Peer-Assisted Learning as a Pathway to Academic Success: Unpacking the Mediating Role of Mathematics Attitude and the Moderating Effects of Interest.

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ABSTRACT

This study examined the relationship between peer-assisted learning (PAL) and students' mathematics achievement, focusing on the mediating role of students' attitudes and the moderating effect of mathematics interest. The research was conducted in the Sekyere-Kumawu District, Ashanti Region, Ghana, with 350 students from Banko SHS and Dadease Agric SHS selected via stratified and simple random sampling.

Using structural equation modeling (AMOS v23), results showed that PAL significantly predicted mathematics achievement. Students' attitudes partially mediated the PAL–achievement link (bias-corrected confidence interval did not include zero). Mathematics interest significantly moderated the attitude → achievement path, strengthening the positive effect of attitude on achievement. The study recommends integrating structured PAL programs into the curriculum and promoting positive mathematics attitudes through motivational activities, reinforcement, and supportive classroom environments.

Keywords: Peer Assisted Learning, Students' Academic achievement, Students' Attitude, and Mathematics Interest.

INTRODUCTION

Overview

Mathematics education is vital for scientific and economic growth, especially in Sub-Saharan Africa, where it is essential for higher education. In Ghana, students often struggle with mathematics due to limited resources, ineffective teaching, and negative attitudes. Peer-assisted learning (PAL) has been shown to enhance performance and motivation. interest, and positive attitudes also play key roles in improving achievement. This study explores how PAL affects academic performance, with attitude as mediator and interest as a moderator.

Background to the Study

Since the 1960s, innovative mathematical concepts and their applications in science, technology, and engineering have significantly shaped global development and everyday life. In today's technology-driven world, mathematics education remains essential for fostering critical thinking, problem-solving, and innovation. In most Sub-Saharan African countries, including Ghana, mathematics is a compulsory subject and a key requirement for higher education admission (Abreh, Owusu, & Amedahe, 2018). It is taught at all educational levels—from basic to tertiary—as it serves as both a foundation and a gateway for further studies and career opportunities. Mathematics thus plays a central role in national development and individual success (Mereku & Mereku, 2019).

Despite its importance, students' performance in mathematics continues to be a major concern in Ghana and other parts of Africa. Several studies attribute this challenge to factors such as inadequate teaching resources, large class sizes, math anxiety, and negative student attitudes (Adom, Mensah, & Dake, 2020; Mutodi &

Ngirande, 2014). Among innovative instructional approaches, peer-assisted learning (PAL) has emerged as a promising strategy for improving learning outcomes. PAL involves students supporting one another’s learning through structured collaboration (Arthur et al., 2022). It promotes engagement, motivation, and deeper understanding of mathematical concepts, particularly among diverse learners (Usman & Jamil, 2019).

Students’ attitudes toward mathematics are also crucial in shaping achievement. Learners who hold positive attitudes tend to value the subject, show greater confidence, and perform better (Chen, 2018; Martin, Mullis, & Hooper, 2020). Similarly, students’ interest in mathematics enhances motivation, persistence, and cognitive engagement, leading to improved performance (Rogan & Schmidt, 2017; Wong, 2019). When students find mathematics interesting and relevant, they are more likely to benefit from interactive and cooperative learning methods such as PAL.

Given these insights, this study investigates the relationship between peer-assisted learning and students’ academic achievement, focusing on the mediating role of students’ attitudes and the moderating effect of mathematics interest among senior high school students in Ghana.

Statement 0f The Problem

Mathematics is a core subject required for entry into senior high schools, colleges of education, polytechnics, and universities in Ghana, reflecting its importance at all educational levels (Denteh, 2017). Over the past three decades, researchers have identified several factors influencing students’ mathematics achievement, including attitudes, interests, and self-efficacy (Reardon & Robinson, 2009).

While studies have examined how these factors relate to achievement, limited research has explored how students’ interest in mathematics moderates the relationship between mathematics attitude and achievement, particularly within the Ghanaian context. This study addresses this gap by examining the relationship between peer-assisted learning and students’ academic performance, focusing on the mediating roles of attitude and the moderating effect of mathematics interest. By doing so, it provides a more comprehensive understanding of the factors that shape mathematics achievement among students in Ghana (Cavanaugh, 2023).

Purpose of the Study

This study sought to find the relationship between peer assisted learning and students’ academic performance, the mediating effect of students’ attitude, and the moderating effect of mathematics interest.

