GEOMETER'S SKETCHPAD (GSP) AND INTERACTIVE WHITEBOARD INTEGRATION ON TRIGONOMETRY

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Objectives of the study

General Objective

The purpose of this study is to determine the effectiveness of Geometer's SketchPad (GSP) and interactive whiteboard integration on Trigonometry as perceived by the BSIS 1 students of Carlos Hilado Memorial State College, Academic Year 2017 – 2018.

Specific Questions

Specifically, the study will answer the following questions:

1. What is the performance of both control and experimental groups on Trigonometry before the intervention?
2. What is the performance of both control and experimental groups on Trigonometry after the intervention?
3. Is there a significant difference between the performance of control and experimental groups on Trigonometry before the intervention?
4. Is there a significant difference between the performance of control and experimental groups on Trigonometry after the intervention?
5. Is there a significant difference between the performance of the control group on Trigonometry before and after the integration?
6. Is there a significant difference between the performance of the experimental group on Trigonometry before and after the integration?

Methodology

Research Design

The researcher used quasi-experimental design in this study since this method seeks the effectiveness of Geometer's Sketchpad (GSP) and interactive whiteboard integration on Trigonometry.

The Nonequivalent Control Group Pretest-Posttest Design

This type of design includes one experimental group and one control group used for comparison. This design often uses already existing groups or creates groups out of convenience because randomization is not possible.

To illustrate the nonequivalent control group pretest-posttest design in this study, the researcher examined the effect of Geometer's Sketchpad (GSP) and interactive whiteboard integration on Trigonometry. It will be disruptive to re-arrange the section to randomize the subjects, therefore existing groups are used. There are also matching methods used to create comparison groups through different methods of "matching" the characteristics of subjects in control group with the subjects selected to be the in comparison group, the experimental group. These methods involve the intentional selection of subjects and therefore, even though the experimental and control groups may be more similar using this method, it is still considered quasi-experimental. Once the experimental and control groups have been identified and established, the groups may be tested and compared in a pre-test/post-test manner.

In general, matching is used to make sure that members of the various groups are equivalent on one or more characteristics. To make absolutely sure that the groups are equivalent on some attribute, the use of matched random assignment is imperative.

In a quasi-experimental design, matched random sampling can be used to equate the groups on one or more characteristics.

The Matching Process

1. Obtain the Midterm grades on the variable of interest and rank order students from highest to lowest according to that grade. The values in Table 1 have been ranked according to Midterm Grade.

BSIS 1A Midterm grade in Trigonometry (Experimental Group)		BSIS 1B Midterm grade in Trigonometry (Control Group)	
Student	Midterm Grade	Student	Midterm Grade
1	96	1	96
2	94	2	95
3	94	3	93
4	93	4	93
5	91	5	90
6	89	6	90
7	89	7	90
8	89	8	89
9	89	9	88
10	88	10	87
11	86	11	86
12	85	12	85
13	85	13	84
14	85	14	84
15	82	15	81

2. Take one student with the top grade (Student 1) from experimental group and match this to the top grade (Student 1) of the control group. Take the next highest score (Row 2) and match them to the control and experimental group. Continue until all participants have been assigned to conditions. Matching of midterm grades of two students should be done of at most a difference of two. For example, a grade of 92 will be matched to a grade of 90 to 94.
3. Expand as necessary according to the design of your study. Take the people with the top 15 test scores (Row 1 to Row 15) and assign them to each group. This procedure will assure that each of the experimental and control groups are equivalent on test scores.

Data Gathering Procedure

After the research proposal was approved by the panel members, the researcher asked permission from the Dean of the College of Technology to conduct a study from BSIS 1 students. The researcher also asked permission from ICT office for the use of room, equipment, facilities, and ICT tools such as Geometer's SketchPad (GSP), interactive whiteboard and others.

The 60 students from BSIS 1 undertake the matching process as defined in quasi-experimental design as a method of selecting participants from experimental and control groups to guarantee that the two groups have equal characteristics in terms of intelligence (Midterm Grade in Trigonometry) before the implementation of the study.

After the approval, a pretest was given to both experimental and control groups to determine their performance before the intervention. After giving the pretest, a study was implemented a 3 meeting-discussion and lesson was given to the experimental group (BSIS

1A) about the graphs of sine and cosine functions via ICT integration of tools, facilities and equipment. At the same time, the control group (BSIS 1B) was given the same lesson or topic without any ICT integration.

