The Effect of PowerPoint Instruction on High School Students' Achievement and Motivation to Learn Geometry

Justice Yawson Mensah
Mozano Senior High School, Ghana

Michael Johnson Nabie
University of Education, Winneba, Ghana

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Abstract

This study explored the effect of PowerPoint integration on students' motivation and achievement in less endowed Senior High Schools (SHSs). The study employed the embedded mixed method approach involving quasi-experimental design in which 80 students were randomly selected from two government-assisted Senior High Schools and assigned to control and experimental groups. Teacher-made Pre- and Post-Geometry Achievement Tests (GAT) and semi-structured interviews were used to collect quantitative and qualitative data respectively. During treatment, Information and Communication Technology (ICT) was integrated using PowerPoint presentation to teach the experimental group while the control group was taught by conventional instructional approach. Both pre-GAT and post-GAT were administered to participants and their responds were scored to obtain quantitative data. The results showed that participants in both groups had improved in their post-GAT compared to their pre-GAT. However, it was revealed that study participants in the experimental group achieved better in the post-GAT than those in the control group. It was also revealed that there was no influence of gender in the achievement of the group taught by PPT presentation. Finally, the findings revealed that ICT integration promotes students' motivation. In conclusion, ICT integration approach to teaching and learning mathematics concepts was found to promote students' motivation and increased achievement in mathematics than the conventional instruction. The implications for practice and research are discussed.

Introduction

Geometry is one of the major content areas covered in the SHS mathematics curriculum. In the SHS core mathematics teaching syllabus, geometry forms a considerable amount of the content which include; plane geometry I studied in the first year, mensuration I and circles theorem studied in second year and mensuration II studied in the third year. Mensuration I in the second year content course covers areas such as length of an arc, areas of segments and sectors, areas of quadrilaterals and perimeter of plane figures. The curriculum requires that at the end of the instructional period, mathematics teachers assist students to organize and use spatial

relationships in two or three dimensions, particularly in solving problems. Apart from the knowledge of geometry being necessary in the study of other concepts in mathematics, geometry also helps in developing the spatial reasoning of students and their problem solving skills (Russell, 2018). Geometry serves as pre-requisite to the study of most concepts such as trigonometry in the mathematics curriculum. At the pre-tertiary level of education in Ghana, geometry is found in every part of the mathematics curriculum from kindergarten to SHS.

However, Geometry is one of the difficult concepts in the SHS curriculum which students find difficult to grasp leading to abysmal performance in the West African Senior School Certificate Examination (WASSCE). The West African Examination Council (WAEC) Chief Examiner's Reports (WAEC, 2015; WAEC, 2016; WAEC, 2017; WAEC, 2018) consistently report of students' difficulties and abysmal performance in geometry, particularly the concept of Mensuration. For instance the 2018 WAEC Chief Examiner's Report for Core Mathematics 2 categorically stated that candidates demonstrated weakness as difficulty in "solving problems involving Mensuration" (WAEC, 2018, p. 230). Furthermore, there is empirical evidence to show that many students in Ghana face severe difficulties in solving questions involving geometry concepts (Baffoe & Mereku, 2010). This suggests that SHS students find geometry concepts difficult and mathematics teachers are faced with the challenge of how to present geometry concepts to students to promote conceptual understanding.

Studies (Abreh, Owusu & Amadahe, 2018; Kalhotra, 2013; Sa'ad et al., 2014) into the causes of these abysmal performances of students in mathematics especially their performances in WASSCE in the sub-region, have identified factors such as students' entry grade, inappropriate or poor teaching strategies and lack of motivation as some of the causes. Consequently, mathematics educators are in constant search for innovative ways to teaching mathematics for understanding to improve students' achievement and performance. One of the new ways of teaching mathematics that promote higher achievement, motivate learning and improve performance of students is the integration of ICT in the teaching and learning process (Tay & Mensah-Wonkyi, 2018). ICT integration in teaching and learning of mathematics involves using technology tools to facilitate the delivery of mathematics concepts to make learning easy for students. Several research studies (Eyyam & Yaratan, 2014; Tay & Mensah-Wonkyi, 2018; Zengin, Furkan & Kutluca, 2012) on ICT integration in Mathematics education found positive impact on students' academic achievements. Specifically, ICT integration is found to promote student-centered instruction, collaboration among students, facilitate real-life connection with concepts, improve students' retention, enhance multiple representations of concepts, motivate learning and provide equal opportunities. Consequently, many African countries are investing heavily in ICT integration policies and infrastructure to make the integration possible at all levels of education (Igun, 2013).