Objectives of the Study

1. To assess the effect of peer assisted learning on students’ mathematics performance.
2. To examine the mediating effect of students’ mathematics attitude through peer assisted learning and students’ academic achievement.
3. To determine the moderating effect of students’ mathematics interest on students’ mathematics efficacy and students’ mathematics performance

Research Questions

1. What is the effect of peer assisted learning on students’ mathematics performance?
2. What is the mediating effect of students’ mathematics attitude through peer assisted learning and students’ academic performance?
3. What is the moderating effect of students’ mathematics interest on students’ mathematics efficacy and students’ mathematics performance?

Significance of the Study

This study benefits educational stakeholders by showing how peer-assisted learning, self-efficacy, mathematics attitude, and interest influence students' achievement. It helps teachers understand how these factors interact to improve learning outcomes and guide effective instructional strategies.

The findings on the mediating roles of self-efficacy and attitude, and the moderating role of interest, offer insights for teachers, school leaders, and policymakers to develop programs that enhance students' confidence, motivation, and engagement in mathematics.

The results can also inform teacher training and policy initiatives that promote effective peer learning and improved mathematics performance. Parents will gain awareness of their children's attitudes toward mathematics, helping them foster positive learning habits and support academic success.

Delimitations

The study focused on Senior High School students in the Sekyere-Kumawu area, using two selected schools from the target population. It included first-, second-, and third-year students offering General Arts and General Science. The study examined key variables such as peer-assisted learning, self-efficacy, mathematics attitude, mathematics interest, and students' mathematics performance.

Limitations

The study's findings cannot be generalized to other regions because it was conducted only in the Sekyere-Kumawu District with just two schools

Organization of the Study

The research is organized into five chapters. Chapter One presents the background, problem statement, objectives, questions, hypotheses, significance, scope, methodology summary, and thesis structure. Chapter Two reviews literature on peer-assisted learning, self-efficacy, mathematics attitude, and interest, outlining the theoretical, empirical, and conceptual frameworks. Chapter Three explains the research design, population, sampling, data collection, analysis, and ethical considerations. Chapter Four presents and analyzes the data, while Chapter Five provides the summary, conclusions, recommendations, and directions for future research.

LITERATURE REVIEW

Introduction

This chapter reviewed the literature in relation to the study, looking at established dimensions of peer-assisted learning and students' performance in mathematics, as well as the mediating variables self-efficacy and student attitude toward mathematics and the moderating function of students' interest in mathematics in relation to their behavior, which were the independent variables.

Theoretical framework

Constructivism

Constructivism views learning as an active, social process in which learners construct knowledge based on prior experiences, interactions, and reflection. According to Baviskar et al. (2009), constructivism functions both as a learning theory and a teaching philosophy, promoting environments where students engage meaningfully with peers and teachers to co-construct understanding.

In the context of peer-assisted learning **(PAL)**, constructivism suggests that students enhance their understanding of mathematical concepts through collaboration and dialogue with peers. When students explain, question, and solve problems together, they not only deepen their comprehension but also develop positive attitudes toward learning. These positive attitudes can, in turn, **mediate** the relationship between peer learning and academic achievement by fostering confidence, persistence, and enjoyment in mathematics.

Furthermore, interest in mathematics, a motivational factor grounded in constructivist ideas of engagement, can **moderate** this relationship. Students with higher interest are more likely to benefit from PAL activities, as they are intrinsically motivated to participate, sustain effort, and apply learned concepts, resulting in improved academic performance.

Therefore, Constructivist Learning Theory provides the underlying rationale for examining how peer-assisted learning influences students' academic achievement, and how **attitudes** and **interest** shape and strengthen this relationship.

Empirical Framework

An empirical framework provides a structured approach for collecting, analyzing, and interpreting data based on observable evidence. It ensures that findings are grounded in real-world data through systematic investigation.

Students' Interest and Its Effect in Mathematics Education

Studies consistently show that students' interest strongly influences mathematics achievement. Heinze (2005) found a significant link between math interest and performance, while Morsanyi (2012) associated interest with attitudes toward statistics, self-efficacy, and anxiety. Frenzel et al. (2012) highlighted the decline of academic interest during adolescence, and Arthur et al. (2014) identified enjoyment as a major factor shaping math interest. Korhonen et al. (2016) observed that boys' educational goals were driven by achievement, whereas girls' were influenced by interest. Ufer, Rach, and Kosiol (2017) noted limited tools for assessing motivation, and Otoo (2018) revealed that motivation and confidence indirectly affect interest through anxiety and perceived usefulness.

