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Enhancing the Interest of Undergraduate Students in Geometry Through GeoGebra-Assisted Instruction in Colleges of Education, Ghana

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Abstract
In a College of Education located in the Volta region of Ghana, this study investigated the impact of GeoGebra-supported teaching on the interest for learning geometry among undergraduate students. Employing a non-equivalent control group pre-test post-test quasi-experimental research design, the study formulated two research questions and two hypotheses to guide its investigation. The sample comprised 73 undergraduate mathematics students, with 38 students in the experimental group and 35 in the control group. Data collection utilized the Geometry Interest Inventory (GII), which was validated by experts, with a calculated Cronbach's alpha coefficient of 0.85 indicating its reliability. Analysis of Covariance (ANCOVA) was employed to test the hypotheses at a significance level of 0.05, while mean and standard deviation were used to analyze data for addressing the research questions. Results indicated that students taught geometry with GeoGebra demonstrated significantly greater interest in the subject compared to those taught with diagrams. Furthermore, the study found that both male and female students exhibited similar levels of interest in geometry when taught using GeoGebra-supported instruction. It was recommended among others that **in** colleges of education, GeoGebra-assisted instruction should be utilized to spark students' enthusiasm in learning geometry, regardless of gender.

Keywords: GeoGebra, Educational Intervention, Student, Interest, Geometry

Introduction

Studying geometry encourages mathematicians to be aware of their environment. The Greeks referred to geometry as "earth measure". Geometry was known to the Greeks as "geometreo," in which "geo" means "earth" and "metreo" means "measure." Geometry is understood as a field of inquiry that fosters a variety of approaches to mathematical issues and an understanding of the universe in both artificial and natural environments (Gamboa & Ballestero, 2009). Due to its natural occurrence in the structure of the solar system, in plants, flowers, animals, and geological formations like rocks and crystals, it also has a big impact on day-to-day living (Lie & Hafizah, 2008). Furthermore, geometry supports students' capacity to visualize, think critically, anticipate, solve problems, form hypotheses, apply deductive reasoning, and present logical arguments during the testing and demonstration procedures, claims Jones (2002). Geometry is a branch of mathematics that can help students become more adept at problem-solving, visualization, intuition, and spatial awareness. As stated by the National Council of Teachers of Mathematics (2000), every student needs a fundamental understanding of geometry to succeed in the classroom and in real-world circumstances. This is due to the fact that geometry empowers individuals to analyze and contemplate their environment.

Despite geometry's significance in mathematics, both instructors and students find the subject challenging to learn and understand (National Council of Instructors of Mathematics, 2009). The research findings expressed concerns about the geometric thinking levels of students in Ghanaian schools and institutions (Baffoe & Mereku, 2010). The annual reports from the Chief Examiners for the End-of-Second-Semester Mathematics Examination in geometry at the College of Education level for the years 2011 and 2012 (University of Cape Coast, Institute of Education, 2011;

University of Cape Coast, Institute of Education, 2012) indicated that the presentations of solutions to most geometrical problems by student teachers were below standard. Similarly, the Chief Examiners' findings from 2013 and 2014 (University of Cape Coast, Institute of Education, 2013; University of Cape Coast, Institute of Education, 2014) revealed that candidates exhibited inadequate understanding of geometry and struggled with applying geometric concepts. The majority of students performed poorly in geometry because they were unable to understand geometric concepts and acquire the necessary problem-solving abilities. Teachers who do not employ effective and relevant teaching strategies that engage students and help them develop their geometric thinking are partly to blame for their pupils' low performance in geometry classes (Alex & Mammen, 2012). Researchers have found that most student-teachers in Ghana have little knowledge of geometry (Armah et al., 2017), and that students' low academic achievement in geometry may be related to their perception of geometry as a difficult subject (Bikic et al., 2016). Research has also revealed further problems with geometry teaching and learning, such as problems with teacher pedagogy, students' disinterest in geometry, their understanding of geometrical concepts, and their lack of use of technology (Dinayusadewi & Agutika, 2020; Ngirishi, 2015). Students' failure to grasp geometric concepts, to identify the connections between geometric attributes and shapes, and to have both procedural and conceptual understanding resulted in an unfavorable grade for their geometry performance (Ngirishi, 2015). In addition, the Chief Examiners' Reports from May/June (2010, 2011) indicated that students' performance in geometry is deemed inadequate, supporting the idea that students' performance is substandard. A number of factors, such as a lack of prior knowledge, weak geometric reasoning skills, difficulty understanding geometric language, difficulty visualizing concepts, instructional methods used by teachers, a lack of instructional materials, and others, have been identified by researchers (Noraini, 2006; Aysen, 2012) as contributing to students' difficulties learning geometry.

