonometry is one of the topics that very few students like and succeed at, and which most students believe to be particularly difficult and abstract as compared with other topics. Orhun (2002) found that students did not develop the concepts of trigonometry certainly and that they made some mistakes. He emphasised that teacher – active method and memorising method provide students the knowledge of trigonometry only for a brief moment of time, but this knowledge is not retained by students in the long run. The poor performance of students in trigonometry in their final West Africa senior high school certificate examination has been confirmed by the Chief Examiner's report for 2004. Also the 2005 and 2007 reports show that students demonstrated lack of understanding in trigonometry.

Information and communication technology (ICT) is a method of teaching and learning of trigonometry. The use of ICT as a tool for teaching and learning allow learners to play an active role rather than the passive role of recipient of information given by a teacher, textbook, or broadcast. The student is actively making choices about how to generate, obtain, manipulate, or display information. ICT allows many students to be actively thinking about information, making choices and executing skills than in a teacher – led lesson. Moreover, when ICT is used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress.

Many researchers have carried out studies to evaluate the benefits of using ICT in mathematics education. British Educational Communications and Technology Agency (BECTA), (2003) summarized the key benefits: ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. ICT gives rapid and accurate feedbacks to students, and this contributes towards positive motivation. It also allows them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations. ICT also supports constructivist pedagogy, wherein students use technology to explore and understand mathematical concepts.

There have been quite a number of studies carried out to evaluate the influence and impact of the use of Geometer's Sketchpad (GSP) on mathematics teaching and learning. Nurul Hidayah (2007) found that a group of secondary school students who had undergone the use of GSP instructional programme gained higher achievement score as compared to their counterparts in the control group. On the other hand Kamariah, Rohani et al, (2009) concluded that there was no significant difference in the mean of mathematical performance between the GSP group and the traditional teaching strategy group.

Geometer's Sketchpad (GSP) is a dynamic construction and exploration tool that enables students to explore and understand mathematics in ways that could not be done with traditional ways, (Key Curriculum Press, 2001). This software enables construction and animation of an interactive mathematics model to be used and explored by teachers and students (Norazah, Effandi, Nik Rahimah & Mohamed, 2010). GSP is a powerful drawing programme to help students explore better and understand mathematical concepts (Weaver & Quinn, 1999). Using GSP, students can construct objects and then explore them by dragging the objects with the mouse. The software relies on very simple command that allows the user to effortlessly create, edit, and manipulate accurate geometrical constructions on the computer screen.

II. METHODOLOGY

RESEARCH DESIGN

The pretest – posttest non – equivalent groups design was used to collect quantitative data to find out whether there was any significance difference between achievement performances of students taught by Geometer's Sketchpad Technology and those taught by the conventional method. In this research, the achievement performance of students was the dependent variable while the teaching strategy (ICT or conventional/non- ICT) was the independent variable. The experimental group underwent learning using Geometer's Sketchpad (GSP) technology while the conventional group underwent learning using a conventional instruction strategy.

POPULATION AND SAMPLE

Two schools were purposively selected among 21 SHS in the Accra Metropolis. The schools are Wesley Grammar School and Ebenezer Senior High School. Wesley Grammar School accepted to give her ICT laboratory while Ebenezer Senior High School was not ready to give her ICT laboratory. Therefore Wesley Grammar School was chosen as the experimental group and Ebenezer Senior High School as the conventional group. In all, 83 students were involved 37 in the experimental group and 46 in the control group

RESEARCH INSTRUMENTS

Three achievement tests made up of pretest, posttest and a retention test were constructed by the researcher as instruments to collect data. The pretest consisted of a 30 item multiple choice questions developed based on a range of mathematics topics covered in SHS 1 and SHS 2 core mathematics syllabus. It had four possible options. In constructing the multiple choice items, a table of specification was used to ensure the content validity and also to facilitate meaningful weighting of the test items. However, the posttest was based on the topic trigonometry that was taught during the period of the research. The test items comprised four essay questions in which each question was for 15 marks. The retention test has the same format, content and scoring as the posttest. The retention test also sought to identify how well the concepts learnt had been retained.