Relationship Between Students' Attitudes and Mathematics achievement

Attitude, unlike emotion, reflects a stable psychological inclination toward a subject (Goldin, 2016; Philipp, 2007). It includes components such as enjoyment, confidence, and perceived value (Davadas, 2017; Di Martino, 2011; Mullis et al., 2020). Studies consistently show that positive attitudes correlate with higher performance (Madeleine, 2013; Hagan, 2020; Daud et al., 2020).

Dowker et al. (2019) found that attitudes explained 26% of the variance in math achievement among English and Chinese students, while Kiwanuka et al. (2020) confirmed similar results in Uganda. Positive attitudes foster motivation and persistence (Chouinard et al., 2007; Wang, 2008).

Neuroscientific evidence supports these findings,Chen, Liu, and Zhang (2018) showed that positive math attitudes enhance memory-based strategies, improving performance. However, mixed results exist: Köller et al. (2001), Mubeen et al. (2013), and Papanastasiou (2000) found weak or non-significant relationships depending on grade level and context, suggesting that instructional and cultural factors may mediate these effects.

Relationship Between Peer-Assisted Learning and Mathematics achievement

Leung (2019) and Alegre (2020) emphasized the need for further research comparing the effects of peer-assisted learning (PAL) at different educational levels. Studies show that PAL promotes engagement and improves mathematics outcomes (Brown, 2019; Pinter, 2022).

Peer tutoring occurs in two forms: same-age and cross-age. While early studies (Hartup, 1976; Scruggs & Osguthorpe, 1986) suggested that younger students benefit more from older tutors, later findings are mixed. Topping (2004) recommended a two-year age gap for optimal results, while Vogelwiesche (2006) found a general preference for cross-age tutoring. However, meta-analyses (Imam, 2022) report no significant

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performance difference between formats. Ramani et al. (2016) noted that same-age tutoring is easier to organize since it occurs within the same classroom setting.

Conceptual Framework

A conceptual framework outlines the researcher's understanding of the relationships among study variables and guides the investigation (Regoniel, 2005). It connects prior theories and observations to the current research focus.

Students' comprehension of mathematics is influenced by cognitive, affective, and environmental factors (Michael, 2015). Their engagement depends on classroom methods and learning environments. Adapting the framework of Anam-Siddique (2011), this study proposes that students' mathematics attitude (SMA) and self-efficacy (MSE) mediate the effect of peer-assisted learning (PEER) on mathematics achievement (ACH), while mathematics interest (SMI) moderates these relationships.

Peer-Assisted Learning and achievement. Peer-assisted learning (PAL) engages students in supporting each other's learning, fostering active participation, collaboration, and improved performance (Havens & Williams, 2019; Arthur et al., 2022). Rooted in social learning theories by Piaget, Vygotsky, Bandura, and Dewey, PAL promotes motivation and deeper understanding of concepts. Originating from Bell and Lancaster's 18th-century model, it now includes same-age and cross-age tutoring, both shown to enhance academic achievement (Topping, 1996). Peer tutoring strengthens academic outcomes, confidence, and social skills for both tutors and learners (Bowman-Perrott et al., 2009). Teachers can effectively use PAL to boost engagement and support diverse learning needs in mathematics classrooms.

Mathematics Achievement

Mathematics achievement reflects students' mastery of mathematical concepts, reasoning, and problem-solving (Lestari & Yudhanegara, 2015). It is vital for scientific inquiry, logical thinking, and intellectual growth across educational levels.

Renninger (2024) identifies four dimensions of achievement: (1) foundational knowledge, (2) logical reasoning, (3) career opportunities, and (4) appreciation of mathematics as a universal discipline. Achievement is shaped by curriculum quality, teaching methods, parental support, and learners' attitudes and interests (Bhattacharjee, 2012; Hagan et al., 2020).