According to research findings, gender influences students' grasp of geometry. While Baharvand (2001) and Uduosoro (2011) found that male students outperformed females in geometry, Ominrin (2009) contends that females surpassed males. In contrast, Gbodi and Olaleye (2006) and Adegun and Adegun (2013) found no gender-based difference in geometry proficiency. Royati et al. (2010) suggest that learning geometry presents cognitive challenges for students. Furthermore, the Chief Examiners' report of the West African Examination Council (WAEC) in 2014 and 2015 noted inadequate performance in geometry, with most students struggling with related questions. In line with this, the idea of students' learning achievement in geometry was rated as extremely low. Telima (2012) postulated that students did not fully understand what they were studying and further indicated that geometric language, visualizing skills, and the teaching approach of the teacher are all factors that are thought to make geometry learning challenging (Aysen, 2012; Noraini, 2006). Empirical evidence demonstrated that a mathematics instructor's choice of pedagogical approach significantly influences students' motivation to learn the subject. Most research results indicate a notable contrast in students' interest levels when taught mathematics with diagrams versus GeoGebra. However, some findings propose that there's no substantial difference in students' interest levels between those instructed with GeoGebra and those taught with diagrams.

In Bimbilla-Ghana, Salifu (2020) investigated how pre-service teachers' understanding of circle theorems and their own performance were affected by the GeoGebra software program. Pre-post testing and quasi-experimental research methods were employed in the study. The study's sample size of 88 pre-service instructors was selected by a straightforward random selection procedure. Based on the study's findings, the experimental group showed more interest in the GeoGebra software package instructional technique for teaching the circle theorem. In the South African province of Limpopo, Chimuka (2017) examined the impact of GeoGebra software integration on Grade 11 pupils' academic performance. The study found that students were more motivated to learn about circle geometry when they were taught using the GeoGebra software package than when they weren't. At Northwestern College in Chicago, Schaver (2019) examined the effects of the GeoGebra software program on students' achievement levels, critical thinking and problem-solving skills, and engagement and motivation. As demonstrated by the study's findings, using the GeoGebra program improved students' enthusiasm and interest in arithmetic. Moreover, Chalaune and Subedi (2020) conducted research on the effectiveness of the GeoGebra software suite in secondary school mathematics instruction in Nepal. Employing a non-equivalent control group and a quasi-experimental research design, the study assessed 48 students selected through convenience and random sampling techniques. Data collection involved a questionnaire and an achievement test administered before and after the examination. The study concluded that the utilization of the GeoGebra software program enhanced students' interest in mathematics education and comprehension. Similarly, in the College of Education, Akwanga, Nasarawa State, Nigeria, Salihu et al. (2020) investigated the impact of assessment for learning and the GeoGebra software package on mathematics achievement

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and interest. Employing a quasi-experimental research design with a non-randomized pre-post-test control group, the study found that students who learned mathematics using GeoGebra software and assessment for learning exhibited a significantly higher interest in the subject compared to those taught through traditional lectures.