After the discussion of the graphs of sine and cosine functions, posttest was given to both experimental and control groups. After giving the posttest for both experimental and control groups, the researcher thoroughly checked the test and necessary and appropriate statistical tools were used. The data was subjected for SPSS.

Results and Discussion

The following are the results of the study after which appropriate descriptive and inferential statistics were used.

1. The performance of both control and experimental groups before intervention is "Low".

2.The performance of the control and experimental groups after the intervention is "Average". It has a difference of 3.93 in favor to experimental group. It implies that the experimental group has improved more compare to the control group.

3. No significant difference was noted in control and experimental groups before the intervention. It entails that the students in both control and experimental groups were comparable and well matched before the intervention. The two groups implies that the two groups are equally matched in terms of the idea of graphs of sine and cosine functions.

4. There is a significant difference in control and experimental groups after the intervention. It is observed that the development of the performance for the experimental group is greater than that of control group. This stresses the effective use of ICT in teaching Trigonometry lessons.

5. There exists a significant difference in control group before and after the intervention. It entails that after teaching graphs of sine and cosine functions using traditional method improves the performance of students in the control group.

6. The experimental group records a significant difference before and after the conduct of intervention. Inclusion of Geometer's Sketchpad and interactive whiteboard on the teaching of Trigonometry has a significant effect on the increase of the performance of students.

Conclusion

Based from the findings of the study, the following conclusions are advanced.

1. Students whose Trigonometry class, specifically graphs of sine and cosine functions, integrated with Geometer's Sketchpad and interactive whiteboard outperformed the students who were exposed to traditional instructional materials in terms of test scores. Use of these ICT tools is concluded to be effective on teaching Trigonometry.

2. Students whose Trigonometry class integrated with Geometer's Sketchpad and interactive whiteboard are far better than the students who were exposed to traditional instructional materials.

4. Geometer's Sketchpad and interactive whiteboard have a significant effect on the learning engagement of students in Trigonometry and so are the conventional instructional materials. Instructional material in any form increases learning engagement if properly used.

GEOMETER'S SKETCHPAD (GSP) AND INTERACTIVE WHITEBOARD INTEGRATION ON TRIGONOMETRY

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Introduction

Developing technological tools such as apps, smart phones, social media, tablets, and YouTube have been included in the teaching and learning process over time. The ongoing evolution of technology hardware, software, and instructional applications affect the teaching and learning process (Nadelson, Bennett, Gwilliam, Howlett, Oswalt & Sand, 2013). In the past, only textbooks were used in the teaching process, which in time continued with the use of computers, projection devices, interactive whiteboards and tablets in order to increase the effectiveness of learning outcomes.

Information and Communication Technology (ICT) is a combination of devices and technology resources, which are used to manipulate and correlate information (Kaware & Sain, 2015). Technology tools cover all electronic and digital devices such as computers, the internet, and other multimedia technology, like Geometer's SketchPad (GSP) and interactive whiteboard. The usage of ICT is becoming more crucial in education as it enables the development of a more proactive teaching and learning environment (Gabare et al., 2014, Daud & Khalid, 2014). Together with the expansion of current era of technology, educators are encouraged to incorporate ICT into their teaching, as a substitute for traditional teaching methods (Kiflee & Khalid, 2014).

ICT is not only a tool for teaching and learning, but also acts as a driving force for an educator to play his or her role in education (Nur & Hazman, 2006). For example, the application of ICT could expose students to various skills linked to their future needs, such as using Geometer's SketchPad, interactive whiteboard, Microsoft Word, email, and the internet for lifelong learning processes.

According to a research conducted by Norazah and Effandi (2007), the use of computers in mathematics education was able to make the teaching and learning methodology of the subject more up-to-date and interesting as compared to the conventional method. Indirectly, this has helped to mould young generation to be physically, emotionally, and intellectually capable in solving mathematical problems.

Geometer's Sketchpad is an interactive geometry software package used to help students learn geometry principles (Groman, 1996). The GSP software enables the construction and the animation of interactive mathematical model to be used and explored by teachers and students (Mahmud et al, 2009). The features in this software opened up space for dynamic image construction which can be manipulated, analyzed, conjectured and tested. The application of the GSP has given the opportunities to students as well as educators not only to enhance their skills and knowledge in using the computers but also to explore the potentials of GSP.