RELIABILITIES OF INSTRUMENT

In determining the reliabilities of the instruments, the Kuder – Richardson 21 was used for the pretest whilst Cronbach's alpha was used for the posttest and the retention test. The estimate of the Kuder – Richardson 21 was 0.75 and that of Cronbach's alpha was 0.80 which were found to be acceptable levels. In general, the tests seemed not too easy and not too difficult. Hence, as conceptual tests, they could be used for the purpose intended.

DATA COLLECTION PROCEDURE

The procedures for data collection for this research consisted of the scores of the pretest and a set of lesson plans on the topic, trigonometry from the core mathematics syllabus (CRDD, 2007). The study compared two methods of teaching trigonometry; the conventional method and the use of Geometer's Sketchpad technology (GSP). The software Geometer's Sketchpad (GSP) was installed on all the computers in the ICT laboratory. During the first phase, the experimental group was initially introduced to the use of GSP. In this phase, the students were required to explore and familiarise themselves with the use of the GSP and its functions. The teacher then assisted the students to form co-operative groups to share and discuss what they were learning. The conventional group on the other hand, at this time was not exposed to any teaching and learning. Thereafter, the two groups were exposed to four weeks of teaching and learning of trigonometry. In the course of the teaching and learning the experimental group used the GSP to solve problems whilst the conventional group used plane sheet and mathematical set. At the end of the teaching, the students were given posttest and retention test in which they solved given problems, without using the GSP.

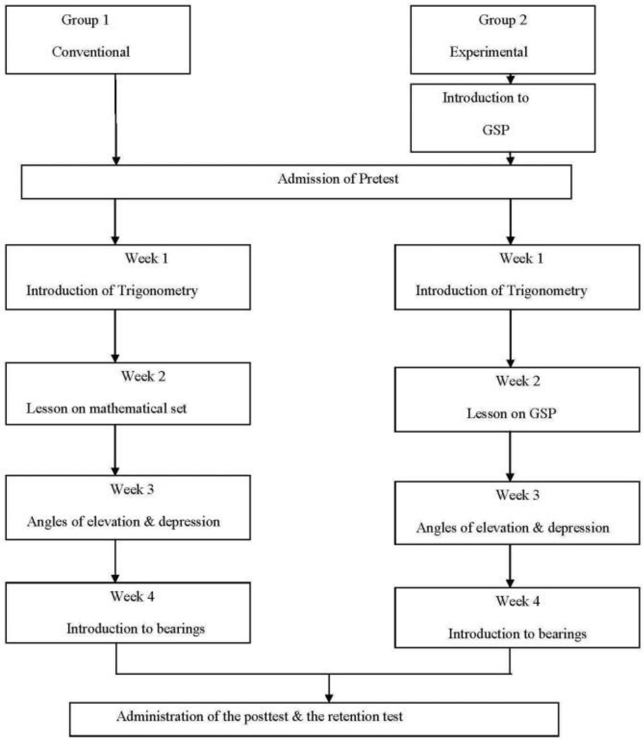

Figure 1: Flow chart of research process

III. RESULTS AND DISCUSSION

The results were analysed based on the following hypotheses:

✓ H_0: There is no significant difference between the mean scores of the experimental group and conventional group on the posttest. A one – way analysis of covariance (ANCOVA) was used to test the hypothesis and the result is presented in table 1

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial Eta square
Corrected Model	8221.166[a]	2	4110.583	29.999	0 .000	0.429
Intercept	7249.559	1	7249.559	52.907	0 .000	0.398
Pretest	7519.920	1	7519.920	54.880	0 .000	0.407
School type	.544	1	0.544	0.004	0 .950	0.000
Error	10962.015	80	137.025			
Corrected Total	19183.181	82				

Table 1: Result of the ANCOVA on Students Pre and Posttest Scores of the Experimental and the Control Groups

From the table, the test indicated no significant difference at $p > 0.05$ level in the performance score for the two groups $[F(1,81) = 0.004, p > 0.05]$.

The means and adjusted means of the group are indicated in table 2.

