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The Use of PowerPoint Presentation in Mathematics Education: A Comparative Study of Endowed and Less Endowed Schools in Ghana

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Abstract

This study investigated the effect of PowerPoint (PPT) instruction on achievement in two categories of SHSs in Ghana; less endowed and endowed schools, using a pre-test post-test quasi-experimental design. The sample consisted of 80 randomly selected students from two purposively selected government-assisted SHSs. The instruments used for data collection were two similar adopted Pre- and Post-Geometry Achievement Tests (GAT). During treatment, PPT presentations were used to teach both groups, some selected topics in geometry. Analysis of pre-GAT scores of both groups revealed that the participants in the endowed group significantly outperformed their counterparts in the less endowed group by a mean difference of 9.20. The results from the independent samples t-test conducted also showed that the endowed group significantly outperformed the less endowed group in the post-GAT. However, the results showed that the mean difference recorded between the two groups in the pre-GAT was significantly reduced to 6.58 in the post-GAT. Finally, the findings revealed no influence of gender in the achievement of both groups when PPT presentation was used in the instructional delivery. In conclusion, the use of PPT presentations in mathematics was found to increase SHS students' achievement in mathematics and also found to be a good instructional approach that can be employed to narrow the gap in achievement levels between endowed and less endowed SHSs. The implications for practice and research are discussed.

Keywords: PPT Presentation, Endowed, Less endowed, Mathematics, Achievement, Gender

1. Introduction

A lot of discrepancies exist between endowed and less endowed SHSs in Ghana. Notable among them include infrastructure, teaching and learning materials, achievement level, setting, parents' educational level and occupation as well as students' entry grade. Moreover, most endowed schools in Ghana are located in cities or towns and blessed with a lot of facilities necessary for teaching and learning unlike the less endowed schools which are mostly located in semi-urban or rural communities and lack basic facilities. Even though students in both categories are placed from the Junior High School (JHS) using the same process, generally, students paced in less endowed schools have low entry characteristics and are mostly from poor homes than their counterparts who are placed in endowed schools. Yet

there is no differentiated curriculum for these two different groups (Ministry of Education [MoE], 2010). Students in both endowed and less endowed SHSs in Ghana are supposed to cover the same curriculum content and sit for the same final examination at the end of their SHS education (MoE, 2010). Consequently, statistics from the West African Examination council (WAEC) indicate that students from these less endowed schools perform abysmally in their final examination (West African Senior School Certificate examination – WASSCE) as compared to those in endowed schools.

Core mathematics is one of the core subjects at the SHS level that students in both categories of schools need to study and write the same final examination. Furthermore, students from both categories are expected to obtain a grade not lower than C6 (A1 – C6) in core mathematics in order to get admission into any tertiary institution in the country or beyond. The Mathematics syllabus for SHS is based on the premise that "all students can learn mathematics and that all need to learn mathematics" (MoE, 2010. p. ii). However, research has shown that students find core mathematics a very difficult subjects and have difficulties in understanding various mathematical concepts (Mensah-Wonkyi & Adu, 2016). Moreover, statistics from WAEC indicate that students' performance in core mathematics is abysmally low on yearly basis in WASSCE hence, the need to find alternative and effective ways of teaching mathematics that are capable of motivating students, improve achievement, and provide equal opportunities for all students from endowed and less endowed schools.

One strategy of teaching mathematics found to improve students' achievement, and motivate students in both endowed and less endowed schools is the integration of Information and Communication Technology – ICT – (Tay and Mensah-Wonkyi, 2018). More so, many research studies (Ganesan & Kwan, 2020; Mensah & Nabie, 2021; Tay & Mensah-Wonkyi, 2018) in the area of ICT integration in mathematics instructional delivery, affirm that ICT integration motivates students and improve their achievement in mathematics. In the 21st century, the use of ICT in mathematics education is no more considered a thing of the developed countries. Ghana and many other developing countries are determined to match the international standards the use of technology in education (Agyei, 2013)

ICT integration into teaching and learning of mathematics at the SHS level is a curriculum requirement. SHS mathematics teachers are required by the curriculum to help students to use technology for problem solving and investigations of real-life situations. However, the level of ICT integration into teaching and learning of Mathematics at the SHS level is low despite curriculum requirement, availability of ICT laboratories in most SHS (MoE, 2015), and the ability of mathematics teachers to integrate ICT into teaching (Asiedu-Addo et al., 2016). Using PowerPoint presentations (PPT) in mathematics classrooms is one way in which mathematics teachers can integrate ICT into instructional delivery.