Furthermore, research indicates that there are differences in how male and female students approach learning mathematics through the use of GeoGebra-assisted instruction. Some researchers found that there is a noticeable difference in the interest of male and female students in learning mathematics when taught using GeoGebra-assisted instruction, contrary to the claims of some authorities who state that there is no difference at all between male and female students in this subject. Nzekwe (2018) examined the impacts of cooperative learning and peer-teaching approaches on students' achievement and interest in mathematics in the Ezeagu Local Government Area of Enugu State. The findings revealed no noticeable distinction between male and female students' mean interest scores when taught using various instructional methods. Asanre et al. (2021) investigated the influence of mathematics game strategy on senior secondary student learning outcomes (academic achievement and interest) in the Ijebu-Ode Local Government Area of Ogun State, Nigeria. The study also indicated that gender did not affect senior secondary school students' interests when taught using a mathematical game technique. Onah (2015) explored the effects of multimedia projection on senior-level students' academic performance and interest in Sets in Enugu, Nigeria, utilizing a non-equivalent control group quasi-experimental research design. Results indicated a significant difference in mean interest levels between male and female students taught sets with MUMPPAS, with females showing higher interest. James et al. (2021) investigated the impact of the GEOENZO software approach on secondary school (SS1) students' interest in geometry in Benue State, Nigeria, employing a non-randomized quasi-experimental pre-test post-test control group design with a sample size of 457 SS1 students. The study concluded that there were no gender differences in interest levels related to geometry in the experimental group. Onwubumpe and Okigbo (2021) assessed the effect of the self-regulated learning cycle (S-RLC) on secondary school students' interest in mathematics in the Onitsha Education Zone in Anambra State, Nigeria. Their findings indicated that the S-RLC raised female students' interest in math more than that of male students. The examination of related empirical studies revealed a research knowledge gap in student interest in learning mathematics using GeoGebra-aided instructions, suggesting the need to bridge this gap to potentially enhance learner interest in mathematics education in Colleges of Education, Ghana.

Statement of the Problem

One of the contributing elements to poor learning achievement in geometry, even with many interventions implemented by various scholars in mathematics education to enhance academic performance, is students' insufficient motivation to learn geometry. Other contributing issues include teachers' passive teaching strategies, which don't promote students' preferred learning styles in geometry, and students' perceptions that geometry is hard. (West African Examination Council Chief Examiners' Report, 2010; 2017; 2018).

Aim and Objectives of the Study

The study aimed to investigate the effect of GeoGebra-aided instruction on students' interest in learning geometry. The study was specifically planned to;

1. Examine the difference in the interest in learning geometry between the students taught geometry using the GeoGebra-aided instruction and those taught using diagram-aided instruction.
2. Determine the difference in the interest between the male and female students in learning Geometry when taught using the GeoGebra-aided instruction.

Research Questions

The study was guided by the following research questions:

1. What is the difference in the interest in learning geometry between the students taught geometry using the GeoGebra-aided instruction and those taught using diagram-aided instruction?
2. What is the difference in the interest between the male and female students in learning Geometry when taught using the GeoGebra-aided instruction?

Hypotheses

The following hypotheses were tested at a 0.05 level of significance:

H_{01}: There is no significant difference in the interest in learning geometry between the students taught geometry using the GeoGebra-aided instruction and those taught using diagram-aided instruction.

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H_{02}: There is no significant difference in the interest between the male and female students taught in learning Geometry when using the GeoGebra-aided instruction.

Method and Materials

The research design for the study was a quasi-experimental pre-test post-test non-equivalent control group, with two intact classes. The sample size for the study consisted of 73 math students, selected by simple random selection techniques. The data was gathered using the Geometry Interest Inventory (GII). The GII was designed to collect data on students' interest in learning geometry. It consisted of 10 items on a four-point Likert scale, ranging from "strongly agree" to "strongly disagree," as well as a closed-ended questionnaire to determine the gender of the sample. Experts evaluated the validity of the instruments, and the GII's reliability coefficient was determined to be 0.85 using Cronbach Alpha. Additionally, a modified four-phase instrument administration approach was used to gather data on the sample's interest in studying geometry. Table 1 shows the research design.

Table 1: Quasi-experimental design

Group	Pre-interest	Treatment	Post-interest
E	Q_1	X_{GAI}	Q_2
C	Q_1	X_{DAI}	Q_2

Where;
E = Experimental Group, X_{GAI} = GeoGebra-Aided Instruction
C = Control Group, X_{DAI} = Diagram-Aided Instruction
Q_1 = Pre-interest (GII) Q_2 = Post-interest (GII)

The data collection procedure involved orientation of the research assistant, pre-test, GeoGebra-aided Instruction, Diagram-aided Instruction, and post-test as shown in Table 2