The use of GSP software with exploratory technique was suggested in many teaching and learning of Mathematics activities to enhance the understanding of mathematical concepts (Stacey, 2007). In addition, the use of dynamic geometry software enhanced many aspects of mathematics learning. One of the advantages of GSP software was its ability to allow students to explore the different properties of graphs of trigonometric functions. Automatic calculation can be done for angles, side length and ratio while adjustment of the drawing was being made. It also enabled user to build, measure and manipulate what was presented on the screen as well as giving immediate feedback when the size and shape of the object is changed (Hannafin & Scott, 1998).

Teoh & Fong (2005) demonstrated that the teaching and learning using Geometer's Sketchpad (GSP) approach helped students to better understand the mathematical concepts taught.

The trigonometric concepts that are investigated in this study include graphs of sine and cosine functions. Along with mathematical terminology and concepts, students will gain a solid understanding of the various commands and functions within the GSP program.

According to Stacey (2007), the use of GSP software with exploratory technique was suggested in many teaching and learning of Mathematics activities to enhance the understanding of mathematical concepts.

De Vita (2014) said that interactive whiteboard (IWB) is a relatively new tool that provides interesting affordances in the classroom environment, such as multiple visualization and multimedia presentation and ability for movement and animation.

According to Jones (2004), using interactive whiteboards in the teaching and learning of mathematics: a research bibliography, around 85% of secondary schools and 37% of primary schools that responded to the survey said that they had interactive whiteboards (IWBs). Although this form of technology is relatively new, there is an emerging body of literature on their effective use in teaching and learning. IWBs provide interesting opportunities for students and teachers alike to interact with digital content in a multiperson learning environment.

Technologically speaking, IWBs connect a computer linked to a data projector and a large touch-sensitive board that displays the image projected from the computer and allows direct input and manipulation through the use of fingers or styli.

IWB technology provides an innovative tool with high potential for mathematics instructional environments. Teachers can use IWBs for modelling mathematical ideas and strategies, demonstrating theorems, explaining difficult concepts, stimulating discussion about relevant mathematical topics, inviting interpretations of what is displayed, and challenging students to apply their mathematics to solve problems. The IWBs, especially the capacity to present a wide variety of multimedia resources, the ability for movement and animation to demonstrate principles and to illustrate explanations, the possibility to match different representations (geometrical and algebraic) may favour enhancements in teaching and learning. Furthermore, mathematics learning is an essentially constructive activity. Learners need to engage in the processes of mathematical thinking: framing and solving problems, looking for patterns, making conjectures, examining constraints, abstracting, inventing, explaining, justifying, challenging, and so fort. In this respect, the interactive affordances of the IWB can be exploited to promote the learners' active involvement in these mathematical thinking processes through the use of a more interactive pedagogy.

Interactive whiteboards (IWB) have many features that engage students in the classroom, but little is understood about how they actually impact student understanding of mathematics. Our aim in this study was to identify how and why the IWB was a productive tool that impacted student learning in mathematics. (Bruce, 2011)

It is on this premise that ICT using Geometer's Sketchpad (GSP) and interactive whiteboard is needed to come into the classroom to keep up with the learning demands of the 21st Century. The BSIS 1 students were taking Trigonometry during second semester as freshmen. They will be learning the graphs of trigonometric functions in Endterm which are best represented by the use of ICT tools such as Geometer's SketchPad (GSP), interactive whiteboard and other mathematical models. ICT integration on Trigonometry is considered a problem in classroom setting, educational system and curriculum because it really affects and a major factor of the performance of both students and the school. It enhances the critical thinking of students and their viewpoint in Mathematics in terms of Geometer's Sketchpad (GSP) and interactive whiteboard

In the light of the foregoing premise, the researchers are determined to look into the effectiveness of the Geometer's Sketchpad (GSP) and interactive whiteboard of the BSIS students of Carlos Hilado Memorial State College.

Review of Related Literature

ICT could be applied to all subjects, including mathematics. Mathematics educators use basic ICT applications in their teaching. These basic applications include Geometer's SketchPad (GSP) and interactive whiteboard software, visuals and graphics, online demonstrations, and multimedia. These applications function as teaching aids in mathematics.There are many benefits to using technology as an educational tool.