Developed by Forethought Inc. in 1987 and acquired by Microsoft Cooperation three months after its appearance, PowerPoint software has become a powerful presentation tool used in educational institutions all over the world. PPT can be used to reach a lot of audiences by providing slides of concepts using a personal computer and a Liquid Crystal Display (LCD) projector. Since its development, the program has been a component of Microsoft office suite developed and released by Microsoft in 1990 and has since been widely used in education.

Furthermore, in order to integrate PPT into instructional delivery, teachers do not need to go through any advanced training as most teacher training institutions equip their prospective teachers with the skill of using PPT in teaching. One advantage of PPT is that, once it is installed on a computer, it can be used to prepare slides of concepts without internet connectivity hence it can be used even in remote areas which have poor or no internet facilities. Using PPT in instructional delivery has been found to make learning more interactive, improved students' academic performance, and eliminate gender disparity in achievement (Gambari et al., 2015; Mensah & Nabie, 2021).

This study sought to explore the comparative effects of using PPT presentation on less endowed and endowed SHS students' achievement in Geometry. The study also explored the effects of PPT on SHS students' achievement in geometry in terms of gender. Consequently, the following research questions guided the study;

1. What is the effect of using PPT presentation on the achievement of SHS students in Geometry?
2. Is there any significant difference in the academic achievement of endowed and less endowed SHS students in Geometry when PPT is integrated in teaching?
3. Does gender influence the academic achievement of endowed and less endowed SHS students in Geometry when PPT is employed in teaching?

2. Theoretical Framework

Engagement theory is used as the theoretical base underpinning this study. Previous studies, (Kearsley & Shneiderman, 1999; Marshall, 2007; Mensah & Nabie, 2021), on technology integration in education used the Engagement theory as their theoretical bases. Engagement Theory (ET) is a framework for technology-based teaching, whose underlying idea is that students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks (Kearsley & Shneiderman, 1999). The ET has many thing in common with the constructivist theory in terms of student's engagement in a collaborative environment. The ET encourages teachers to use practical activities to encourage students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about it. Unlike the constructivist, the proponents of the engagement theory believe that technology can promote him engagement of students better than the other means of engagement (Marshall, 2007). Engagement theory promotes students' activities that involve cognitive processes and students are motivated to learn due to the conducive learning atmosphere that technology creates. According to Kearsley and Shneiderman (1999), the environment created by ICT integration is the best teaching and learning environment that students can excel through genuine focused experiences to enable function outside the classroom and in real life.

Engagement Theory comprises three components as illustrated by (Kearsley & Shneiderman, 1999):

1. Relating: learning activities that occur in a group context (collaborative work). This forces students to clarify and verbalize their problems to facilitate solutions. It emphasizes teamwork and communication
2. Creating: Learning activities that are project based. Students are involved in the development of their assessment tasks and apply ideas in specific context. It emphasizes creativity and purpose.
3. Donating: learning activities that have an outside or authentic focus. Students make useful contributions during task. This motivates students because they are occupied with activities throughout.

Engagement theory underpins this study because of its emphasis on providing a collaborative and meaningful experience in a technology-enhanced learning environment. The use of PowerPoint presentations could create such experiences for students. The theory was also used because it states explicitly that technology should be integrated in instructional delivery to promote students' engagement. In this study, students' engagement was promoted by integrating PowerPoint presentation (technology) into the teaching and learning of geometry concepts.

3. Methodology

3.1. Design

This study employed pretest-posttest experimental group design where two different groups were randomly selected for treatment as a strategy of enquiry. The design of the study is presented in Figure 1 below.