Table 2: shows the data collection procedure

S/N	Experimental Group	Control Group	Treatment
1.	+	+	Pre-test (GII)
2.	+	-	GeoGebra-aided Instruction
3.	-	+	Diagram-aided Instruction
4.	+	+	Post-test (GII)

The data collection process comprised several steps, including orientation for the research assistant, pre-test administration, GeoGebra-aided instruction, diagram-aided instruction, and post-test assessment. To ensure effective and efficient data collection, the research assistant received comprehensive training on the research design, GeoGebra-aided instruction, and diagram-aided instruction. Following the orientation, both the experimental and control groups underwent a pre-test (GII), which was then collected for scoring after 35 minutes. Subsequently, the experimental group received instruction in Geometry over a period of three weeks with the assistance of GeoGebra. Similarly, the control group received instruction in the same Geometry material over the same duration but with the use of diagrams. Following the instructional period, both groups underwent a post-test (GII), and after 35 minutes of completion, the responses were collected for evaluation. Hypotheses were tested using Analysis of Covariance (ANCOVA) at a significance level of 0.05, and the data collected were analyzed using mean and standard deviations to address the research questions.

Results

Table 3A: Summary of descriptive statistics comparing undergraduate students who learned geometry using the GAI versus those who learned it using the DAI in terms of their interest in the subject.

		Pre-GII		Post-GII		Gain-GII	
Treatment	N	Mean	SD	Mean	SD	Mean	SD
GAI	38	1.81	0.19	3.47	0.07	1.66	0.20
DAI	35	1.53	0.08	2.37	0.17	0.84	0.21

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The outcome from Table 3A displays a summary of descriptive data on the difference in students' interest in learning geometry between those who received teaching using GeoGebra and those who received instruction using diagrams. It demonstrates that students who learnt with GeoGebra-assisted instruction had a mean Pre-GII score of 1.81, SD=0.19, a mean Post-GII score of 3.47, SD=0.07, and a mean Gain-GII score of 1.66, SD=0.20. However, students who were taught utilising diagram-aided teaching had mean Pre-GII scores of 1.53, SD=0.08, mean Post-GII scores of 2.37, SD=0.17, and mean Gain-GII scores of 0.84, SD=0.21.

Table 3B: Summary of descriptive statistics on the interest gain of student groups taught using GAI and those taught using the DAI

		GAI		DAI	
		Statistic	**Std. Error**	**Statistic**	**Std. Error**
Mean		1.66	0.03	0.84	0.03
95% CI	Lower Bound	1.59		0.77	
	Upper Bound	1.72		0.91	
Median		1.70		0.90	
Variance		0.04		0.04	
Std. Deviation		0.20		0.21	
Minimum		0.90		0.00	
Maximum		2.00		1.10	
Range		1.10		1.10	
Interquartile Range		0.30		0.30	
Skewness		-1.57	0.38	-1.93	0.40
Kurtosis		4.85	0.75	6.98	0.78

The results from Table 3B specifically show the summary of descriptive statistics on the interest gain of student groups taught using GAI and those taught using the DAI. These statistics shed light on the central tendency, spread, skewness, and kurtosis involving the two methods. They aid in the understanding of the features of the data and provide insights into how they are distributed. The results show that for GeoGebra-Aided Instruction (GAI), the mean gain interest value was 1.66, indicating the mean value and uncertainty level in the estimate. The 95% confidence interval for the mean ranges from 1.59 to 1.72, providing the range within which the true mean population mean is likely to fall. The median was 1.70, with a variance of 0.04 and a standard deviation of 0.20. The minimum and maximum values were 0.90 and 2.00 respectively. The interquartile range, providing the spread of the middle 50% of the data was 0.30. The skewness value of -1.57 showed that the distribution was negatively skewed with a standard error of skewness of 0.38. The kurtosis value of 4.85 with a standard error of kurtosis of 0.75.

