

Building a positive Senior High School Students' Attitude towards Geometry: A guide to implementing Inquiry-Based Teaching Methods

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Abstract

Even though geometry is essential in our education and daily lives, students still express low interest in learning the topic as a result of the approaches teachers adopted in teaching. Using an inquiry-based approach grounded in blended constructivist and social constructivist theories, the study aimed to develop and implement interventions that actively engage students in geometry lessons, hence improving their attitudes towards learning geometry. The study employed an explanatory sequential design, integrating quantitative data from pre- and post-intervention tests with qualitative insights from focus group discussions. The geometry attitude test instrument was used to collect data from eighty-seven students from two senior high schools. The multistage sampling technique was used to select the schools, the teachers and students who participated in this study. The quantitative data were analysed using mean, standard deviation, and an independent sample t-test, while the qualitative data were analysed thematically by themes and supported with direct quotes. The findings revealed that students' attitudes toward learning geometry before the intervention were poor; however, the implementation of an inquiry-based intervention improved students' attitudes in terms of motivation and self-confidence. Also, across gender and school types, students saw an improvement in their attitudes. The study highlights the importance of adopting inquiry-based methods to create engaging and supportive learning environments, ultimately fostering positive attitudes and better performance in geometry.

Keywords: Inquiry-Based Learning, Attitudes toward Mathematics, Geometry, Motivation, Self-Confidence.

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Introduction

Geometry is a crucial branch of Mathematics that deals with space and shapes (Gelfand & Alekseyevskaya, 2020), which is important in our daily lives because the items or objects we interact with daily are composed of geometric shapes. One needs geometric knowledge to understand their relations to ensure the effective and efficient use of these objects and shapes (Serin, 2017). In education, the study of geometry forms the basis of other topics which resulted in the students gaining more information and understanding the importance of the world they live in. Research (Russell, 2014) indicates that the study of geometry provides countless basic skills and assists in developing the thinking skills of logic, deductive reasoning, analytical reasoning and problem-solving. Other professions such as architects, engineers, carpenters, physicists etc rely heavily on geometry knowledge to perform their duties.

Despite these benefits of geometry, students throughout the world still perceive geometry to be a difficult field of study (Tsao, 2017) since the problems and difficulties of understanding and applying the theories and concepts of geometry persist. Research (Eze & Madu, 2022) identified students' low interest in the subject as one of the contributing factors to their poor achievement in mathematics. Interest is the disposition and feelings of an individual towards an activity, which shows behaviourally the extent the person likes to participate in the activity

(Harackiewicz et al., 2016). Globally, there is low interest in the study of mathematics and mathematics-related disciplines at all levels of education (Leyva et al., 2022; Eze & Madu, 2022; Arhin, & Yanney, 2020) as a result of the teaching approaches most mathematics teachers adopted in their classrooms which dampen the students' interest (Juman et al., 2022; Salman et al., 2012). In most secondary schools, students absent themselves in mathematics classes and those who stay during the lesson pay little attention to their teachers. This, consequently, leads to their poor achievement in both internal and external mathematics examinations, which invariably increases a student's hatred for mathematics and mathematics-related courses. Studies revealed that most students are normally passive during mathematics instructional sessions (Suryabayu & Handayani, 2017). This situation is very prevalent in most mathematics classrooms worldwide, especially at the secondary school level (Mishiwo, 2022; Alzahrani, 2018) which leaves the students with no or less opportunity to construct and own their knowledge. This makes the teaching and learning of geometry problematic which creates poor attitudes among students and hence poor performance.

To improve students' interest in mathematics as required explicitly in the Senior high school Mathematics Curriculum that “develop interest in studying mathematics to a higher level in preparation for professions and careers in science, technology, commerce, industry and a variety of work areas” (Ministry of Education, 2017, 2010), there should be a paradigm shift from the teacher-centred approach to a student-centred approach (Ministry of Education, 2017). According to Hoidn and Reusser (2020), a student-centred instruction approach is an instructional approach in which the content of the lesson, pace of the lesson, preparation of the lesson, lesson materials and all the activities within the lesson are centred around the students, determined by the student. This student-centred instructional approach is rooted in the constructivist approach to teaching and learning, which reveals that students create long-lasting understanding and knowledge when they are involved in the learning processes.