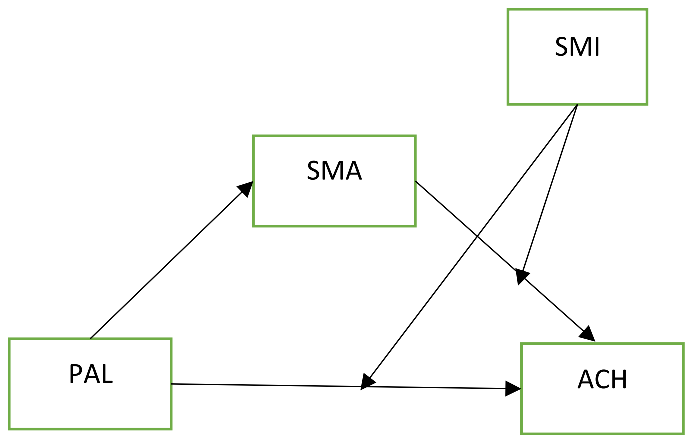

Figure 1: Conceptual Framework

SMA- Students' Mathematics Attitude SMI- Students' Mathematics Interest PEER- Peer Assisted Learning ACH- Students' Mathematics Achievement

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METHODOLOGY

Introduction

Research methodology outlines the systematic steps taken to investigate a particular research problem. This study looks at the mediating roles that students' attitudes, efficacy, and interest in mathematics have in the relationship between peer assisted learning and academic success. It took a well-planned scientific inquiry to guarantee the validity and trustworthiness of the study's techniques, procedures, methods, and conclusions. As a result, among other methodological components, this chapter addresses the research philosophy, methodology, design, study population, sampling strategies, data collection methods and processes, and features pertaining to validity, reliability, data analysis, and ethical considerations.

Research Paradigm

This study adopted a positivist research paradigm, which emphasizes objective, measurable, and generalizable knowledge (Saunders et al., 2015). Positivism relies on logical reasoning, systematic procedures, large samples, and quantitative analysis to test hypotheses and establish causal relationships (Cottrell, 2014). The study followed a quantitative and deductive approach, consistent with positivist principles. Hypotheses were formulated and tested statistically to examine cause-and-effect relationships between variables (Manion & Morrison, 2002; Ary et al., 2018). This approach aligns with the hypothetico-deductive model, where theories are tested through empirical observation and numerical analysis (Park, 2020).

Research approach

This study employed a quantitative approach, which emphasizes collecting and analyzing numerical data using statistical methods to identify patterns and relationships (Creswell, 2014). Quantitative research relies on deductive reasoning, breaking the social environment into measurable variables expressed as frequencies or rates, then testing relationships among them statistically (Rahman, 2017).

Data collection and analysis were guided by theory and hypotheses, using descriptive statistics to summarize findings (Shekhar et al., 2019; Tashakkori & Teddlie, 2010). This approach assumes an objective reality that can be systematically measured and analyzed (Galli, 2019).

Research Design

A research design provides the overall framework for collecting and analyzing data to address research questions (Siedlecki, 2020). This study used a descriptive cross-sectional design, which examines data from a population at a single point in time. Descriptive surveys help identify patterns, attitudes, and perceptions related to a phenomenon (Aubert et al., 2006). This design was chosen to describe existing conditions, analyze relationships among variables, and provide insights useful for decision-making and policy development.

Population

A population, according to Best and Kahn (2009), is any group of individuals who share one or more characteristics that are relevant to the researcher’s interest. This population may include all individuals of a certain type or a specific segment of them. In this study, the target population comprises senior high school students in the Sekyere-Kumawu District. The final data collection involved two schools: Bankoman SHS and Dadease Agric Senior High School, with a combined student population of 3000

Sample size

A sample is a subset of a population selected to represent the broader group and provide insights about it. It serves as a smaller version of the entire population from which it is drawn. In this study, the accessible sample consisted of 350 students from the study site, representing approximately 8% of all senior high school students within the study area. This sample size was determined using Yamane's formula for calculating sample sizes from a population, with a significance level (e) of 0.05, as shown below:

N n = 1_______ + Ne_2 $where$ N = 4400 $n = \frac{4400}{1 + 4400(0.05)^2}$

$n \approx 350$

Sampling Procedure

Sampling involves selecting a smaller, representative subset of a population for study. Since including the entire population is often impractical, a sample enables researchers to generalize findings. In this study, **proportional stratified random sampling** was used to select participants from each school based on their population size. This method, recommended when a population contains distinct subgroups, involves dividing the population into strata and randomly selecting participants from each (Acharya et al., 2013). Common stratification variables include age, gender, religion, and school.