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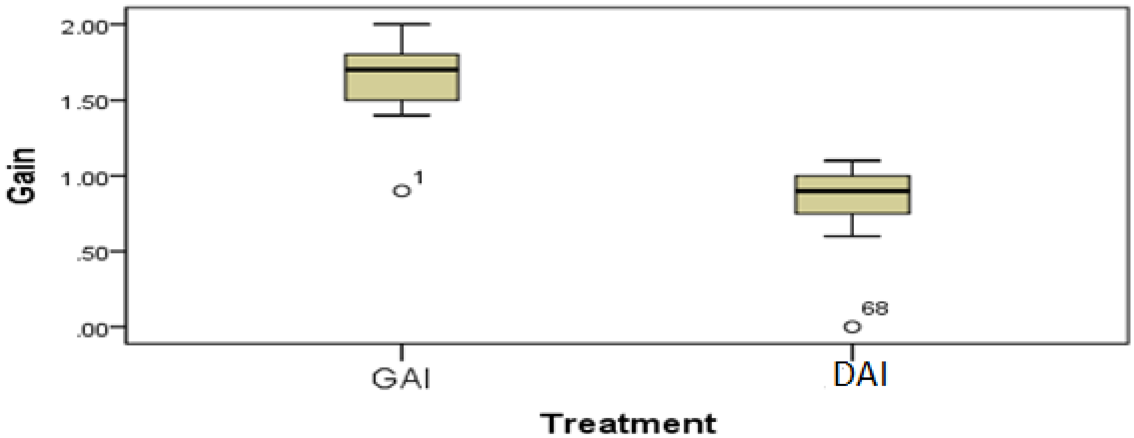

Fig. 1: Box plot

The results further showed that for DAI, the mean gain interest value was 0.84. The 95% CI ranges from 0.77 to 0.91. The median was 0.90, with a variance of 0.04 and a standard deviation of 0.21. The minimum and maximum values were 0.00 and 1.10 respectively. The interquartile range was 0.30. The skewness value of -1.93 showed that the distribution was negatively skewed with a standard error of skewness of 0.40. The kurtosis value of 6.98 with a standard error of kurtosis of 0.78. Additionally, a clustered boxplot (Figure 1) of the student interest gains based on the treatments is displayed in Figure 1. The students that were taught with GAI had a score suggesting an outlier. The upper and lower 25% of the instances contained in the middle 50% are denoted by a whisker of a boxplot. As a result, the bottom half of the interest gain for students taught using the GAI ranges from 0.90 to 1.70, whereas the upper half ranges from 1.70 to 2.00. When students were taught with DAI, the lower half of the interest gain ranged from 0.00 to 0.90, while the higher half ranged from 0.90 to 1.10.

Table 4A: Summary of descriptive statistics on the disparity in undergraduate student interest in learning geometry when taught using the GAI between male and female students

		Pre-GII		**Post-GII**		**Gain-GII**	
Gender	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Male	23	1.90	0.18	3.48	0.07	1.59	0.21
Female	15	1.68	0.10	3.45	0.07	1.77	0.10

The outcome from Table 4A displays a summary of descriptive statistics on the difference in student interest in studying geometry when taught using GeoGebra-aided teaching between male and female students. It demonstrates that male students who learnt using GeoGebra-assisted instruction had a mean Pre-GII score of 1.90, SD=0.18, a mean Post-GII score of 3.48, SD=0.07, and a mean Gain-GII score of 1.59, SD=0.21. Contrarily, female students who were trained using the same methodology had Pre-GII mean scores of 1.68, SD=0.10, Post-GII mean scores of 3.45, SD=0.07, and Gain-GII mean scores of 1.77, SD=0.10.

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Table 4B: Summary of descriptive statistics on the interest growth of the student groups taught utilising GAI, both male and female

		Male		Female	
		Statistic	**Std. Error**	**Statistic**	**Std. Error**
Mean		1.59	0.04	1.77	0.03
95% CI	Lower Bound	1.50		1.71	
	Upper Bound	1.68		1.82	
Median		1.60		1.80	
Variance		0.04		0.01	
Std. Deviation		0.21		0.10	
Minimum		0.90		1.60	
Maximum		1.90		2.00	
Range		1.00		0.40	
Interquartile Range		0.20		0.10	
Skewness		-1.47	0.48	0.35	0.58
Kurtosis		4.14	0.93	0.73	1.12