The inquiry-based instructional approach is a student-centred instructional approach noted for constantly engaging students during teaching and learning processes (Marshall, Smart & Alston, 2017) hence promoting students' total involvement and participation in the mathematics lessons. According to Chowdhury (2016), inquiry-based teaching is deep-rooted in learning by discovery which is a constructivist approach to teaching. An inquiry is an active learning process determined by a question and critical thinking. Students construct deeper and more long-lasting knowledge and understandings through inquiry than any pre-packaged knowledge delivered by teachers to students (Mensah-Wonkyi & Adu, 2016). Marshall et al. (2017) asserted that the inquiry-based teaching approach has a positive effect on the mathematics achievement of students and their attitudes. In addressing the gap in the students' lack of interest in learning geometry hence resulting in their abysmal performance, this study was designed to assess the effectiveness of inquiry-based teaching and learning approaches in nurturing a positive attitude of senior high school students towards the learning of geometry, aiming to identify practices and strategies that educators can implement to enhance students' motivation and self-confidence.

This study is very important because there is no evidence of any single study that employed inquiry-based teaching and learning approaches to enhance students' attitudes in terms of motivation and self-confidence towards the learning of geometry in Ghana. This study will contribute to the literature on the use of inquiry-based teaching and learning approaches in enhancing senior high school students' attitudes towards the learning of geometry.

Research Objectives

The study was guided by the following objectives:

1. To investigate how an inquiry-based teaching approach influences senior high school students' attitudes towards learning geometry, particularly their motivation and self-confidence.
2. To examine whether students' attitudes towards geometry differ by gender after experiencing inquiry-based instruction.
3. To assess whether students' attitudes towards geometry differ by school type after experiencing inquiry-based instruction.

Research Questions

The following research questions were formulated:

1. How does the implementation of an inquiry-based teaching approach develop positive attitudes (motivation and self-confidence) of senior high school students towards learning geometry?
2. To what extent do students' attitudes towards geometry differ across gender after exposure to inquiry-based instruction?
3. To what extent do students' attitudes towards geometry differ across school types after exposure to inquiry-based instruction?

Literature

Theoretical Framework

The study employed constructivism as the underpinning theory. Constructivism is a theory that explains how people might acquire knowledge and learn. According to Bada and Olusegun (2015), constructivists believe that people increase their awareness and knowledge of the world by engaging in experiences and reflecting on those experiences by reconciling new information together with what they already know. This is done by either altering our beliefs or neglecting the new ideas as not important. Kusumaryono and Suyitno (2016) argued that constructivism changes students from being passive learners to active learners, which enhances students' beliefs and attitudes. Constructivism established the fact that students develop a positive attitude towards learning when students are involved in the creation of their understanding or ideas or knowledge. In the context of this study, the positive attitude of the students could result in improved motivation and confidence in learning geometry, as they are in control of their learning.

Again, social constructivism was adopted to emphasise the social interaction of the students when creating or forming their knowledge and attitude. Social constructivism as propounded by Vygotsky in 1978 states that students create their knowledge through interaction and collaboration with peers, teachers, and the broader social environment (Burns, Pierson & Reddy, 2014). One tenant of social constructivism is the importance of positive interactions between students and teachers or peers. These interactions can enhance motivation and self-confidence in learning, as students feel supported in a collaborative environment. Again, the study adopted an inquiry-based learning approach to form the basis of the design, development, and implementation of the study intervention. The inquiry-based learning instructional approach is a discovery approach based on the constructivist approach to learning which says that learners construct new ideas based on existing ones (Gholam, 2019).