From literature, the most widely used theories in the field of ICT integration on students' achievement are the Constructivist theory (Bhagat & Chang, 2015; Tay & Mensah-Wonkyi, 2018; Zengin et al., 2012) and the Engagement theory (Kearsley & Shneiderman, 1999; Marshall, 2007). The two theories share many features in terms of student-centered approach to teaching. This study grounded on the Engagement theory. According to this theory, ICT teaching and learning environment provides the best meaningful and authentic opportunities for student learning and stimulates the kinds of experiences students will face outside the classroom (Kearsley & Shneiderman, 1999). The underlying fundamental idea of the Engagement theory is that students are

meaningfully engaged in learning worthwhile activities through interaction with others in order to understand what they learn (Kearsley & Shneiderman, 1999). The theory shares many features of the constructivist theory which encourages teachers to use practical activities for firsthand experiences that encourage students to actively learn to create their own knowledge, reflect on, and talk about it. It holds the view that in a mathematics classroom "technology can facilitate engagement in ways which are difficult to achieve otherwise" (Marshall, 2007, p.109). Using PowerPoint presentation in teaching mathematics concepts creates a conducive learning environment in which students' can be highly engaged. Technology-enhanced learning environment provides collaborative and meaningful experiences as well as motivation for students to increase their performance in mathematics.

Numerous studies have shown that mathematics performance is strongly related to students' motivation towards mathematics learning (Mullis, Martin, Foy & Arora, 2012; Pantziara & Philippou, 2013; Yu & Singh, 2016). Most studies found that ICT integration in teaching mathematics, in general, have positive impact on students' motivation (Bettice, 2012; Sparrow, Kissane & Hurst, 2010; Wong & Wong, 2017) and achievement (Bhagat & Chang, 2015; Tay & Mensah-Wonkyi, 2018; Zengin, Furkan & Kutluca, 2012). As students are more motivated to learn mathematics when technology is appropriately integrated in the teaching and learning process, Wong and Wong (2017) concluded that technology is a potential tool for motivating students to study mathematics as technology-enhanced learning enhance students' self-efficacy which is a core determinant of student learning. In their quasi-experimental study, Tay and Mensah-Wonkyi (2018) explored the effect of using Geogebra software in teaching and learning of circle theorems on the academic performance of SHS students. The results showed that the experimental group improved significantly in the post-test as compared to their counterparts in the control group taught by the traditional method.

ICT in Mathematics Curriculum Implementation

In Ghana, mathematics teachers are required to make students develop interest in studying mathematics to the higher level in preparation for professions and careers in science, technology, commerce, industry and a variety of work areas (Ministry of Education [MOE], 2010). The Ministry of Education in Ghana recognizes the value of ICT as a tool to diversify instruction and welcomes the integration of ICT in mathematics education at all levels of education as a means of achieving this objective. Consequently, the SHS mathematics curriculum requires mathematics teachers to use technology for problem solving and to engage in mathematical investigations of real life. This is to enable students to develop positive attitudes towards the subject. Furthermore, the ICT integration policies such as the Ghana ICT for Accelerated Development (ICT4AD) Policy (2003), ICT in Education Policy (2008) and ICT in Education (2015) have been revised over the years to meet the state of the times. For instance, in August 2015 the then Minister of Education, Professor Naana Jane Opoku-Agyemang assented to a reviewed 2008 ICT in education policy, which gives the guideline on how ICT can be integrated in education to harness its full potential for national development. The policy stands on three pillars, in which the pillar "ICT as integrated into the teaching and learning" (Ministry of Education [MoE], 2015, p. 18) opens the way for subject teachers to integrate ICT in the national curriculum implementation process. The implication is that, mathematics educators have the responsibility to identify and integrate ICT

tools into their teaching process to improve students' achievement and motivation to learn.

Teacher training and availability of ICT integration facilities in schools are undoubtedly necessary factors for successful integration of ICT in mathematics education. The Mathematics curriculum of teacher training universities in Ghana, whose core mandate is to train mathematics teachers for the SHS level, has ICT integration as a major component of the curriculum. For instance, ICT is a minor course of study for all undergraduate and post-graduate students offering Mathematics education at the University of Education, Winneba (UEW). The first researcher being a product of this university experienced ICT integration at both the undergraduate and post-graduate levels of his study. These ICT courses prepare all beneficiaries to fully integrate ICT into teaching. A tracer study on the products of the department found that about 96% of participants were aware of ICT integration in mathematics education (Asiedu-Addo, Apawu, Owusu-Ansah & Armah, 2016). Research has also shown that, mathematics teachers are the most conversant with ICT integration in educational institutions (Chao, 2015). This implies that mathematics teachers have the potential to employ ICT into the teaching process more than any other subject teachers.

Various governments in Ghana have made efforts to promote ICT integration in the educational sector. For example, the e-readiness assessment report conducted by the Ministry of Education, in 2009, indicated that the number of SHSs having access to computer lab was relatively high as about 87% of all senior high institutions are reported having at least one computer laboratory (Agyei, 2013). Bourne (2017) maintains that current improvement in technology and the role of its tools in society and the digital word today, makes it imperative for curriculum developers to incorporate ICT into teaching and learning in schools. This is more so for mathematics teachers who are called upon to teach mathematics in ways that stimulate learning and built positive attitudes towards learning the subject.