Age (2018) investigated the effect of Geometer's SketchPad on senior secondary school students' interest and achievement in Geometry in Gboko Metropolis. Results from the study revealed that students taught geometry using GSP approach achieved higher scores as well as showed greater interest in learning geometry than those taught with conventional approach.

According to the study of Onal & Demir (2017) in the use of the interactive whiteboard in Mathematics and Mathematics lessons. It was found that the participants in the survey had a positive attitude towards the use of the interactive whiteboard in mathematics lessons and that they were positively affected by the interactive whiteboard in learning mathematics. In addition, it was concluded that participants' attitudes towards mathematics and the use of the interactive whiteboard was above average.

Li (2015) studied the integration of interactive whiteboard technology into regular lesson instruction. Findings have shown that interactive whiteboards could potentially be beneficial in classrooms.

Tai, Leou & Hung (2015) studied the effectiveness of GSP-Aided Instruction. The results revealed the following: in learning the area of triangles, the experimental group performed significantly better than the control group.

Bakar, Tarmizi, Ayub & Yunus (2009) experimented the effect of utilizing Geometer's Sketchpad on performance and mathematical thinking of secondary mathematics learners: An initial exploration. Findings indicated that the use of GSP induced higher mathematical thinking process among the GSP group. These findings showed that the use of GSP had an impact on both mathematical thinking process and performance.

According to Tajudin (2013) on the study of the Graphing Calculator (GC) and Geometer's Sketchpad (GSP) in teaching and learning of Mathematics. The findings from this study provide evidence of pedagogical impact in incorporating the latest trends in mathematics education, namely, integrating the GC tool and GSP software to maximize the mathematical and pedagogical benefits to students.

Aloraini (2012) investigated the impact of using multimedia on students' academic achievement in the College of Education at King Saud University. The analysis result of the post test showed the following: There are statistically-significant differences between the experimental group and the control group at a significance level of 0.05 for the interest of the experimental group.

Nordin (2010) studied the pedagogical usability of the Geometer's Sketchpad (GSP) digital module in the mathematics teaching. The results showed that the prototype digital modules met the requirements of the pedagogical usability criteria mentioned. It is suggested that a study on the applications of GSP in mathematics teaching to be carried out to promote higher order thinking skills among secondary school students.

Research findings have revealed that the learning of mathematics with GSP was made easier compared to the conventional method (Teoh & Fong, 2005).

Nasr (2005) carried out a research to study the effectiveness of the use of multimedia computer technology on teaching Geometry to the third preparatory grade students on students' academic achievement and the development of innovative thinking. There are statistically-significant differences between the average grades of the two groups of study (experimental and control groups) at the level of academic achievement in Geometry due to the pattern of the program used, which is based on the technology of interactive multimedia at a significance level of 0.01 in favor of the experimental group. There are statistically-significant differences between the average grades of the two groups of study (experimental and control groups) in innovative thinking test as for Geometric circle due to the pattern of the program used, which is based on the technology of interactive multimedia at a significance level of 0.01 in favor of the experimental group.

Ibrahim (2003) conducted a study which aims to "Using multimedia technology to present computer basics subject in a way that leads to the availability of adequate skills and information related to the computer domain". The study results showed significant statistical differences at the significance level of 0.01 between the average grade of the experimental group in the post application and the delayed post academic achievement test.

Abdul-Majid (2002) has conducted a study on "The effect of a proposed program using enhanced multimedia along with computer in teaching Analytical Geometry on acquisition of knowledge and developing the divergent thinking and decision-making skills of the first grade high school students". There is a difference in the average grades between the experimental group and the control group in favor of the experimental group grades in the academic achievement test. There is a difference in the average grades between the experimental group and the control group in favor of the experimental group grades in the test of developing the divergent thinking skills. There is a difference in the average grades between the experimental group and the control group in favor of the experimental group grades in the test of decision-making skills.

Hong et al. (2001) conducted a study which aimed at finding out the impact of multimedia software on students' academic achievement in the main concepts of astrology, their ability to acquire the skills of solving big problems as well as the simple skills. The results showed the following: Statistically-significant differences between the average marks of the experimental group students' achievement & that of the control group in favor of the experimental group. It was apparent that Geometer's SketchPad (GSP) software is an effective tool which helps students to acquire the special skills of solving problems as they become able to apply the problem-solving technique on new similar environments and situations.