Participating in-service mathematics teachers were trained on how to design and develop inquiry-based learning interventions and implement them in constructivist classrooms. Constructivism, social constructivism theory and inquiry-learning approach were contextualised to form the conceptual framework that grounded this study. This framework provided the basis to fuse an inquiry-based learning approach into a constructivist approach to prepare participating in-service teachers to design, develop and implement the study intervention and also showed the expected effects of the intervention. The conceptualisation of the theories to suit this study is shown in Figure 1.

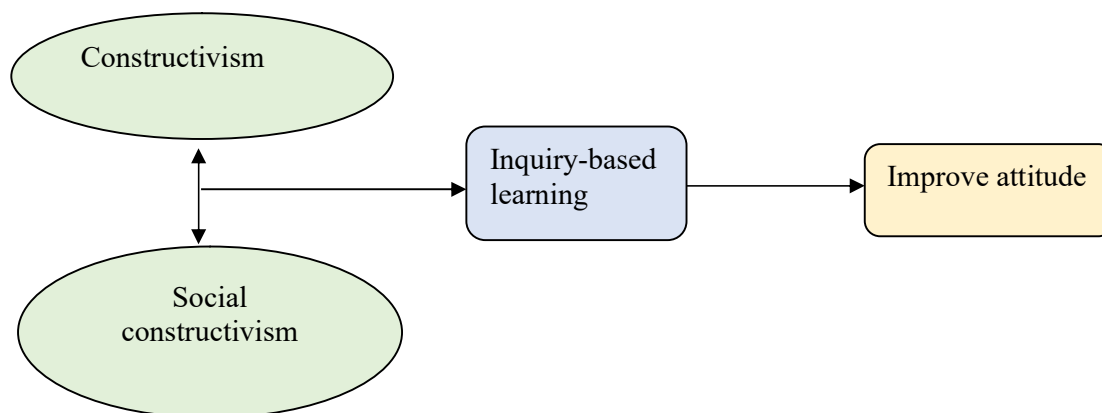


Figure 1. Conceptual framework of the study (Author's Construction, 2025)

This framework signifies that when a teacher adopts an inquiry-based teaching and learning approach to teach geometry in a blended constructivism and social constructivism classroom, it improves the students' attitude towards the learning of geometry.

Inquiry-Based Learning in the Study

Inquiry-based learning (IBL) is a student-centred instructional approach that emphasises active participation, questioning, exploration, and discovery rather than the passive reception of knowledge. Rooted in constructivist and social constructivist theories, IBL enables learners to construct their own understanding by engaging with problems, investigating solutions, and reflecting on their findings (Chowdhury, 2016; Marshall, Smart, & Alston, 2017). In mathematics, and particularly in geometry, this approach encourages students to explore concepts, manipulate objects or figures, and collaborate with peers to develop deeper and more meaningful knowledge (Mensah-Wonkyi & Adu, 2016).

In this study, inquiry-based learning was adopted as the central intervention to improve students' attitudes toward geometry. Participating in-service mathematics teachers were trained to design and implement inquiry-based lesson activities that placed students at the centre of the learning process. Lessons involved group work, the use of manipulatives and geometry tools, problem-solving tasks, and guided questioning to encourage critical thinking (Marshall et al., 2017). By shifting from teacher-dominated instruction to inquiry-driven exploration, students were given the opportunity to build self-confidence and motivation, actively engage with geometric concepts, and take ownership of their learning. This provided a basis for assessing how IBL influences attitudes such as motivation and self-confidence, while also capturing students' lived experiences through focus group discussions.