Gender issues in academic achievement have been a critical issue of concern among educators, researchers and stakeholder especially in Mathematics, Science and Technology education. Previous studies on gender and academic achievement in mathematics have identified conflicting views. While most researchers in mathematics education have found male students outperforming their female counterparts (Johnson & Kasmer, 2018; Cobb-Clark & Moschion, 2017) others found no significant difference in the performance of male and female students, especially when student centered instructional methods are employed (Adeleke, 2007; Awofala & Lawani, 2020). Consequently new and innovative ways of teaching that can bridge the gap in performance between male and female students in Mathematics are of grave concern to stakeholders in education. Student-centered instructional approaches such as ICT integration could provide equal opportunities such as equal interactive teaching and learning environment for both male and female students in the mathematics classroom and help mathematics teachers to bridge the achievement gap.

One of the ICT tools of interest in this study is the use of PowerPoint (PPT) presentations in the SHS mathematics curriculum implementation. PowerPoint is an ICT program developed by a software company, Forethought Inc., in 1987 and acquired by Microsoft Cooperation three months after its appearance. The program has become a component of Microsoft office suite developed by Microsoft and first released in 1990.

PowerPoint is widely used in many fields including banking, commerce, education, health and governance to present ideas and concepts to a larger audience using a Liquid Crystal Display (LCD) projector. In education, PowerPoint can be used in the classroom by combining computer and LCD projector to display slides of concepts to students (Gambari, Yusuf & Belogun, 2015). It can also be used to make interactive preparation of concepts by incorporating visual and auditory components to one's presentation, which can be uploaded on virtual platforms for students' consumption. In the education system of Ghana, PowerPoint is used by many educators, especially at the tertiary level, for presentations. Once PowerPoint is installed, it can be used to develop presentations without internet connectivity hence it is a powerful tool that can be used even in remote and underdeveloped areas to make teaching with ICT possible. The use of PowerPoint in instructional delivery, improves students' academic performance, makes learning more interactive and eliminates gender disparity in achievement (Gambari, Yusuf & Belogun, 2015).

Research studies on the use of PowerPoint (PPT) as a tool for teaching and learning mathematics found positive impact on students' achievement and motivation to learn. In Gambari, Yusuf and Belogun (2015) quasi-experimental study of Technical Drawing students, the experimental group outperformed the control group in the Technical Drawing Achievement Test. However, there was no significant difference in the achievements by gender. These results suggest that using PPT presentation as an instructional tool has the potential of improving students' achievement and to bridge the gap in student performance. In spite of the research evidence of the positive impact of PPT on student achievement, there are conflicting views in research concerning its effect on gender performance in mathematics education. While some researchers found significant difference between the performance of males and females with males performing better (Johnson & Kasmer, 2018; Cobb-Clark & Moschion, 2017), others found no difference in their performance (Adeleke, 2007; Awofala & Lawani, 2020). In a longitudinal study of Australian children (Cobb-Clark & Moschion, 2017), it was found that even though the females in the sample scored an average of 9 points higher in reading than the male students, their scores on numeracy showed that the males in the sample scored an average of 12 points higher than their female counterparts. On the other hand, Adeleke (2007) study of Senior High students in Nigeria found no significant difference in the performance between boys and girls when problem solving strategies were used to teach the experimental group . This finding is consistent with a recent quasi experimental by Awofala and Lawani (2020), involving 220 senior secondary students in Nigeria, where there was no significant difference between achievement of males and females in the experimental group who were taught mathematics using differentiated instructional strategy. However there was a slight difference between the achievement of males and females taught with the conventional method. These Nigerian studies are relevant in the Ghanaian context as SHS students in both countries partake in the same WASSCE at the end of their senior high education.

The inconsistencies of literature on students' academic performance in mathematics by gender using ICT necessitates more research on the effect of specific ICT tools on students' achievement. Exploring the effect of specific ICT tools on students' achievement in terms of gender especially in Ghana is thus timely. Literature suggest that previous studies (Bhagat & Chang, 2015; Tay & Mensah-Wonkyi, 2018; Zengin, Furkan & Kutluca, 2012) mostly investigated the effect of Geogebra, Geometers' sketch pad and other interactive geometry software on students' academic achievement in mathematics. Literature on the effect of PPT

presentations on students' achievement by gender in Ghana is scarce or non-existent. The current study of PowerPoint presentations on SHS students' mathematics achievement by gender fills this void.

Problem Statement

The SHS mathematics curriculum requires mathematics teachers to integrate ICT into their lesson delivery to develop students' interest and make problem solving and investigation meaningful to learners (MoE, 2010). From literature, there are many ICT tools that can be integrated in teaching mathematics to create meaningful learning environment and to motivate learners develop positive attitude toward the subject. However, research evidence (Agyei, 2013; Agyemang & Mereku, 2015; Amanor, 2014; Dziekpor, 2014; Mensah, 2017) indicate that many mathematics teachers in Ghana do not integrate ICT in their lesson delivery contrary to curriculum requirement and students continue to perform abysmally in their sub-regional examinations. Teachers' failure to integrate ICT into mathematics education may be due to lack of confidence in utilising ICT in curriculum delivery (Agyei, 2013; Buabeng-Andoh, 2012), unawareness of the potentials of ICT in their teaching (Ndebalima, 2014) or doubt in integrating potential of ICT in improving the academic performance and motivation of students in learning mathematics (Buabeng-Andoh, 2012). Besides, for teachers to integrate technology into their teaching, they must be sure that the technology can bring about improved teaching and learning moments, for improved outcomes. Consequently, the study was designed to find answers to the following questions:

1. What is the effect of ICT integration using PowerPoint instruction on SHS students' achievement in mathematics?
2. Does gender influence SHS students' academic achievement in mathematics?
3. In what ways do ICT integration using PowerPoint motivate students to study mathematics?