Salem's study (2000) tackled "The Effect of using computer as an educational tool in teaching the curriculum of statistics on the development of statistical skills among the third grade commercial secondary school students". The study results showed significant statistical differences in the average grades of the experimental and control groups in favor of the experimental group after teaching the program.

Objectives of the study

General Objective

The purpose of this study is to determine the effectiveness of Geometer's Sketchpad (GSP) and interactive whiteboard integration on Trigonometry as perceived by the BSIS 1 students of Carlos Hilado Memorial State College, Academic Year 2017 – 2018.

Specific Questions

Specifically, the study will answer the following questions:

1. What is the performance of both control and experimental groups on Trigonometry before the intervention?
2. What is the performance of both control and experimental groups on Trigonometry after the intervention?
3. Is there a significant difference between the performance of control and experimental groups on Trigonometry before the intervention?
4. Is there a significant difference between the performance of control and experimental groups on Trigonometry after the intervention?
5. Is there a significant difference between the performance of the control group on Trigonometry before and after the integration?
6. Is there a significant difference between the performance of the experimental group on Trigonometry before and after the integration?

Research Design

The researcher used quasi-experimental design in this study since this method seeks the effectiveness of ICT integration using Geometer's SketchPad (GSP) and interactive whiteboard on Trigonometry.

In a quasi-experimental design, subjects are not randomly assigned to treatment or there is no randomization. A quasi-experimental research designs, like experimental designs, test causal hypotheses. A quasi-experimental design by definition lacks random assignment, however, assignment to conditions (experimental versus control or comparison) is by means of administrator selection (e.g., by officials, teachers, policymakers, researchers and so on) (Cook & Campbell, 1979).

A quasi-experimental design of pretest, intervention, and posttest was conducted within the BSIS 1 students of Carlos Hilado Memorial State College-Talisay during Second Semester of Academic Year 2017 – 2018. The intervention was implemented during a one-hour session and discussion for 3 meetings that focuses on the graphs of sine and cosine functions to determine if there is a significant difference exists between experimental and control groups before and after the intervention. The research was conducted using Geometer's SketchPad (GSP) and interactive whiteboard on teaching Trigonometry for 15 students from BSIS 1A (experimental group) and traditional teaching for 15 students of BSIS 1B (control group).

The various analyses that can be performed upon a two-group control group pretest-posttest designs are (Fig 1):

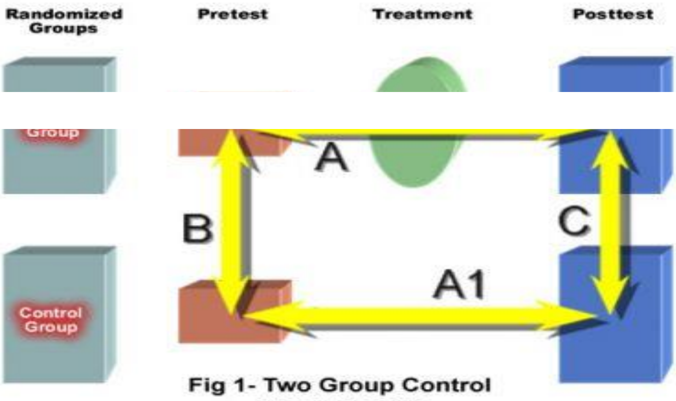

Fig 1- Two Group Control Group Design

This design allows researchers to compare the final posttest results between the two groups, giving them an idea of the overall effectiveness of the intervention or treatment (C). The researcher can see how both groups changed from pretest to posttest, whether one, both or neither improved over time. If the control group also showed a significant improvement, then the researcher must attempt to uncover the reasons behind this. (A and A1) The researchers can compare the scores in the two pretest groups, to ensure that the randomization process was effective. (B) (Shuttleworth, 2009)

The Nonequivalent Control Group Pretest-Posttest Design

This type of design includes one experimental group and one control group used for comparison. This design often uses already existing groups or creates groups out of convenience because randomization is not possible.

A nonequivalent control group pretest-posttest design is a quasi-experimental research design in which a dependent variable is measured in one group of participants before (pretest) and after (posttest) a treatment and that same dependent variable is also measured at pretest and posttest in another nonequivalent control group that does not receive the treatment. In this design, it compares mean scores before and after the intervention in a group that receives the treatment and also in a nonequivalent control group that does not receive the treatment (Cook & Campbell, 1979).