The results from Table 4B specifically show the summary of descriptive statistics on the interest gain of male and female student groups taught using GAI. The results show that for males, the mean gain interest value was 1.59. The 95% CI for the mean ranges from 1.50 to 1.68. The median was 1.60, with a variance of 0.04 and a standard deviation of 0.21. The minimum and maximum values were 0.90 and 1.90 respectively. The interquartile range was 0.20. The skewness value of -1.47 showed that the distribution was negatively skewed with a standard error of skewness of 0.48. The kurtosis value of 4.14 with a standard error of kurtosis of 0.93. The results further showed that for females, the mean gain interest value was 1.77. The 95% CI ranges from 1.71 to 1.82. The median was 1.80, with a variance of 0.01 and a standard deviation of 0.10. The minimum and maximum values were 1.60 and 2.00 respectively. The interquartile range was 0.10. The skewness value was 0.35 with a standard error of skewness as 0.58. The kurtosis value of 0.73 with a standard error of kurtosis of 1.12.

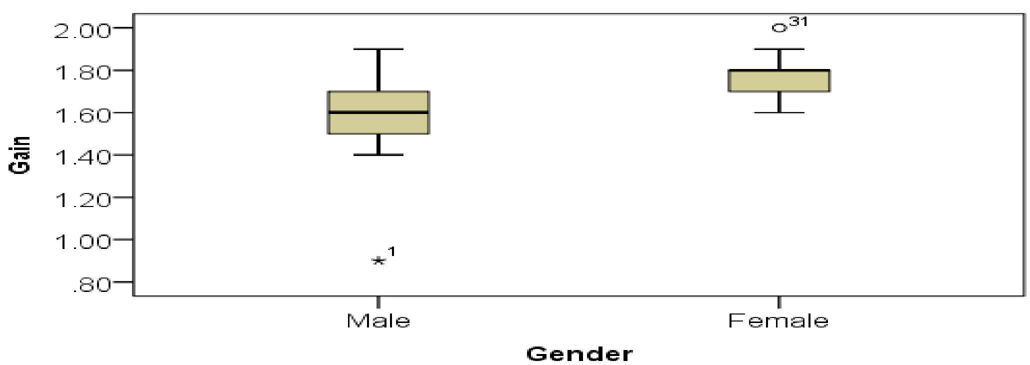

Fig. 2: Boxplot

Additionally, a clustered boxplot (Figure 2) of the male and female student interest gains who learned using GAI is displayed in Figure 2. There appeared to be an outlier in the scores of the males. The upper and lower 25% of the instances contained in the middle 50% are denoted by a whisker of a boxplot. As a result, the bottom half of the interest gain for male students taught using the GAI ranges from 0.90 to 1.60, whereas the upper half ranges from 1.60 to 1.90. For the female students taught with GAI, the lower half of the interest gain ranges from 1.60 to 1.80, while the higher half ranges from 1.80 to 2.00, though with an outlier.

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Table 5: Summary of ANCOVA on the difference between undergraduate students who were taught geometry using the GAI and those who were taught with the DAI in terms of their interest in learning the subject.

Source	SS	df	MS	F	Sig.	η^2
Corrected Model	22.157[a]	2	11.078	626.251	.000	.947
Intercept	4.729	1	4.729	267.308	.000	.792
Pre-GII	.003	1	.003	.151	.699	.002
Treatment	11.468	1	11.468	648.292	.000	.903
Error	1.238	70	.018			
Total	654.260	73				
Corrected Total	23.395	72				

a. R Squared = .947 (Adjusted R Squared = .946)

According to Table 5, the difference in interest in learning geometry between undergraduate students who received GeoGebra-assisted instruction and those who received diagram-assisted instruction can be shown. The result indicated an F-calculated value of 648.292, a p-value of 0.00 and η^2 =0.903. This shows a very high Partial Eta effect-size value of 90.3%. The findings showed that undergraduate students who were taught geometry using diagram-aided teaching and those who were taught geometry using GeoGebra differed significantly in their interest in learning the subject (F1, 70=648.292, p=0.00). At a significance level of.05, the null hypothesis 1 was rejected.