Method

Design

The study employed the embedded mixed method approach with quasi-experimental group design as a strategy of enquiry based on our understanding that no single data set is sufficient to answer all the research questions that are different in nature (Creswell, 2012). The Quasi-experimental group design is diagrammatically presented below (see Figure 1).

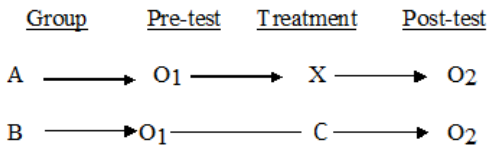

Figure 1. Quasi-experimental Group Design Structure

The pre-test O_1 was administered to both the experimental (A) and control (B) groups to determine the entry point of participants before treatment. The experimental group received ICT integrated lessons (X) while the

control group underwent conventional instruction (C) after which a post-test (O_2) was administered to both groups to measure the student achievement resulting from the different teaching methods (Creswell, 2012).

Study Group and Setting

The study group consisted of all 2018/2019 second year (SHS2) students in less endowed government assisted SHSs in the Gomoa West District in the Central Region of Ghana. The two out of the four government assisted SHSs in the district, coded as School A and School B, were purposively selected based on their common status and academic achievement for the study. Students in these schools, just like in any other SHS in Ghana, were admitted through the Computerized School Selection Placement System (CSSPS). Generally, students in these schools (less endowed) are mostly from low socio-economic backgrounds with low entry grades.

Participants and Sampling Technique

Systematic random sampling technique was used to select 40 participants each from schools A and B and assigned as Experimental (school A) and Control (school B) groups. By this sampling technique, the required number is selected from the sample depending on the sample size relative to the number in the population (Descombe, 2010). The systematic sampling technique enabled the researchers to select samples from each class using their class registers (roster) or lists without disrupting the contact hours of students. As a result, students selected from each school were representative of the population of the school (see Tables 1a and 1b).

Table 1a. Samples from Academic Programs and Streams in School A

Program of Study	Number of Streams	Number of Students	Number selected
General Arts	7	291	19
Business	2	112	7
General Science	1	23	2
Home Economics	2	122	8
Agricultural Science	1	60	4
Total	**13**	**608**	**40**

Table 1b. Samples from Academic Programs and Streams in School B

Program of Study	Number of Streams	Number of Students	Number selected
General Arts	5	237	16
Business	2	89	6
General Science	1	28	2
Home Economics	2	104	8
Visual Arts	1	49	4
Agricultural Science	1	51	4
Total	**12**	**558**	**40**

From Table 1a, the number of students offering General Arts was 291 out of a total population of 608. By the systematic sampling technique, the required sample (s) was calculated using the formula proposed by Descombe (2010). Hence 19 students were selected from that academic program (General Arts). These 19 participants were then selected from the seven streams offering General Arts in proportion to the number of students in each stream.

Similarly, seven (7) participants were selected from 112 students offering Business etc. The same procedure was applied to the selection of participants from school B as shown in Table 1b. In all, the study participants consist of 80 SHS2 students made up of 40 participants (19 males and 21 females) from school A and 40 participants from school B (16 males and 24 females). Furthermore, four (4) students were selected randomly from the experimental group to illicit their views on how they were motivated by the method of ICT integration in teaching after they had written the post-test. Random selection was used because the sample involved was relatively small (40 participants) and to give each of the 40 participants equal opportunity of being selected.

Instruments

Two instruments, Geometry Achievement Test (GAT) and a semi-structured interview guide were used to collect data from the participants. The GAT provided the opportunity to measure the level of attainment of participants in Area and Perimeter of plane shapes over the period while the semi-structured interview enable the researchers to better understand and explore views of participants taught with PPT on how this method motivated them to study during treatment,

Geometry Achievement Test (GAT)

Downie (1961) as cited in Rani and Aisha (2017) defined mathematics achievement test as any written activity "that measures the attainments or accomplishments of an individual after a period of training or learning" (p. 651). To gather quantitative data, the researchers used Geometry Achievement Test (GAT) which contains questions involving Mensuration 1 concept. From literature, GAT is widely used in the field of mathematics to measure the attainment of students in many effect studies (Bhagat & Chang, 2015; Tay & Mensah-Wonkyi, 2018; Armah, Cofie & Okpoti, 2017) in geometry.

Two versions of the GAT (one administered as pre-test and the other administered as post-test) were developed basically to eliminate biasness from the scores. Both versions of the GAT measured the same construct. To ensure that the items included in the tests are in the Ghanaian context and measure the objectives in the curriculum, the GAT was developed by the researchers themselves on the concept of Mensuration 1. The GAT was in two sections; Sections A and B, containing 23 items measuring the two profile dimensions; Knowledge and Understanding (KU) and Application of Knowledge (AK) prescribed by the teaching syllabus. In all, section A contained 20 multiple choice items while section B contained three subjective questions of greater difficulty measuring all the objectives on Mensuration I (see Table 2).