To illustrate the nonequivalent control group pretest-posttest design in this study, the researcher examined the effect of Geometer's SketchPad (GSP) and interactive whiteboard integration on Trigonometry. It will be disruptive to rearrange the section to randomize the subjects, therefore existing groups are used. There are also matching methods used to create comparison groups through different methods of "matching" the characteristics of subjects in control group with the subjects selected to be the in comparison group, the experimental group. These methods involve the intentional selection of subjects and therefore, even though the experimental and control groups may be more similar using this method, it is still considered quasi-experimental.

In general, matching is used to make sure that members of the various groups are equivalent on one or more characteristics. To make absolutely sure that the groups are equivalent on some attribute, the use of matched random assignment is imperative.

In a quasi-experimental design, matched random sampling can be used to equate the groups on one or more characteristics.

The Matching Process

The researcher obtained the Midterm grades on the variable of interest and rank order students from highest to lowest according to that grade. The values in table 1 have been ranked according to Midterm Grade. The researcher took one student with the top grade (Student 1) from experimental group and match this to the top grade (Student 1) of the control group. Then, the researcher took the next highest score (Row 2) and match them to the control and experimental group. Continue until all participants have been assigned to conditions. The matching of midterm grades of two students should be done of at most a difference of two. For example, a grade of 92 will be matched to a grade of 90 to 94. The researcher took the people with the top 15 test scores (Row 1 to Row 15) and assign them to each group. This procedure will assure that each of the experimental and control groups are equivalent on test scores.

BSIS 1A Midterm grade in Trigonometry (Experimental Group)		BSIS 1B Midterm grade in Trigonometry (Control Group)	
Student	Midterm Grade	Student	Midterm Grade
1	96	1	96
2	94	2	95
3	94	3	93
4	93	4	93
5	91	5	90
6	89	6	90
7	89	7	90
8	89	8	89
9	89	9	88
10	88	10	87
11	86	11	86
12	85	12	85
13	85	13	84
14	85	14	84
15	82	15	81

Once the experimental and control groups have been identified and established, the groups may be tested and compared in a pre-test/post-test manner.

Data Gathering Procedure

After the research proposal was approved by the panel members, the researcher asked permission from the Dean of the College of Technology to conduct a study from BSIS 1 students. The researcher also asked permission from ICT office for the use of room, equipment, facilities, and ICT tools such as internet connection, data projector, interactive whiteboard, and others.

The 60 students from BSIS 1 undertake the matching process as defined in quasi-experimental design as a method of selecting participants from experimental and control groups to guarantee that the two groups have equal characteristics in terms of intelligence (Midterm Grade on Trigonometry) before the implementation of the study.

After the approval, a pretest was given to both experimental and control groups to determine their performance before the intervention.

After giving the pretest, a study was implemented a 3 meeting-discussion. The experimental group underwent learning using Geometer Sketchpad technology and interactive whiteboard while the control group underwent learning using a conventional or traditional instructional strategy. This study used four phases for the experimental group, namely: 1) Introduction to Geometer Sketchpad (GSP) and interactive whiteboard; 2) Introduction to Graphs of Sine and Cosine functions; 3) Integrated teaching and learning using Geometer Sketchpad with exercises; and 4) Assessment using a set of Graphs of Sine and Cosine Functions Test as the posttest. The conventional (control group), on the other hand, underwent only Introduction to Graphs of Sine and Cosine Functions (phase 2 undergone by the experimental group), followed by a session on teaching and learning with further exercises. During the time when the experimental group underwent the posttest (at Phase 4), the control group then was administered the same test..

After the discussion of the graphs of sine and cosine functions, posttest was given to both experimental and control groups. After giving the posttest for both experimental and control groups, the researcher thoroughly checked the test and necessary and appropriate statistical tools were used. The data was subjected for SPSS.