At Bankoman **SHS**, with a population of approximately 2,100 students, a sample of **169 participants** was selected. At Dadease Agric SHS, a sample of **181 participants** was drawn. Within each school, **simple random sampling** was used to select participants. At **Bankoman** SHS, slips of paper marked "YES" and "NO" were folded and mixed for students to draw. Those who selected "YES" were included in the sample. The same procedure was used at Dadease Agric SHS, where 192 slips marked "YES" were included in the draw. Students who picked "YES" formed the final sample for that school.

Research Instrument

A questionnaire was used as the main data collection instrument, a common tool in educational research (Taherdoost, 2018). Its purpose was to obtain accurate and reliable data on the effects of peer tutoring, self-efficacy, mathematics attitude, and interest on students' mathematics performance.

The questionnaire consisted of **50 closed-ended items** based on five constructs: Peer-Assisted Learning, Self-Efficacy, Student Mathematics Attitude, Mathematics Interest, and Mathematics Performance. Each construct included **10 items** rated on a **five-point Likert scale** (1 = Strongly Disagree to 5 = Strongly Agree).

Section A gathered participants' background information (sex, age, level, and parental background), while Sections B to E addressed the respective constructs listed above.

Data Collection Procedure

The questionnaire was individually distributed by the researcher in each of the two schools. Students of mathematics at high schools within the district were given a questionnaire to respond. The questionnaire that was given out received responses from all 350 participants in total. It took one month, and three weeks to administer the questionnaire and responses were obtained for further analysis.

Validity and Reliability of Instrument

Validity refers to how well an instrument measures what it is intended to measure (Taherdoost, 2018; Moses, 2021). It considers factors such as clarity, consistency, readability, and relevance of items. Reliability, on the other hand, measures the stability and consistency of the instrument over time (Surucu & Maslakci, 2020).

To ensure both validity and reliability, the researcher adapted existing validated instruments and sought expert review for feedback. A pilot test was conducted, and Cronbach's alpha coefficients were computed for all variables, each exceeding **0.8**, confirming high reliability.

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Data Analysis Procedure

The data analysis tool that the researcher employed in the analysis was Structural Equation Modeling (SEM). According to (Fan, 2016), because of the vast range of problems it may help solve, structural equation modelling (SEM) is a popular analysis tool for quantitative data. The term "structural equation modelling" (SEM) refers to a broad range of techniques used by researchers in both quantitative and empirical studies in the social sciences, business, and other disciplines. The social and behavioural disciplines use it the most. To depict the various components of a visible or hypothetical event that are said to be directly structurally linked to one another, SEM entails the construction of a model. The structural characteristics of the model suggest theoretical connections between the factors that most accurately depict the studied event. The hypothesized causal structuring is frequently portrayed by lines showing the causal relationships between the variables, but these relationships can also be represented by equations. When using structural equation modelling, various pieces of information relevant to this technique should be reported. A collection of statistical techniques known as structural equation modelling analyses connections between one dependent variable and several independent variables.

Ethical Consideration

When conducting a study, (Saunders, Lewis, and Thornhill, 2007) emphasize how crucial it is to get respondents' consent and follow research ethics. Thus, the researcher assured the respondents of their privacy and confidentiality. The researcher reassured the participants one more time, stressing that any information they submitted would be treated with the utmost discretion and that their names would stay secret. In addition, the participants were made aware of their right to decide not to participate in the study. Finally, the researcher was open and honest; neither did he purposefully mislead the volunteers about any of the components of the investigation, including any risks, discomforts, or rewards.

RESULTS OF THE STUDY

Overview

The purpose of this study is to determine the relationship between students' academic performance and peer-assisted learning, as well as the moderating role of mathematics interest and the mediating role of students' attitude and efficacy. This section contains explanations of the specific study goals and information regarding data analysis.

Exploratory Factor Analysis (EFA)

From a variety of connected items, distinct and uncorrelated components were extracted using exploratory factor analysis (EFA). EFA was also used to calculate the factor structure of the dataset using SPSS (version 23) and evaluate its internal reliability. The linked elements were analyzed, and the loading of each observable variable onto its matching latent variable was assessed. As per (Sürücü, 2022), this approach reduced or deleted several observable survey factors that did not load appropriately onto the latent variables. The EFA findings are shown in Table 3, where the observed variables are arranged according to the relevant hidden variables.