Table 2. Structure of GAT Pre and Post-tests

Objective	**Number of items/profile Dimension**	
	Multiple choice (KU)	**Subjective (AK)**
Find the length of an arc of a circle	2	0
Calculate the perimeter of plane figures.	10	1
Calculate the areas of sectors and segments	6	1
Find the areas of quadrilaterals	2	1
Total	**20**	**3**

Semi-structured Interview

To gather qualitative data, the researchers used open-ended semi-structured interview guide, which outlined the topics to be discussed with participants to solicit their responses on how ICT integration motivate them during treatment. To elicit participants views on the motivational benefits of PowerPoint instruction, the following questions were asked; what difference did ICT integration make in your learning process as compared to your teachers' method?; How did the PowerPoint instruction motivated you to study Mathematics?; If you are taught with this method throughout the rest of your time in school, would you have the zeal to study mathematics? Why? Would you prefer that this method of ICT integration is employed by mathematics teachers in your school? Why? According to McLeod (2014), semi-structured interviews (unlike structured) have the advantage of generating qualitative data through the use of open-ended questions which allow the participants have in-depth conversation with the interviewer.

Validity and Reliability of Instruments

The GAT

To ensure the validity of the GAT, the SHS mathematics syllabus and approved textbooks by the Ghana Education Service (GES) were consulted in the test construction. This was followed by consultation with experts in the field of mathematics education including three lecturers at the department of Mathematics Education of the University of Education, Winneba (UEW), two Master of Philosophy in Mathematics Education students of UEW two Ghana Education Service (GES) SHS mathematics teachers to ensure content validity. Furthermore, the GAT was piloted on 20 students selected from a similar school in the district mainly to detect lack of clarity in the phrasing of the questions, and to give indication for the appropriateness of time needed for its completion.

The researchers employed parallel forms reliability test approach to examine the reliability of the two versions of the GAT. The first version (pre-test) was administered to an intact SHS 2 class of 42 students in one of the selected schools and after three days, the second version (Post-test) was administered to the same students. Participants' responses for both versions of the GAT were scored and correlated using Pearson correlation coefficient (r) used in reliability testing in SPSS. The r value of 0.843 obtained indicates a good degree of reliability of the GAT.

Semi-structured Interview

The semi-structured interview guide contained four topical items intended to solicit views of students on how PowerPoint instruction motivated them during treatment. The interview guide outlined only the major topical areas (their experience with PowerPoint instruction, how they were motivated, their preference of PowerPoint instruction to the conventional method and suggestions for the adoption of the PowerPoint instructional method) to ask participants and probes were made when the need arose. The questions on the interview guide were verified by the second researcher who is a senior lecturer at the department of Mathematics Education of UEW to ensure that they were appropriate.

Data Collection Procedures

Administration and Grading of GAT

The pre-test and post-test were both administered under same conditions before and after treatment respectively. The pre-test was administered in April 2019, three weeks after SHS 2 students resumed for the second semester of 2018/2019 academic year while the post-test was administered in June 2019, immediately after treatment. Each test lasted for an hour after which the participants' responses were collected for grading.

The GAT was scored by employing adapted WASSCE marking procedures. Each correct response of the 20-items of the multiple-choice test was awarded one (1) mark. Each written response to the subjective part of the GAT was scored by considering the suitability of formulas and diagrams, appropriateness of the methods employed and the correctness of final answer. An M mark was awarded to methods, a B mark for accuracy not followed by method mark and an A mark for accuracy of the final answer followed by method mark. The total marks awarded for the written response section was 30 points. Hence a participant can obtain a minimum of zero (0) and a maximum of fifty (50) points for both sections of the GAT.

Semi-structured Interview

The interviews were conducted after treatment. Due to the busy nature of participants, each interview took a minimum duration of 20 minutes and a maximum duration of 30 minutes. The interviews were recorded with an electronic device and notes were also kept as a back-up. To ensure the trustworthiness of the interview data, member checking was done to ensure that the researchers reported exactly the views of respondents during the interview. Participants were contacted for clarifications on certain points they made before making conclusions to reduce the threat of respondent bias. Furthermore, the researchers kept and referred to records of the interview to ensure the true presentation of participants' voices.

Treatment

The treatment took a total of four weeks. During these four weeks, both the experimental and control groups were taken through six lessons involving Mensuration 1 concept. The conventional method of teaching, where

marker board and textbook examples are used in the teaching process, was applied to the control group while ICT integration (projected PowerPoint lessons) approach was applied to the experimental group. The PowerPoint lessons for the experimental group were prepared by the researchers using Microsoft office and several mathematics softwares such as Geogebra, Microsoft Paint, Math type, and Geometers Sketch Pad. The lessons for the experimental group were also designed in accordance with fundamental principles of the Engagement Theory (ET). The only difference between the teaching strategies was that ICT was integrated into the teaching and learning process of the experimental group while the conventional method of teaching mathematics was applied to the control group.