Attitude of Students towards Mathematics

Attitude towards Mathematics in this study is conceptualised as the like or dislike of the subject; willingness to participate or avoid mathematical activities, one's feeling of being good or bad at Mathematics, and one's assertion that Mathematics is useful or useless (Kibrilioglu, 2015). Research identified three different components of attitude: the cognitive component (perceived usefulness of Mathematics), the affective component (Self-confidence, anxiety, enjoyment), and the behavioural component (Intrinsic motivation) (Maio & Haddock, 2010). Zan and Di Martino (2007) argued that attitude toward Mathematics is considered to be a more complex way students associate their emotions with Mathematics in terms of either positive or negative values, beliefs, and behaviours toward Mathematics. According to Setapa et al. (2016), the attitude of students needs to be encouraged during the teaching and learning process to achieve successful accomplishments. The willingness of students to use or understand their expertise is a consequence of the success of the teaching and learning processes. A positive mindset motivates the critical thinking of students, being involved in the classroom, working in groups together, and developing teamwork and communication skills.

Literature has identified attitude as the major contributing factor causing good or poor performance in Mathematics (Ngussa & Mbuti, 2017). Mutai (2011) indicated that once a positive attitude is developed, it can lead to an improvement in students' learning and performance. Nonetheless, a negative attitude hampers effective and sound learning of Mathematics, hence, affecting the learning outcome and performance (Joseph, 2013). In this regard, attitude cannot be overlooked because it is a fundamental factor contributing to students' learning and performance.

Studies have revealed a sharp decline in students' attitudes towards learning mathematics, which is very common among secondary students worldwide (Wen & Dubé, 2022; Kunwar, 2020). For example, Wen and Dube revealed that students in developed countries such as Canada, Australia, and the United Kingdom score below average on tests of interest and enjoyment in mathematics. Contrarily, students in Finland and Japan who have high achievements in mathematics also exhibited negative attitudes towards mathematics (OECD, 2003 as cited in Wen & Dube, 2022). However, some studies conducted in the United States and the United Kingdom have revealed that students who exhibit a positive attitude towards mathematics are more likely to achieve higher scores on standardised tests (Leung, 2020). This finding is consistent with the theory that motivation and interest in a subject are critical factors in enhancing learning outcomes (Lamb et al., 2019).

Ahmed et al. (2013) argued that there is a decline in motivation and self-confidence among adolescents toward learning mathematics across various grades. For example, Dutch adolescents in Grade 7 enjoy mathematics less due to the decrease in their motivation and self-confidence towards learning mathematics (Ahmed et al., 2013). A similar finding was reported among German adolescents from Grades 7 to 8 (Frenzel et al. 2009). These findings were supported by the study conducted among Australian adolescents, which revealed a decrease in their intrinsic valuing of mathematics from junior years and was fairly stable in their senior years (Watt et al., 2012).

Research (Zacharos et al., 2021) indicated that students' attitudes towards geometry are shaped by the methods of instruction, the relevance of the subject in real-life applications, and the availability of technological tools. This was corroborated by Sahlberg (2015) who argued that in Finland, where innovative pedagogical approaches such as inquiry-based learning and the integration of technology are emphasised, students tend to develop a more favourable attitude towards geometry. Similarly, research from the Netherlands suggests that students who are exposed to dynamic geometry software, which allows for interactive manipulation of geometric figures, demonstrate increased interest and engagement with the subject (Drijvers et al., 2022).

Hwang and Son (2021) highlighted in their study that a positive attitude towards mathematics significantly influences students' achievement in the subject, with motivation, interest, and confidence playing key roles in boosting performance. They further argued that attitudes are shaped by various factors, including teaching methods, peer and parental influence, and past experiences, where engaging and supportive environments foster better outcomes. Also, Hwang and Son (2021) explained that gender differences persist, with males generally having more positive attitudes, though this gap is narrowing due to inclusive practices. Self-confidence is identified as critical for cultivating a positive attitude, and teachers are instrumental in reinforcing this by creating relatable, enjoyable learning experiences.

A study conducted by Bhowmik and Roy (2016) found that though both boys and girls have positive attitudes towards the learning of mathematics, boys exhibited a slightly higher positive attitude. Also, research (Yaşar, 2016) found a moderate level of attitude towards the study of mathematics among high school students in Turkey. Furthermore, the findings showed that students' attitudes toward mathematics varied based on their school types.