Table 1: Exploratory Factor Analysis (EFA)

Measurement Items	**1**	**2**	**Components 3**	**4**	
SMI1	.935				
SMI2	.887				
SMI3	.981				
SMI4	.916				

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue X October 2025

SMI5	.963				
ACH1		.851			
ACH2		.856			
ACH3		.887			
ACH4		.873			
ACH5		.770			
SMA1			.717		
SMA2			.898		
SMA3			.811		
SMA4			.764		
SMA5			.691		
PEER1				.866	
PEER2				.821	
PEER3				.696	
PEER4				.777	
PEER5				.669	

Total Variance Explained		62.99%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.936
Bartlett's Test of Sphericity	Approx. Chi-Square	8801.180
	Df	666
	Sig.	.000
a. Determinant		8.573E-1

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue X October 2025

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 5 iterations. **Source: Field Survey (2025)**

The number of observable variables linked to each matching latent variable on the right is displayed in Table 3. It was determined that the Students' Mathematics Interest (SMI) variable was loaded on the first construct with five (5) observable items in its correct definiteness. The second construct with five (5) observable items in its correct definiteness was Students' Mathematics Achievement (ACH). Students' Mathematics Attitude (SMA) variable had six (5) items and the fourth construct loading was Peer-Assisted Learning variable with five (5) observable items in its correct definiteness. The coefficient of determination, with a Kaiser-

Meyer-Olkin Measure of Sampling Adequacy (KMO) of 0.936, was found to be

8.573E-1. The KMO stated that there was 93.2>50 percent presumption of adequate loading for the observable factors on the hidden(latent) variables in their perspective dimension.

Descriptive Analysis

Descriptive statistics such as the mean and standard deviation are used to summarize and describe the main features of a dataset (Investopedia, 2025; Purdue OWL, 2024). This study presents mean scores for five constructs, peer-assisted learning, mathematics self-efficacy, attitude, interest, and achievement, measured on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The results are shown in Table 2.

Table21: Descriptive Statistics

Variable	**Mean**	**Std. Deviation**
ATTITUDE OF STUDENTS IN MATHEMATICS I have trouble understanding anything related to mathematics	3.2329	1.11583
I'm just not good at mathematics.	3.6082	.93904
I get very nervous during mathematics class.	3.0932	1.03620
I often worry that it will be difficult for me to attend math lectures	3.9233	.64589
I often feel helpless when trying to solve a math problem	3.7836	.59277
Mathematics makes me feel uneasy and confused.	3.9288	.81562
Total	**3.5950**	**0.8575**
STUDENTS' ACHIEVEMENT IN MATHEMATICS I am good at working out difficult mathematics tasks	3.2959	1.32396
Mathematics is not one of my strengths	3.5671	1.23769
I am just not good at mathematics	3.4849	1.14734

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Mathematics is extra problematic for me than for many of my

classmates	3.8192	1.16740
I think learning mathematics will help me in my daily life	3.1781	1.17134
Total **PEER-ASSISTED LEARNING IN MATHEMATICS** Peer assisted learning is an effective intervention for the	**3.4690**	**1.12095**
improvement of content knowledge, and increase understanding of subject matter. Peer assisted learning is found to be effective in assisting students	3.6740	.91117
improve teaching practices in the classroom. In peer assisted learning, students work in one-on-one pair which	3.6356	.69641
increase academic commitment in the school environment. Peer assisted learning creates a friendly learning environment in the	3.6329	.65214
school. Peer assisted learning helps the teacher to engage all students of the	3.7507	.80574
classroom in learning activity according to their individual needs	3.8575	.91776
Total **STUDENTS' INTEREST IN MATHEMATICS**	**3.71014**	**0.79664**
I enjoy learning mathematics	3.4822	.56727
I like mathematics	3.5534	.62505
Mathematics is boring	3.0110	1.02437
I learn many interesting things in mathematics	3.6712	.77486
I like to solve mathematics problems	3.4411	1.40641
Total	**3.43178**	**0.80759**

Source: Field Survey (2024)

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue X October 2025

Descriptive analysis was used to assess model fit and test the normality of questionnaire items. Mean and standard deviation evaluated whether data met multivariate normality assumptions. On a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), mean scores above 3.0 indicate positive responses. Table 2 presents descriptive statistics for students' mathematics interest, self-efficacy, attitude, peer-assisted learning, and achievement. All variables recorded means above 3.0 and standard deviations within ±2, suggesting normal distribution, with SD values below 1.5 indicating tightly clustered data around the mean.