Type of school	Mean	Std.Deviation	Adjusted mean	N
Control	52.15	15.82	54.84	46
Experimental	58.00	14.17	54.66	37
Total	54.76	15.30		83

Table 2: Means, Standard Deviation and Adjusted Means on Students Posttest Scores of the Experimental and the Control Groups

From table 2, although there was no significant difference between the two groups, the control group performed slightly better with a mean of 52.00 (adjusted to 54.84) than the experimental group with a mean of 58.00 (adjusted to 54.66).

- ✓ H_0: There is no significant difference between the mean score of high and low achievers on the posttest when they are taught using Geometer's Sketchpad and the result is shown in table 3

Source	Type lll sum of Square	df	Mean Square	F	Sig	Partial Eta Square
Corrected Model	1507.112	2	753.556	6.947	0.000	0.290
Intercept	387.939	1	387.939	3.577	0.067	0.095
Pretest	1273.049	1	1273.049	11.737	0.002	0.257
Group	484.070	1	484.070	4.463	0.042	0.116
Error	3687.861	34	108.466			
Corrected Total	5194. 973	36				

Table 3: Result of the ANCOVA on Posttest Scores of High and Low Achievers in the Experimental group

Analysis of covariance was used to test the hypothesis and the result showed a significant difference at $p < 0.05$ level in the mean score for the two groups $[F(1,35) = 4.46, p < 0.05]$. Therefore the null hypothesis of no significant difference between high and low achievers when taught using Geometer's sketchpad was rejected and the conclusion was that there was a significant difference between the mean scores of high and low achievers.

The means and adjusted means of the experimental group on the posttest are shown in table 4.

Students'	Mean	Std. Deviation	Adjusted Mean	N
Low	56.58	11.56	65.62	19
High	61.61	12.76	52.07	18
Total	59.03	12.01		37

Table 4: Means, standard deviation and Adjusted Means of High and Low Achievers in the Experimental Group on Posttest

With a mean of 56.58 (adjusted to 65.62) the performance by the low achievers was better than that of the high achievers with a mean score of 61.61 (adjusted to 52.07) as shown in table 4. This means, when Geometer's sketchpad was used as an instructional strategy, low achievers seemed to benefit more from the teaching.

- ✓ H_0: There is no significant difference between the experimental group and the conventional group on the retention test and the result is in table 5.

Source	Type lll Sum of Square	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	20939.170	2	10469.585	571.305	0.000	0.935
Intercept	70.416	1	70.416	3.842	0.053	0.046
Posttest	19189.190	1	19189.190	1047	0.000	0.920
School type	196.203	1	196.203	10.706	0.002	0.118
Error	1466.058	80	18.326			
Corrected Total	22405.229	82				

Table 5: Result of the ANCOVA on Students Posttest and Retention test Scores for the Experimental and Control Groups

The result in table 5 showed a significant difference at $p < 0.05$ level in the mean score for the two groups $[F(1,81) = 10.71, p < 0.05]$. This means the null hypothesis was rejected and concluded that there was a significant difference in the mean score of the experimental group and the control group.

Table 6 presented the means and adjusted means scores on the retention test

Type of School	Mean	Std. Deviation	Adjusted Mean	N
Control Group	54.98	16.22	57.69	46
Experimental Group	64.22	15.64	60.84	37
Total	59.10	16.53		83

Table 6: Means, Standard Deviation and Adjusted Means on Students' Retention test Scores of Experimental and Control Groups

Table 6 indicates that the experimental group with a mean of 64.22 (adjusted to 60.84) performed better than the control group with a mean of 54.98 (adjusted to 57.69). This means the students who underwent learning of trigonometry using Geometer's sketchpad as an instructional strategy performed better on the retention test than the students that learnt trigonometry through the conventional approach.

RECOMMENDATIONS

In response to the findings it has become imperative for the utilization of ICT in the teaching and learning of mathematics. Dynamic geometry software improves upon the achievement of low achievers within a class. Therefore the software should be included in the teaching and learning of mathematics since they are now free on the internet for easier access and usage. In view of this, the Ghana Education Service (GES) should organise in- service training for teachers in SHS to equip them with knowledge and skills on the software. Again, dynamic software should be included in the curriculum at colleges of education and the universities of education for pre- service teachers.

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