Research revealed that students who performed better in geometry had positive attitudes toward geometry than their counterparts with poorer attitudes (Mato & De La Torre, 2010). Based on this finding, Mata et al. (2012) argue that a positive attitude towards geometry reflects a positive emotional disposition while a negative attitude towards geometry relates to a negative emotional disposition. Additionally, a positive attitude towards geometry reflects a positive self-confidence, enjoyment, value and emotional disposition likewise, a negative attitude towards geometry relates to a negative self-confidence, value, enjoyment and emotional disposition (Atanaso-Pachemska et al., 2015; Mata et al., 2012).

Methods

Study design

This study employed an explanatory sequential mixed-methods design, which involves collecting and analysing quantitative data first, followed by qualitative data to further explain or expand the quantitative results (Creswell & Plano Clark, 2018). In the first phase, a one-group pretest–posttest design was used to measure changes in students' motivation, self-confidence, and engagement after exposure to the inquiry-based teaching intervention in geometry. In the second phase, qualitative focus group discussions were conducted to provide deeper insights into the quantitative findings, helping to explain the reasons behind observed changes and to capture students' lived experiences of the intervention.

This design was deemed appropriate because it allowed the researcher to not only measure the impact of the intervention numerically but also to understand the contextual and experiential factors influencing students' attitudes and perceptions (Ivankova, Creswell, & Stick, 2006). By integrating quantitative and qualitative data, the study provided a more comprehensive understanding of the effects of inquiry-based teaching on student learning in geometry.

Although the explanatory sequential mixed-methods design strengthened the depth and interpretation of findings, some limitations remain. The one-group pretest–posttest design does not include a comparison or control group, which limits the ability to attribute observed changes exclusively to the intervention (Shadish, Cook, & Campbell, 2002). Nevertheless, the mixed-methods approach enhanced the credibility of the results by using qualitative insights to explain the quantitative changes.

Participants

This study was conducted in two senior high schools in Ghana. One category B school and C school. Category B schools are presumed to have very good students and improved infrastructure as compared to category C schools, who were resource constrained. The study involved 8 in-service mathematics teachers and 87 students. Multistage sampling was used to select both the schools and respondents. In the first stage, the researcher used simple random to select two senior high schools out of 7. Again, criteria purposive sampling was used to select the in-service mathematics teachers and the classes they teach to participate in the study. Specifically, four in-service mathematics teachers were selected from each school. In school A, fifty students participated in the first phase of the study and 37 students also participated in the second phase of the study.

Data collection instrument

The study's data was collected using a geometry attitude scale questionnaire and a focus group discussion. The geometry attitude scale was adapted from Asuman and Paksu (2007). The items on the questionnaire were measured on the five Likert's scale ranging from strongly agree to strongly disagree. The questionnaire contained 12 items grouped into two subscales namely motivation and self-confidence. Per the data collected, Cronbach's Alpha reliability coefficient of the motivation scale was 0.72 and self-confidence was 0.71. To

interpret the results, the researcher adopted mean scores of less than 3.0 to be a negative or poor attitude and greater or equal to 3.0 to be a positive attitude. Also, a focus group discussion was used to collect the qualitative data after the enactment of the lesson interventions.

Data analysis

The data analysis was done in two stages. In the first stage, the quantitative data was analysed using descriptive and inferential statistics. The mean and standard deviation were computed to determine the students' attitudinal level towards the learning of geometry. Also, an independent paired t-test was performed to determine any significant statistical differences between the students' attitudes before and after the implementation of the intervention. Again, an independent sample t-test was conducted to determine the gender difference in the student's attitudes and school type towards the learning of geometry.

The second stage was the qualitative analysis. The qualitative data were analysed using data reduction techniques. The audio data were transcribed and coded. Coding in qualitative analysis is identifying themes or categorising data. The researcher interpreted the themes or categorised data with direct quotes to support the quantitative findings.