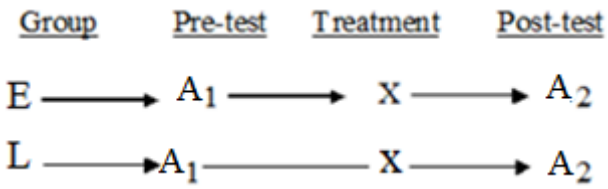

Fig. 1: Structure of the Design

The design in Figure 1 is an adapted form of Creswell (2012) format for quasi-experimental research. That is, the pre-test (A_1) was administered to both groups (schools E and L) to determine the entry point of participants before treatment. Both groups received instructions, where PowerPoint was integrated, (X) after which a post-test (A_2) was administered to both groups to measure their level of attainment resulting from the treatment.

3.2. Population and Sampling

The population included of all form 2 (SHS 2) students in the 2021/2022 academic year of four-government assisted SHSs in the Gomoa West district of the Central region of Ghana. The accessible population comprised of one endowed and one less endowed SHSs, selected purposively from the four schools in the district. The two schools were purposively selected based on their characteristics in achieving the purpose of the study. That is, school E is the only

endowed school in the district while school L shares same characteristics with other less endowed schools in the district.

A sample of 40 participants each, from schools E and L, were selected using the systematic random sampling technique. Descombe (2010) described this sampling technique as a method where the researcher is able to select the required number from the sample depending on the size of the sample in relation to the number in the research population. This sampling technique enabled us to select the participants from each class using their class records or lists without disrupting the contact hours of students. Tables 1a and 1b show how participants were selected from each school using the systematic sampling technique.

Table 1a: Selected participants from School E

Program of Study	Number of Streams	Number of Students	Number of students selected
General Arts	6	302	19
Business	2	126	8
General Science	1	56	3
Home Economics	2	123	8
Visual Arts	1	34	2
Total	12	641	40

Table 1b: Selected Participants from School L

Program of Study	Number of Streams	Number of Students	Number of students selected
General Arts	6	496	22
Business	3	95	4
General Science	1	52	2
Home Economics	3	244	10
Agricultural Science	2	43	2
Total	15	930	40

As shown in Tables 1a and 1b, the sample consists of 80 second year students, selected randomly from all the academic programs and streams of the two schools. In all, 40 students each were selected from the endowed school (school E) and the less endowed school (school L).

3.3. Instruments

Two similar Geometry Achievement Tests (GATs) were adopted from the study of Mensah and Nabie (2021) as instruments for data collection. The pre-GAT provided the opportunity to measure the entry point of participants in both groups before treatment was

implemented while the post-GAT was used to measure participants' level of attainment in the concepts of plane shapes after treatment.

3.3.1. The Geometry Achievement Test (GAT)

The participants' entry characteristics and level of attainment after treatment was completed were measured using two similar GATs adopted from (Mensah & Nabie, 2021). The GAT contain questions involving concepts on area and perimeter of plane shapes and was made up of two sections, section A and B. Section A contain 20 multiple-choice type questions and section B contain three subjective questions. Mensah and Nabie (2021), reported a reliability coefficient of 0.812, correlated using Pearson correlation coefficient (r) used in reliability testing in SPSS.

3.3.2. Administration and Grading of the GAT

The two forms of the GAT (pre-test and post-test) were admininisterd under same conditions in the 2021/2022 academic year. The pre-test was administered in October 2021 before treatment commenced while the post-test was administered in December 2021 after treatment had been completed. The two forms of the GAT were administered and scored under the same conditions as Mensah and Nabie (2021) described in their study.

3.4. Treatment

The researchers used a total of four weeks to implement the treatment. During these 4 weeks of treatment, both groups (Endowed and Less endowed) were taken through projected PPT lessons on area and perimeter of plane shapes. Lessons were prepared in PowerPoint on concepts involving area and perimeter of plane shapes using mathematics softwares such as such as Geogebra, Microsoft Paint, Math type, and Geometers Sketch Pad. The lessons were prepared taking into consideration the requirements of the SHS mathematics curriculum as well as the objectives of the study. Furthermore, the lessons were designed in line with the fundamental principles of the Engagement Theory (ET).

4. Results and Discussion

The results of this study are presented here section by section based on the research questions stated. This section gives the results of the quantitative data obtained from administering the instruments used for data collection.