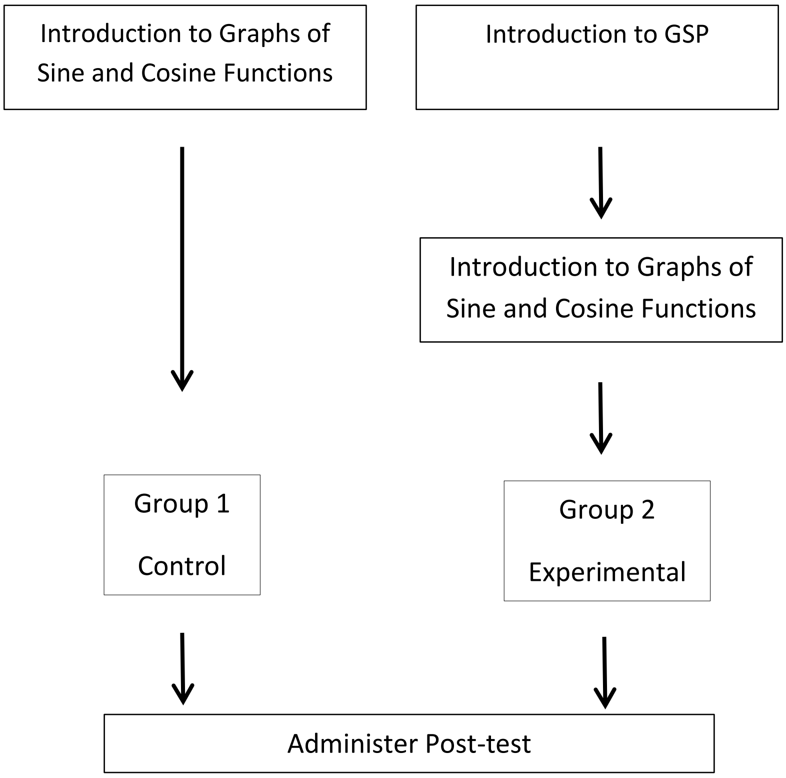

Figure 1: Flowchart of Research Process

Statistical Treatment and Data Analysis

To analyze the gathered data in accordance to the researcher design and hypothesis of the study, the following procedures and statistical tools were adopted:

For problems 1 and 2, which sought to determine the performance of control and experimental groups before and after the intervention, the researcher used the descriptive measures such as the mean and standard deviation.

The following score range was used in evaluating the performance of students in the control and experimental groups before and after the intervention.

Table 1
Scale used in the performance

Rating	Verbal Interpretation
24.01 - 30.00	Very High
18.01 - 24.00	High
12.01 - 18.00	Average
6.01 - 12.00	Low
0.00 - 6.00	Very Low

For problem 3, 4, 5, and 6, which determine the significant difference in the performance of experimental and control groups before and after the intervention, t-test independent sample means was used for problems 3 and 4 while paired t test was used for problems 5 and 6 in this study. The significance level was set at 0.05. SPSS was employed in this study.

Results and Discussion

This chapter deals with the results and discussion of the data that were gathered in connection with the specific problems and hypotheses of this investigation.

Performance of Control and Experimental Groups on Trigonometry Before the Intervention

Table 1
Performance of Control and Experimental Groups on Trigonometry Before the Intervention

Groups	N	Mean	SD	Interpretation
Control	15	7.53	2.00	Low
Experimental	15	7.47	1.06	Low

As reflected in the table, the students from the control (M = 7.53, SD = 2.00) and experimental (M = 7.47, SD = 1.06) groups both obtained a "Low" performance on Trigonometry before intervention. A difference of 0.06 in the mean pretest scores of two groups implies that the two groups are equally matched in terms of the idea of graphs of sine and cosine functions. This result was taken from the students' scores before the intervention.

Performance of Control and Experimental Groups on Trigonometry After the Intervention

Table 2
Performance of Control and Experimental Groups on Trigonometry After the Intervention

Groups	N	Mean	SD	Interpretation
Control	15	13.07	2.89	Average
Experimental	15	17.00	2.36	Average

Table 2 shows that the students from the control (M = 13.07, SD = 2.89) and experimental (M = 17.00, SD = 2.36) groups both obtained an "Average" performance on Trigonometry after intervention.

A difference of 3.93 of the two mean scores implies that the experimental group has improved more compare to the control group.

Difference between the Performance of Control and Experimental groups on Trigonometry before the intervention

Table 3
t-test Result for the difference between the performance of Control and Experimental groups on Trigonometry before the intervention

	Mean	SD	Df	t – ratio	*p*
Control	7.53	2.00	14	1.09	0.915
Experimental	7.47	1.06			

Table 3 reveals that there was no significant difference in control and experimental groups before the intervention [t(14) = 1.09, p = 0.915) at 0.05 level of significance.