Results

To answer research question one, the researchers computed a paired sample t-test to determine the students' mean performance in the pre- and post-tests (see Table 1).

Table 1. Mean difference of students' attitude in pre and post-tests (N = 87)

Test	Mean	Std dev.	t	Df	Sig. (2-tailed)	Effect size
Self-confidence pretest	2.39	1.069	-6.740	86	0.001	1.47
Self-confidence post-test	3.45	0.803				
Motivation pretest	2.30	0.589	-27.194	86	0.001	0.68
Motivation post-test	4.30	0.460				

p = 0.05 M < 3.0 = poor attitude & M ≥ 3.0 = positive attitude**

The students exhibited poor attitudes in terms of low self-confidence (M = 2.39 & SD = 1.069) and poor motivation (M = 2.30 & SD = 0.589) in the pretest because their mean values were less than 3.0. However, after the implementation of the study, their attitudes in terms of self-confidence (M = 3.45 & SD = 0.803) and motivation (M = 4.30 & SD = 0.460) toward the learning of geometry had improved as evidenced by their mean scores. Comparing their means scores, it was revealed that there were significant statistical differences in the student's self-confidence before (M = 2.39 & SD = 1.069) and after (M = 3.34 & SD = 0.803, t (86) = -6.740, p = 0.001). Again, there were significant statistical differences in the student's motivation before (M = 2.30 & SD = 0.589) and after (M = 4.30 & SD = 0.460, t (86) = -27.194, p = 0.001). Cohen's d paired sample effect sizes were conducted for both constructs which revealed that for self-confidence (d = 1.47) which signified that the intervention had a significant impact or contributed largely to the enhanced student confidence in the post-test, with the difference being more than 1.47 standard deviations from the mean. Motivation (d = 0.68) indicates a moderate to substantial difference between the paired measurements, suggesting that the intervention had a meaningful impact but not extremely strong.

Also, to address research question two, an independent t-test statistic was performed to investigate the intervention's impact on the students' attitudes towards learning geometry across genders (see Table 2).

Table 2. Mean difference in students' attitudes based on gender

Attitude	Sex	N	Mean	Std. Dev	t	df	Sig. (2-tailed)
Self-confidence	Male	49	3.372	0.855	-1.029	85	0.306
	Female	38	3.298	0.885			
Motivation	Male	49	4.293	0.423	-0.101	85	0.920
	Female	38	4.303	0.509			

$p = 0.05$

The variances were assumed to be equal for both the male and female students in self-confidence and motivation as $F(1, 85) = 0.274, p = 0.602$ and $F(1, 85) = 1.812, p = 0.182$, respectively. As presented in Table 3, the result revealed that the impact of the intervention across gender was statistically insignificant, meaning both the male ($M = 3.372$ & $SD = 0.855$) and female students ($M = 3.298$ & $SD = 0.885, t(85) = -1.029, p = 0.306$) enhanced their self-confidence equally. Also, the impact of the intervention on the motivation of the students across genders was statistically insignificant as evidenced by the mean scores of males ($M = 4.293$ & $SD = 0.423$) and females ($M = 4.303$ & $SD = 0.509, t(85) = -0.101, p = 0.92$). The results indicated that both male and female students benefited equally.

In order to answer the research question three, a further analysis was conducted to determine how the students perceived the intervention based on their school type using the post-test score. (see Table 3).

Table 3. Mean difference of students' attitudes based on school type

School type	N	Mean	Std. Dev.	T	df	Sig. (2-tailed)
Self-confidence	50	3.16	0.566	-4.331	85	0.001
	37	3.84	0.908			
Motivation	50	4.32	0.415	0.463	85	0.644
	37	4.27	0.519			

$p = 0.05$

Levene's test of the equality of variance $F(1, 85) = 3.738, p = 0.057$ assumed equal variance. Even though students from both schools saw improvement in their self-confidence, there was a significant statistical difference between the self-confidence of the students in category C ($M = 3.16$ & $SD = 0.566$) and the self-confidence of the students in category B ($M = 3.84$ & $SD = 0.908, t(85) = -4.331, p = 0.001$). This means that the intervention created a higher self-confidence among students in their attitude towards learning geometry in Category B than their counterparts in Category C.