4.1. Research question one

Research question one investigated the effects of using PPT presentation in teaching and learning of mathematics in sharp contrast to traditional way of teaching on SHS students' attainment in geometry. An informal interview with subject teachers in both schools revealed that they teach by the conventional method. The implication is that the pre-test scores emanated from the conventional method of teaching, which is very common among mathematics teachers. The pre-tests for the groups were analyzed basically to discover whether there was any significant difference in achievement between the two groups and also to measure their

level of attainment before treatment is implemented. Table 2 shows the descriptive statistics of the pre-test achievement scores of the endowed and the less endowed groups.

Table 2: Descriptive Statistics of Pre-test Scores of the two Groups

Group	N	Mean	Stand Dev.	Maximum	Minimum
Group E	40	23.03	5.36	30.00	10.00
Group L	40	13.83	6.77	27.00	4.00

The results from Table 2, showed a mean score of 23.03 for group E (Endowed school) and 13.83 for group L (Less-endowed school). The difference between the mean scores of the two groups is 9.20. in terms of minimum and maximum scores, group E recorded minimum score of 10 and a maximum score of 30 out of a total of 50 points while group L recorded a minimum score of 4 and a maximum score 27 out of a total of 50 available points. Table 3 shows the results from an independent samples t-test that was performed at 95% confidence interval to ascertain whether the difference in the mean scores was statistically significant.

Table 3. Independent Samples t-test of Pre-test scores of the Groups

Groups	N	Mean	Std. Dev.	t-value	df	p-value
Endowed (E)	40	23.03	5.36	6.737	78	0.000
Less Endowed (L)	40	13.83	6.77			

The results from Table 3 revealed that there was statistically significant difference between the endowed school $(M = 23.03,\ SD = 5.36)$ and the less endowed school $(M = 13.83,\ SD = 6.77)$ conditions; $t\ (78)\ =\ 6.737, p < 0.05$. These results suggest that the groups (i.e. endowed and less endowed) were not at the same level in terms of achievement in the terms of the concepts (Area and Perimeter) before the researchers carried out the treatment. After treatment, a post-test was administered to both groups and the results compared with corresponding pre-test scores. Table 4 shows the descriptive statistics of pre-test and post-test scores for group E.

Table 4. Descriptive Statistics of Pre-test and Post-test Scores of Group E

Test	N	Mean	Stand Dev.	Maximum	Minimum
Pre-test	40	23.03	5.36	30.00	10.00
Post-test	40	31.28	8.25	45.00	15.00

The results from Table 4 suggest an improvement in the post-test scores. The maximum score improved from 30 to 45 while the minimum score improved from 10 to 15. Table 5 shows the descriptive statistics of pre-test and post-test scores for group L.

Table 5. Descriptive Statistics of Pre-test and Post-test Scores of School L

Test	N	Mean	Stand Dev.	Maximum	Minimum
Pre-test	40	13.83	6.77	27.00	4.00
Post-test	40	24.70	8.47	40.00	10.00

Table 5 shows that there was an improvement in the mean scores between the pre-test (13.83) and the post-test (24.70). Also, the maximum score of 27 in the pre-test has increased to 40 in the post-test while the minimum of 4 also increased to 10.

To ascertain whether the mean difference between the pre-test and post-test scores of each group was significant, a paired samples t-test was performed at 95% confidence interval for each group and the results illustrated in Table 6;

Table 6. Paired Sample T-tests of the Two Groups

	N	Mean Difference	Std. Dev.	Std. Error Mean	t-value	df	p-value	Eta Squared
Pre-test – Post-test (Group E)	40	8.250	3.418	0.540	-15.268	39	0.000	0.265
Pre-test – Post-test (Group L)	40	10.875	2.065	0.327	-30.238	39	0.000	0.298

The results from Table 6 shows that both groups (Endowed and Less-endowed schools) improved significantly in their post-test scores compared to their pre-test scores. There was statistically significant difference in the mean scores of group E from the pre-test to the post-test, conditions; $t(39) = -15.268, p < 0.05$. The eta squared value of 0.265 shows a large effect size between the two scores. This value showed that 26.5% of the variance of the post-test scores of participants was accounted for by the teaching method (Use of PPT)). According to the Cohen's rules of thumb on magnitudes of eta squared interpretation given by Miles and Shelvin (2001), an eta squared value of 0.01 (1%) has small effect size while eta squared values of 0.06 (6%) and 0.14 (14%) have medium and large effect sizes respectively.