Table 6: Summary of ANCOVA on the difference in the interest between the male and the female undergraduate students taught in learning Geometry when taught using the GAI

Source	SS	df	MS	F	Sig.	η^2
Corrected Model	.013[b]	2	.007	1.242	.301	.066
Intercept	3.329	1	3.329	617.435	.000	.946
Pre-GII	.002	1	.002	.309	.582	.009
Gender	.013	1	.013	2.330	.136	.062
Error	.189	35	.005			
Total	457.340	38				
Corrected Total	.202	37				

a. Treatment = GAI
b. R Squared = .066 (Adjusted R Squared = .013)

The summary of the ANCOVA on the difference in undergraduate students' interest in learning geometry when using GeoGebra-assisted instruction is shown in Table 6's result. The outcome showed that the F-value was 2.330, the p-value was 0.136, and the η^2 value was 0.062. The Partial Eta effect-size value here is 6.2%, which is small. The findings showed that while employing GeoGebra-assisted instruction, there is no appreciable difference in the undergraduate students' enthusiasm for studying geometry between genders (F1, 35=2.330, p=0.136). The second null hypothesis was kept at a significance level of.05.

Discussion

According to Table 3's findings, there was a 0.82 difference in the mean gain-GII mean scores between students who studied using the GAI and those who were taught using the DAI in terms of their levels of interest. The ANCOVA result in Table 4.5, when put to the test of statistics, revealed an extremely high Partial Eta effect-size value of 90.3%. The results showed that undergraduate students who were taught geometry using GeoGebra-aided instruction and those who were taught using diagram-aided instruction differed significantly in their interest in learning geometry (F1, 70 = 648.292, p = 0.00), favouring students who were taught geometry using GeoGebra-aided instruction. At a significance level of.05. The null hypothesis 1 was rejected. This result is consistent with earlier findings (Salifu, 2020; Schaver, 2019; Chalaune & Subedi, 2020; Salihu et al., 2020; Chimuka, 2017) that found a significant difference in the interest in learning Mathematics between students taught Mathematics using the GeoGebra software-aided strategy and those taught with a conventional instructional method in favour of the experimental group.

Along these same lines, Table 4's results showed that undergraduate students who employed the GAI for study differed, on average, by 0.08. Through statistical testing with the ANCOVA, Table 4.6's results showed a low Partial Eta effect-size value of 6.2%. The results demonstrated that there is no discernible gender difference in undergraduate

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students' excitement for studying geometry while using GeoGebra-assisted instruction ($F_{1, 35}=2.330$, $p=0.136$). The significance threshold for the second null hypothesis was maintained at.05. The present finding corroborates earlier studies (Nzekwe, 2018; Asanre et al., 2021; James et al., 2021) that reported no discernible variation in students' interest in mathematics between genders. The outcomes, however, are at variance with past studies (Onah, 2015; Onwubumpe & Okigbo, 2021) that found a significant difference in students' motivation to learn mathematics between male and female students.

Conclusion

Regarding the impact of these qualities on students' academic achievement, there is a need for considerably more enthusiasm in geometry learning on the part of the students. Researchers in mathematics education have found that, among other things, students' perceptions of geometry's difficulty, its abstract nature, and their hostility against the subject all contribute to their lack of interest in studying the subject. GeoGebra-aided instruction was implemented by the researcher in response to the factors that were likely to increase students' disinterest in geometry and to counteract the negative effects on their academic performance. Irrespective of gender, the study's findings demonstrated the beneficial impacts of GeoGebra-assisted geometry learning on undergraduate students' engagement. Furthermore, the successful application of GeoGebra-assisted instruction demonstrated that students' motivation in studying geometry is independent of gender. Furthermore, the study's findings also showed that GeoGebra-assisted instruction can lessen geometry's abstract nature in order to improve students' learning outcomes, eliminate students' perceptions of the subject's difficulty, lessen teachers' difficulties in explaining abstract geometric concepts, encourage students to participate actively in the learning process, and improve students' capacity to create, explore, and investigate geometric concepts of interest. Conclusions about the effective usage of GeoGebra-assisted instruction in geometry classrooms consistently highlight how students' interest in geometry was piqued and how gender disparities in geometry interest were eliminated.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Students' interest in learning geometry may be piqued and maintained by using GeoGebra-aided instruction.
2. In colleges of education, GeoGebra-assisted instruction may be utilized to spark students' enthusiasm in learning geometry, regardless of gender.

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