For the students' motivation, equal variance was assumed as evidenced by $F(1, 85) = 3.25, p = 0.075$. Considering the students' motivation towards the learning of geometry, it was clear the impact of the intervention was felt, equally irrespective of their school type as evidenced by their mean differences (category B school [$M = 4.32$ & $SD = 0.415$] and category C school [$M = 4.27$ & $SD = 0.519, t(85) = 0.463, p = 0.644$]) which were not significant.

The qualitative data collected through a focus group discussion revealed two major themes and six sub-themes that contributed to the improvement in the student's attitudes toward the learning of geometry (see Table 4).

Table 4. Themes of the qualitative data

Major themes	Sub-themes
Motivation	Increased Interest in Geometry
	Engagement through Group Work
	Enjoyment of the Learning Process
Self-confidence	Increased Understanding and Independence
	Success in Problem-Solving
	Peer Support as a Confidence Booster

Most of the students expressed that they were motivated to learn because of the increased interest in geometry derived from their participation in the inquiry-based intervention. This assertion was supported by the quotes;

"I'm now interested in doing geometry and this has enabled me to remember what we learnt some time ago." (Student 2)

"Actually, at first, I was not interested in learning the subject but with apportioning us to groups, we have learned a lot by using the equipment... that has made me gain interest in the subject." (Student 11).

Also, some of the students admitted that engagement through group work motivated them to develop a positive attitude towards the learning of geometry. This was supported by the quotes.

"Sir, the participation in the group work has helped me to understand it because by sharing ideas, my group members brought different views about the work, and we were able to solve it successfully." (Student 6).

"Through the group studies, I have been able to remember everything that I was taught in the geometry concept." (Student 8).

Again, some of the students expressed that the enjoyment of the learning process motivated them to develop a positive attitude toward the learning of geometry. This was revealed in some of the students' comments as follows;

"I have realised that it was super interesting using the materials and the tools given to get to the solution, so it has improved my understanding and ability to learn on my own." (Student 12).

"I feel happy." (Student 13).

Another major theme identified was Self-Confidence. Most of the student revealed that increased understanding and independence have improved their confidence towards learning of geometry. This was supported by the following quotes from the students;

"When I came to join the class... I was scared of geometry questions, but with the introduction of inquiry learning... it has helped me to get a deeper understanding of the topic and remember it." (Student 1).

"Since we have been able to use different types of material in getting to the solution, I have been able to understand more about geometry learning, so I can now solve questions concerning geometry." (Student 3)

Also, many students admitted that their success in solving problems or questions in geometry greatly influenced their self-confidence.

"I was not able to solve geometry questions, but after the lesson... I have improved, I can tackle and solve more questions." (Student 4)

"I'm no longer in tragedy when it comes to geometry questions because, with the tools and equipment we used, I'm now perfect and interested in solving the geometry questions." (Student 5)

Finally, the majority of the students affirmed that peer support was their confidence Boost. In the sense that as they interact with their peers during the lesson, they have constructed their knowledge and understanding which boosted their confidence in the study of geometrical concepts. This was revealed in the following quotes;

"Because we are shared in groups when I did not have the idea of the question, my friends helped me to understand the question and also help me to answer it." (Student 9)

"In the class, I was able to interact with my friends and I was able to present the answers on the board so [it] helped me to remember everything I did in the class and whatever my friends told me." (Student 10)

Discussion

Before the implementation of the study's intervention, the findings of the study showed that the students had poor attitudes towards the learning of geometry as indicated by the pre-test results in terms of poor motivation

($M = 2.30$ & $SD = 0.589$) and lack of self-confidence ($M = 2.39$ & $SD = 1.069$). However, after the implementation of the study intervention, the findings revealed an enhanced or improved attitude of the students toward the learning of geometry. This positive attitude was displayed in the students' enhanced motivation ($M = 4.30$ & $SD = 0.460$, $t(86) = -27.194$, $p = 0.001$) and self-confidence ($M = 2.39$ & $SD = 1.069$) and after ($M = 3.34$ & $SD = 0.803$, $t(86) = -6.740$, $p = 0.001$) in learning and solving problems involving geometry.