This result suggests that the difference recorded between the scores on the pre-test and the post-test of the respondents in group E (endowed) taught using PPT was large. Also, there was statistically significant difference in the mean scores of group L from the pre-test to the post-test, conditions; $t(39) = -30.238, p < 0.05$. Again, the eta squared value of 0.298 showed a large effect size indicating that 29.8% of the variance of the post-test scores were improved by integration of ICT at the treatment stage. By this eta squared value, it implies that difference in the mean scores of group L on the pre-test and post-test, where ICT was used was also large. However, the effect of ICT integration on the achievement of students in the less endowed school was larger than that of the endowed school as depicted by the eta squared values.

4.2. Research Question two

Research question two was basically formulated to determine whether or not there is a significant difference in the academic attainment of the endowed (group E) and the less endowed (group L) SHS students in Geometry after both groups were taken through lessons using PPT presentations. To achieve this, an independence samples t-test was performed using the post-tests scores of the two groups at 95% confidence interval. The results from the analysis is illustrated in Table 7 below;

Table 7. Independent Samples t-test of the Two Groups

Groups	N	Mean	Std. Dev.	t-value	df	p-value	Eta Squared
Group E	40	31.28	8.25	4.052	78	0.000	0.174
Group L	40	24.70	8.47				

From Table 7, the results from the independent samples t-test showed a statistically significant difference between the mean scores of the endowed group $(M = 31.28,\ SD = 8.25)$ and the less endowed group $(M = 24.70,\ SD = 8.47)$ conditions: $t(78) = 4.052, p < 0.05$. This result suggests that the participants from the endowed group outperformed their counterparts from the less endowed school, who were both taught using PPT, on the post-test. An eta squared value of 0.174 (17.4%), from Table 7 shows a large effect size. The result implies that even though ICT integration in teaching mathematics led to improvement in the academic achievement of SHS students in both endowed and less endowed schools, the difference in the achievement level between these schools was still large. In other words, ICT integration could not entirely bridge the gap in the achievement levels between students in endowed school and those in less endowed schools. However, the mean difference between the groups in the pre-test (9.2) was reduced to 6.58 in the post-test. This result suggests that this method of teaching is capable of reducing the achievement gaps between endowed and less endowed SHSs.

4.3. Research Question Three

Research question three aimed at finding out whether the achievement of SHS students in geometry, when PowerPoint presentations in the instructional delivery, is influenced by gender. To this end, the post-test scores of each group (endowed and less endowed groups), which were both taught with PowerPoint presentation approach, were analyzed separately based on gender. To test whether there was significant difference between the post-test scores of the male and female participants of each group, their post-test scores were analyzed using independent samples t-test performed at 95% confidence interval. The result from the analysis of the post-test scores of the two groups is illustrated in Table 8.

Table 8. Independent samples T-test showing the Influence of Gender

Group	Gender	N	Mean	Stand Dev.	t-value	df	p-value
Group E	Male	17	32.46	8.65	1.564	38	0.675
	Female	23	30.10	8.37			
	Total	**40**	**31.28**	**8.51**			
Group L	Male	19	23.21	8.75	0.043	38	0.966
	Female	21	23.10	8.27			
	Total	**40**	**23.16**	**8.51**			

The results from Table 8, indicated statistically no significant difference between the attainment of male students $(M = 32.46, SD = 8.65)$ and female students $(M = 30.10, SD =$

8.37) of the endowed group (group E), conditions; $t\,(38) = 1.567, p = 0.675 > 0.05$. Similarly, the results revealed statistically no significant difference between the achievement of male students ($M = 23.21, SD = 8.75$) and female students ($M = 23.10, SD = 8.27$) of the less endowed group (group L), conditions; $t\,(38) = 0.043, p = 0.966 > 0.05$. The results showed that the use of PowerPoint presentation is capable of putting male and female students in both endowed and less endowed schools on the same level, in terms of achievement in geometry.