Data Analysis

Data collected involved both quantitative and qualitative data. Quantitative data collected from the scores of the GAT were analyzed by employing both descriptive and inferential statistics using Statistical Package for Social Sciences (SPSS) version 21.0. Measures of central tendencies and measures of dispersion were employed to understand how one score compares with another while independent samples t-test were run to compare for any significant difference in the scores of the experimental and control groups at 95% confidence level. Recorded data generated from the one-on-one interviews were analyzed using thematic analysis. That is recorded audio from the interviews granted to participants were analyzed based on the topical areas contained in the interview guide. The researcher reported all events that emanated from the interviews by describing and interpreting the outcomes of the recorded audios.

Results

The results are presented based on the research questions that guided the study. The quantitative data generated from the GAT was analyzed using both descriptive and inferential statistics. The qualitative data generated from interviews was analyzed using thematic analysis.

Quantitative Data

Research Question One

Research question one focused on the effectiveness of ICT integration using PPT presentation in teaching and learning in contrast to conventional instruction on students' achievement in geometry. The pre-tests for both groups were analyzed to ascertain whether there was any significant difference in achievement between the two groups before treatment is implemented. The descriptive statistics (see Table 3) of the pre-treatment achievement scores of the two groups is presented below.

Table 3. Descriptive Statistics of GAT Pre-test Scores

Group	N	Mean	Stand Dev.	Maximum	Minimum
Experimental (A)	40	13.83	6.77	27.00	4.00
Control (B)	40	13.38	7.25	24.00	3.00

From Table 3, the results showed a mean score of 13.83 and 13.38 respectively for the experimental and control groups with a mean difference of 0.45. The minimum score for the experimental group was 4 while that of the control group was 3. Also, the experimental and control groups scored a maximum mark of 27 and 25 respectively. To test whether the difference in the mean scores was statistically significant, independent samples t-test (see Table 4) was performed at 95% confidence interval.

Table 4. Independent Samples T-test of Pre-test Results

Group	**N**	**Mean**	**Std. Dev.**	**t-value**	**df**	**p-value**
Experimental (A)	40	13.83	6.77	0.287	78	0.775
Control (B)	40	13.38	7.25			

The results from the independent samples t-test (Table 4) performed on the pre-test scores of the two independent groups revealed that there was no statistically significant difference between the experimental group $(M = 13.83, SD = 6.77)$ and control group $(M = 13.38, SD = 7.25)$ conditions $t = 0.287$; $p = 0.775 > 0.05$. This result suggests that both the experimental and control groups were at the same level in terms of conceptual understanding of the concept of Mensuration (perimeter and area of plane figures) before treatment.

To answer research question one, the following hypothesis was formulated and independent samples t-test (see Table 5) was conducted at 95% confidence interval, to establish if there was statistically significant difference in the post-test scores between the group taught with ICT (school A – experimental) and the group taught with the conventional method (school B - control).

Hypothesis one. H_0 **:** There is statistically no difference between ICT integration using PowerPoint presentation and conventional instructional methods of teaching on SHS students' achievement in geometry.

Table 5. Independent Samples t-test of GAT Post-test Scores

Group	**N**	**Mean**	**Std. Dev.**	**t-value**	**df**	**p-value**	**Eta Squared**
Experimental (A)	40	23.70	8.47	2.885	78	0.005	0.096
Control (B)	40	18.50	7.63				

The results of the independent samples t-test as shown in Table 5 above, revealed that there was statistically significant difference between the experimental group $(M = 23.70, SD = 8.47)$ and control group $(M = 18.50, SD = 7.63)$ conditions; $t = 2.888$; $p = 0.005 < 0.05$. This result suggests that the experimental group which was taught by ICT integration using PPT presentation outperformed the control group taught by the conventional method. The eta squared value of 0.096 indicates a medium effect size (Cohen 1988) which implies that 9.6% of the variance in the post-test scores of the GAT (dependent variable) was elucidated by the teaching method (independent variable). Hence, the results showed that ICT integration method using PPT presentation was effective when compared with the conventional instructional method.

Research Question Two

Research question two sought to find out whether gender has any influence on SHS students' academic performance when ICT is integrated into the instructional delivery using PPT presentation. To answer this question, the following hypothesis was formulated and tested at 95% confidence interval**.**

Hypothesis two. H_0 : There is a significant difference between the performance of male and female SHS students in mathematics.

The post-test scores of the group taught with ICT integration were analyzed based on gender. The descriptive statistics of the post-treatment achievement scores is presented below (see Table 6).

Table 6. Descriptive Statistics of GAT Post-test Scores based on Gender

Treatment	Gender	N	Mean	Stand Dev.	Maximum	Minimum
PPT presentation	Male	19	23.21	8.75	40	10
	Female	21	23.10	8.27	37	10
	Total	**40**	**23.16**	**8.51**		
Conventional	Male	16	23.75	7.42	33	8
	Female	24	17.38	7.38	30	7
	Total	**40**	**20.56**	**7.40**		

From Table 6, the male students, taught mathematics with ICT integration approach, had a mean sore of 23.21 ($SD = 8.75$) while their female students had a mean score of 23.10 ($SD = 8.27$) with a mean difference of 0.11. Meanwhile the male students, taught with the conventional approach, had a mean sore of 23.75 ($SD = 7.42$) while their female students had a mean score of 17.38 ($SD = 7.38$) with a mean difference of 6.37. The mean differences suggest that male and female students taught mathematics using PPT presentation perform at the same level (Mean difference $= 0.11$) while male students taught mathematics using the conventional method perform better than their female counterparts (Mean difference $= 6.37$) . To test the hypothesis, an independent samples t-test (see Table 7) was performed at 95% confidence interval using the post-treatment achievement scores of male and female students from both groups.