The findings support studies that revealed that low interest in the study of mathematics and mathematics-related disciplines at all levels of education (Leyva et al., 2022; Eze & Madu, 2022; Arhin, & Yanney, 2020) as a result of the teaching approaches most mathematics teachers adopted in their classrooms which dampen the students' interest (Juman et al., 2022; Salman et al., 2012). Additionally, Marshall et al. (2017) asserted that the inquiry-based teaching approach has a positive effect on the mathematics achievement of students and their attitudes which is the same as the study's finding. This study aligns with studies that revealed a sharp decline in the student's attitude towards the learning of mathematics among secondary students across the globe (Wen & Dubé, 2022; Kunwar, 2020).

Also, these findings agree with Ahmed et al. (2013) who argued that there is a decline in motivation and self-confidence among adolescents toward learning mathematics across various grades. A similar finding was reported among German adolescents from Grades 7 to 8 (Frenzel et al. 2009). Furthermore, this study confirms the findings of Zacharos et al. (2021) that students' attitudes towards geometry are shaped by the methods of instruction. Drijvers et al. (2022) concluded that students who are exposed to dynamic geometry software, which allows for interactive manipulation of geometric figures, demonstrate increased interest and engagement with the subject (Drijvers et al., 2022). According to Sahlberg (2015), students tend to develop a more favourable attitude towards geometry when using innovative pedagogical approaches such as inquiry-based learning and the integration of technology.

A further finding revealed that the study intervention enhanced the attitudes of the male and female students equally. This finding is inconsistent with Bhowmik and Roy's (2016) finding that though boys and girls have positive attitudes towards learning mathematics, boys exhibited a slightly higher positive attitude. The findings did not corroborate the finding that gender differences persist, with males generally having more positive attitudes (Hwang & Son, 2021). However, the study supports Hwang and Son's (2021) explanation that self-confidence is identified as critical for cultivating a positive attitude, and teachers are instrumental in reinforcing this by creating relatable and enjoyable learning experiences.

Furthermore, the findings revealed the study intervention had improved the attitude of the students across school types; however, more improvement was realised in the students' self-confidence in Category B schools than in Category C schools, while the students' motivation was the same across the school type. This finding corroborates the finding of Yaşar (2016) that students' attitudes toward mathematics varied based on their school types.

Finally, the finding of the study confirms the framework of the study that the use of an inquiry-based learning approach to teach geometry in the blended constructivist and social constructivist environment suggested improvement in students' attitudes.

Conclusion and Recommendation

This study established the use of an inquiry-based teaching and learning approach in teaching geometric concepts as a critical tool for enhancing students' attitudes towards the learning of geometry. The findings of the study emphasised that the students who participated in the study or experienced inquiry-based intervention saw an improvement in their attitudes in terms of adequate motivation and a higher self-confidence toward learning geometry, irrespective of their gender and school types.

The study, therefore, recommended that schools should encourage and support teachers with the necessary resources to enable them to create conducive learning environments to implement inquiry-based teaching and learning approaches, especially during the teaching of geometric concepts, since it significantly improves their attitudes through motivation and self-confidence.

Ethical Statement

This study obtained ethical approval from the University of Cape Coast Ethical Review Board. Permissions were also granted by the headmasters of the participating schools. All student participants and their guardians provided informed consent before participation. Confidentiality and anonymity were assured throughout the study.

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Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript.

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