5. Discussion

The findings showed that integrating technology, using PowerPoint presentations, into teaching mathematics provided students in both endowed and less endowed schools with new learning experiences in learning geometry concepts. Some of the experiences derived from using this approach to teaching geometry included: connecting students' immediate environment to the classroom; providing students with real life images of concepts; giving opportunities for students to create their own knowledge and creating opportunities for students to collaborate with each other while attempting the activities on the group computers. These opportunities provided by using PowerPoint instruction may not be possible when other teaching methods, such as the conventional approach, are used. Moreover, this method of teaching was found to be suitable in both endowed and less endowed schools.

Furthermore, the analysis of the pre and post-tests scores of each group revealed that there was statistically significant difference in their achievements. This result indicated that the achievements of students from both endowed and less endowed schools improved significantly when PowerPoint presentation was used to teach them geometry. The eta squared values of 0.265 and 0.298 for the endowed and less endowed groups respectively, both showed large effect size (Cohen, 1988). These findings strongly agree with the studies by (Ganesan & Kwan, 2020; Mensah & Nabie, 2021; Tay & Mensah-Wonkyi, 2018) who in separate studies found significant improvement in the achievement of students who were taught by integrating technology into the teaching and learning process. However, the results from the independent samples t-test conducted on the post–tests of the endowed and less endowed groups showed a significant difference between the achievement of the endowed and the less groups. This finding showed that students in the endowed group significantly outperformed those in the less endowed group. The interpretation is that the use of PowerPoint instruction, in teaching the concept of area and perimeter of plane shapes, could not bridge the achievement gap between students in endowed and less endowed schools. This finding might be as a result of the large discrepancies, such as entry characteristics and infrastructure, which exist between endowed and less endowed SHSs in the country.

The findings also indicated that gender has no influence on the achievement of students, from both endowed and less endowed schools, in mathematics when PowerPoint is used in the instructional delivery. That is, using PowerPoint presentation was also found, in this study, to have bridged the achievement gap of male and female students in mathematics, in agreement to the findings of earlier studies (Awofala, 2017; Awofala & Lawani, 2020; Meggiolaro, 2017; Mensah & Nabie, 2021). For example, Mensah and Nabie (2021) found that, the use of

PowerPoint instruction bridged the gap between the academic achievements of male and female students in the experimental group unlike the conventional method, which could not do so.

6. Conclusion

This study contributes new knowledge in one of the topical issues in mathematics education, the use of technology in instructional delivery. Particularly, the study provides new insight on the effects PPT presentations on the academic achievement of SHS students in both endowed and less endowed schools. It was found in this study that participants in both groups, who were taught with the method where PowerPoint presentation was used in the teaching and learning process, improved significantly in their post-test as compared to their pre-test scores. It was also gender has no influence on the academic achievement in geometry when PPT presentations was used in teaching both endowed and less endowed SHS students.

However, the findings indicated that technology integration, using PowerPoint presentations could not bridge the existing academic achievement gap in mathematics between students in endowed schools and those in less endowed schools. It was found that students in the endowed school outperformed those in the less endowed school when both groups were taught using PowerPoint presentation approach. This could be as a result of the existing challenges that less endowed SHSs face in terms of entry characteristics, infrastructure, among others.

7. Recommendations

The implication of the findings of this study for mathematics teachers is that the use of PowerPoint instructional approach in teaching mathematics, especially geometry, is capable of improving the academic achievement of both high and low achieving schools. It is recommended that the Ghana Education Service (GES) should consider making this method a conventional method in SHSs across the country. Also, the Ministry of Education (MoE) should consider integrating the use of technologies, especially PowerPoint presentation, in mathematics education as a course of study in the curriculum of all teacher training institutions in the country. However, there is the need to provide SHSs with mathematics laboratories stocked with computers and at least an LCD projector, to enable mathematics teacher to use this method of teaching.

In this study, it was found that the use of technology (PowerPoint) could not entirely eliminate the achievement gap in mathematics between endowed and less endowed schools in the Gomoa West district. It is recommended that further studies can be done using other technologies to teach the same concept or other concepts in the mathematics curriculum. Furthermore, this study was limited to one district in the central region, further studies can be replicated in other parts and in other jurisdictions

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