It entails that the students in both control and experimental groups were comparable and well matched before the intervention.

Difference between the Performance of Control and Experimental groups on Trigonometry after the intervention

Table 4
t-test Result for the Difference between the performance of Control and Experimental groups on Trigonometry after the intervention

	Mean	SD	Df	t – ratio	*p*
Control	13.07	2.89	14	-4.17*	0.001
Experimental	17.00	2.36			

$^*p < 0.05$

Table 4 shows that there is a significant difference in control and experimental groups after the intervention [t(14) = -4.17, p = 0.001] at 0.05 level of significance.

It is observed that the development of the performance for the experimental group is greater than that of control group. This stresses the effective use of Geometer's Sketchpad and interactive whiteboard on teaching Trigonometry.

Difference between the Performance of Control group on Trigonometry before and after the intervention

Table 5
t-test Result for the Difference between the performance of Control group on Trigonometry before and after the intervention

	Mean	SD	Df	t – ratio	*p*
Control-Pretest	7.53	2.00	14	-5.85*	0.000
Control-Posttest	13.07	2.89			

*$p < 0.05$

Table 5 reveals that there is a significant difference in control group before and after the intervention. t-ratio of the control group before and after the intervention [t(14) = -5.85, p = 0.000] at 0.05 level of significance.

It entails that after teaching graphs of sine and cosine functions using traditional method improves the performance of students in the control group.

Difference between the performance of Experimental group on Trigonometry before and after the intervention

Table 6
t-test Result for the Difference between the performance of Experimental group on Trigonometry before and after the intervention

	Mean	SD	Df	t – ratio	*p*
Experimental-Pretest	7.47	1.06	14	-13.31*	0.000
Experimental-Posttest	17.00	2.36			

*$p < 0.05$

Table 6 reveals that there is a significant difference in experimental group before and after the intervention. t-ratio of the experimental group before and after the intervention [t(14) = -13.31, p = 0.000] at 0.05 level of significance.

Results can be taken to mean that the intervention performed on the experimental group did significantly and positively increase the performance of students. Inclusion of Geometer's Sketchpad and interactive whiteboard on the teaching of Trigonometry has a significant effect on the increase of the performance of students.

Conclusion

Based from the findings of the study, the following conclusions are advanced.

1. Students whose Trigonometry class, specifically graphs of sine and cosine functions, integrated with Geometer's Sketchpad and interactive whiteboard outperformed the students who were exposed to traditional instructional materials in terms of performance. Use of these ICT tools, the Geometer's SketchPad (GSP) and interactive whiteboard is concluded to be effective on teaching Trigonometry.
2. Students whose Trigonometry class integrated with Geometer's Sketchpad and interactive whiteboard are far better than the students who were exposed to traditional instructional materials.
4. Geometer's Sketchpad and interactive whiteboard have a significant effect on the learning engagement of students in Trigonometry and so are the conventional instructional materials.

Recommendations

Based from the findings and conclusions of the study the following recommendations are advanced.

1. Information and Communication Technology tools, specifically Geometer's Sketchpad and interactive whiteboard should be integrated on teaching Trigonometry for it is proven to increase the performance of students. Trainings and workshops should be given to teachers to equip them with knowledge on how to manipulate Geometer's Sketchpad (GSP) and interactive whiteboard in the teaching learning process.
2. The schools should design an ICT strategy using Geometer's Sketchpad and interactive whiteboard that aims at equipping teachers and students with knowledge and skills required for ICT integration.
3. There is need for the schools to invest more in computers and related technology so that the access to ICT tools using Geometer's Sketchpad and interactive whiteboard cannot be limited only in laboratories and library but expand through establishment of ICT resource center's and availing at least one computer in each classroom.
4. ICT training should not be limited to Ms Office suites but rather aim at training students with the appropriate skills to use ICT for their learning.
5. There is a need for further in-depth investigation on teachers' willingness, confidence, motivation, feeling, thinking, belief and the actual practices through classroom observations.

7. Conventional materials are not obsolete. They are still effective in improving the pupils' performance on Trigonometry. While it is encouraged integrating ICT tools specifically Geometer's Sketchpad and interactive whiteboard of 21st century instruction in class
8. A similar study should be conducted in some other schools to confirm or deny the present findings. Likewise, utilizing a different time frame and variables other than what are included in the present study is highly recommended.