Table 7. Independent samples t-test of Post-test Scores based on Gender

Treatment	Gender	N	Mean	Stand Dev.	t-value	df	p-value
PPT presentation	Male	19	23.21	8.75	0.043	38	0.966
	Female	21	23.10	8.27			
	Total	**40**	**23.16**	**8.51**			
Conventional	Male	16	23.75	7.42	2.672	38	0.011
	Female	24	17.38	7.38			
	Total	**40**	**20.56**	**7.40**			

The results of the independent samples t-test as illustrated in Table 7, revealed that there was statistically no significant difference between the achievement of male students ($M = 23.21, SD = 8.75$) and female students ($M = 23.10, SD = 8.27$) taught mathematics using PPT presentation, conditions; $t\,(38) = 0.043, p = 0.966 > 0.05$. Meanwhile the results revealed a statistical significant difference between the achievement of male students ($M = 23.75, SD = 7.42$) and female students ($M = 17.38, SD = 7.38$) taught mathematics using the conventional approach, conditions; $t\,(38) = 2.672, p = 0.011 < 0.05$. This showed that male students taught mathematics using the conventional instruction performed better than their female counterparts taught with the same method. Furthermore, the results also showed that male students taught mathematics with the ICT integration approach performed at the same level like their female counterparts taught with the same method. The results indicated the potential for ICT integration to bridge the achievement gap between boys and girls in Mathematics.

Qualitative Data

Research Question Three

Research question three sought to find out ways in which ICT integration in teaching and learning mathematics motivate students to study mathematics. To answer this research question, four students from the experimental group, coded S01, S02, S03 and S04 were interviewed to elicit their views on how they were motivated by the method of ICT integration using PPT presentation in teaching. The responses of the interviewees were thematically analyzed based on the topical questions in the semi-structured interview guide prepared by the researchers. All the respondents stated that their mathematics teachers taught them by the conventional approach.

When asked the question, what difference did ICT integration make in your learning process as compared to your teachers' method? S03 remarked that, "*when I see something projected I am able to remember as compared to you telling me what it is. So looking at the picture I am able to get it rather than you telling me".* The response of this student suggests that the visual presentation made possible by the integration of ICT is fun as supported by S02 when he said that:

> *Using ICT is fun because we don't write plenty notes and always most of the concepts are practical and we are watching as if we are watching movie so it's easy for you to understand than to write notes and after that you have to go and sit down and study it again*.

When S01 was asked how the ICT integration method motivated him, S01 recalled his own experiences learning mathematics during the treatment stage saying, *previously during preps, [it's very very] rare, I don't learn mathematics but now I learn it almost every day*. When he was asked how ICT integration motivated him, he sat in an upright position and said:

> *The lessons we had with you were so practical that even if you are sleeping and someone call you from your sleep and ask you a question on what we have done you can recall easily. The way the images were displayed … for example when you were teaching us perimeter, [you can see a student going round the field] to show that perimeter is the total distance around a shape.*

Responding to the same question, S03 remarked that, *I learn a lot from watching and practicals than reading notes and your teaching with ICT is helping me to achieve that.* S04 in his answer to the same question remarked in his response that:

> *ICT has motivated me because I understand [when using the ICT to teach core math] I understand better than the teacher coming to the class [to come and teach]. Also when you started teaching us with ICT I learn core maths three times in a week but first I only learn core maths when we are going to write a test or examination.*

These responses showed that the students were motivated to study mathematics because of the practicality of lessons that ICT integration promotes. Specifically, the interview results showed that PowerPoint presentation of the concept created an atmosphere similar to that of a movie show and full of practical activities and real-life connections. The results from the post-test provided a further evidence that participants who were taught using the ICT integration approach have improved significantly from their pre-test to post-test.

Discussion

The findings indicated that ICT integration as a mode of instruction provided students with new learning experiences in mathematics, particularly in teaching geometry concepts. These learning experiences included: enabling students visualize the concepts being taught, seeing real life images of concepts and relating them to their environment and giving students the opportunity to work in groups and interact with each other by manipulating several exercises installed on the computers. This offered the participants new and interactive ways of learning mathematics concepts in a very conducive and inspired environment provided by technology.

Furthermore, findings from the independent samples t-test showed a statistically significant difference between the achievement in the post-tests of participants who were exposed to ICT integration approach and those exposed to the conventional approach. However, the eta squared value of 0.096 showed a medium effect size (Cohen 1988). This may be as a result of the similarities that exist between these two less endowed schools in terms of students' entry grade, socio-economic status, school facilities and parents/guardians educational level. The findings show that ICT integration using PPT presentation in teaching mathematics is more effective than the conventional instruction. ICT integration instruction was found to be more effective than the conventional instruction in this study because the method: was student-centered; provided multi-modal way of communicating concepts to students; connected the concept to real-life situations and provided a conducive teaching and learning environment powered by technology. These finding strongly agree with the studies by (Bhagat & Chang, 2015; Tay & Mensah-Wonkyi, 2018; Zengin, Furkan & Kutluca ,2012) who in separate studies found students who were exposed to ICT integration as a teaching strategy, improved significantly in the post-test as compared to those exposed to the conventional method. ICT integration instruction using PPT presentation was also found to eliminate the gap between achievement of male and female students in mathematics. This finding is supported by earlier findings (Adeleke, 2007; Awofala, 2017; Awofala & Lawani, 2020; Meggiolaro, 2017) which in separate studies, using student-centered instructional approaches, found no significant influence of gender on the academic achievement of students in mathematics. This finding shows

that integration of ICT into teaching mathematics concepts, specifically by using PPT presentations, could put all students on the same level to study mathematics and eliminate male dominance in the performance of mathematics. However, the findings also revealed that there was statistically significant difference between the achievement of male and female students, in favor of male students, taught by the conventional approach in mathematics. This is in line with previous studies (Cobb-Clark & Moschion, 2017; Xhomara, 2018) who found disparities in the performance of male and female students in mathematics in favour of male students.

Students' views on how ICT integration methods of teaching motivate them were also investigated in this study and the findings indicated that ICT integration instruction motivated the students to study mathematics through its multiple representation capabilities and practical nature. These findings resonate strongly with the studies conducted by many researchers (Bettice, 2012; Passey & Rogers, 2004; Sparrow, Kissane & Hurst, 2010; Wong & Wong, 2017) in separate studies found that ICT integration in mathematics education promotes motivation of students through its practical nature and visual presentation of concepts.

Conclusion

The main contribution of this study is new knowledge about the effects of ICT integration, particularly PPT presentations on SHS students' motivation and academic achievement in less endowed schools. It is obvious that ICT integration into teaching mathematics in general and into Geometry specifically has positive impact on high school students' motivation and achievement. It was found in this study that participants taught with the method where ICT was integrated into their lessons significantly outperformed their counterparts taught the same lesson by conventional instruction. Furthermore, it was revealed that there was no significant difference between the achievement of male and female students taught mathematics using PPT presentation. ICT integration was found as a potential tool to bridge the achievement gap between boys and girls. Meanwhile, male students taught by the conventional instruction outperformed their female counterparts taught by the same method. Finally, the findings also revealed that ICT integration into teaching mathematics promotes students' motivation through the following ways; it makes the learning process practical, it engages students in the teaching process, it presents concepts in multi-dimensional way, it promotes real-life connection with concepts, it promotes retention through its visualizing qualities, it brings the students' immediate environment closer to the classroom and it creates a very conducive student-centered teaching and learning environment.

Recommendations

It was established in previous studies that mathematics teachers are conversant with ICT integration (Asiedu-Addo, et al., 2016; Chao, 2015) and most SHSs have at least one computer laboratory (MoE, 2009 cited in Agyei, 2013). Consequently, the implication for mathematics teachers is that ICT integration can be used to gain students' attention especially in schools where students' interest in mathematics is low. Also, this teaching method can be used in low achieving schools, most of which are less endowed, to improve performance. Furthermore, the government through the Ghana Education Service (GES) should try as much as possible to harness these benefits of ICT integration in teaching mathematics. The good news is that ICT integration

methods such as PowerPoint presentations require at least a computer and an LCD projector. It is therefore recommended that GES should consider establishing a mathematics laboratory in all SHSs in the country furnished with at least a computer and an LCD projector to make teaching with this method possible. It is further recommended that stakeholders in education at the SHS level should consider organizing Seminars/workshops intermittently for Mathematics teachers on the use of appropriate technological tools such as PowerPoint presentations in teaching and learning mathematics concepts, especially geometry, by experts in the field.

This study was limited to one district (Gomoa West district) and one concept in Mathematics (Area and perimeter of plane shapes). Further studies can be replicated in other parts of the country as well as in other concepts in mathematics in order to understand the general picture. Also, the duration of the study was also a limitation. If SHS students are exposed to ICT integration method of teaching throughout their stay in school, its impact could be measured in their final examination (WASSCE), so this study can be replicated in this span of time. In this study, it was revealed that gender has no significant influence on the achievement of SHS students in Mathematics when PPT presentation was used. It is recommended that other ICT tools could be used in further studies to get the general picture. Also, group interaction within gender influence on academic achievement in mathematics is another area worth investigating.

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Author Information

Justice Yawson Mensah

https://orcid.org/0000-0002-9813-487X

Mozano Senior High School

P. O. Box GE 20, Gomoa Eshiem

Ghana

Contact e-mail: *jymensah2017@gmail.com*

Michael J. Nabie

https://orcid.org/0000-0002-1801-1862

University of Education, Winneba

P. O. Box 21, Winneba

Ghana