Confirmatory Factor Analysis (CFA)

CFA was conducted to test the hypothesized relationships between observed variables and their underlying latent constructs. It assessed how well the observed data fit the theoretically grounded model and specified causal relationships among latent factors.

Using AMOS (version 23), CFA evaluated the validity of the measurement model. This approach was chosen for its flexibility in estimating multiple statistical parameters and assessing construct validity (Byrne, 2016; Brown, 2015). Table 4 presents the CFA results. Following the EFA, only variables with factor loadings above 0.5 were retained. As shown in Table 4, all factor loadings exceeded 0.5, indicating strong construct validity and suitability for further analysis.

Table3: Confirmatory Factor Analysis

Model Fit Indices: *CMIN = 310.855; DF = 164; CMIN/DF = 1.895; CFI = .960; TLI = .953; RMR = .024; RMSEA = .051; PClose = .439*

Loading

Attitude of Students in Mathematics AVE=0.587; CR=0.877; CA=0.84;

I have trouble understanding anything related to mathematics	.783
I'm just not good at mathematics.	.772
I get very nervous during mathematics class.	.789
I often worry that it will be difficult for me to attend math lectures	.749
I often feel helpless when trying to solve a math problem	.735
Students' Achievement in Mathematics AVE=0.582; CR=0.874; CA=0.85;	
I am good at working out difficult mathematics tasks	.790
Mathematics is not one of my strengths	.717
I am just not good at mathematics	.800
Mathematics is extra problematic for me than for many of my classmates	.764
I think learning mathematics will help me in my daily life	.741

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academic commitment in the school environment.	.800
Peer assisted learning creates a friendly learning environment in the school. Peer assisted learning helps the teacher to engage all students of the	.688
classroom in learning activity according to their individual needs **Students' Interest in Mathematics AVE=0.670; CR=0.910; CA=0.910;**	.705
I enjoy learning mathematics	.776
I like mathematics	.832
Mathematics is boring	.810
I learn many interesting things in mathematics	.858
I like to solve mathematics problems	.814

Source: Field Survey (2025)

Table 3 from the EFA shows five observed variables each for Students' Mathematics Attitude (SMA), Students' Mathematics Interest (SMI), Peer-Assisted Learning (PEER), and Mathematics Achievement (ACH). After CFA analysis using AMOS v23, all factor loadings exceeded 0.5, and all items were retained for further analysis.

As shown in Table 4, the CFA model fit indices met the recommended thresholds (Hair et al., 2014): CMIN/DF < 3, RMR and RMSEA < 0.08, and CFI and TLI ≥ 0.9. The results indicated CMIN/DF = 1.895, RMR = 0.024, RMSEA = 0.051, and p-close = 0.451 (> 0.05). Both TLI (0.96) and CFI (0.95) exceeded 0.9, confirming a good model fit. Figure 2 presents the CFA model diagram.

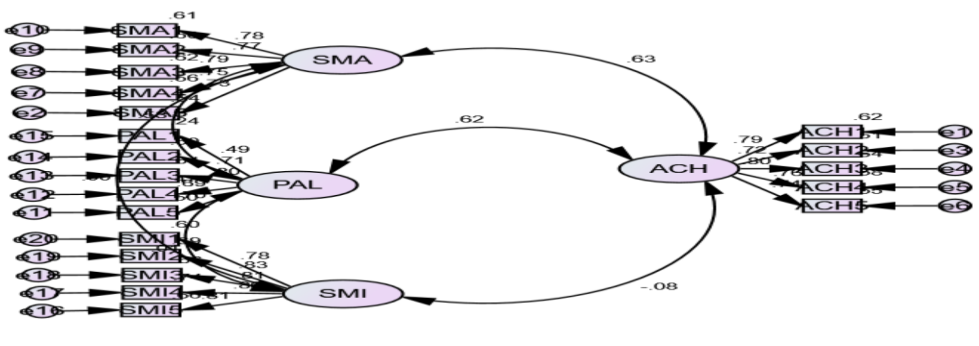

Figure 2: Confirmatory factor Analysis diagram

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Discriminant Validity

Convergent validity and reliability of the CFA model were assessed using Average Variance Extracted (AVE) and Composite Reliability (CR). Convergent validity measures how closely observed items relate within the same construct (Trochim & Donnelly, 2001). Acceptable thresholds are AVE ≥ 0.5 and CR ≥ 0.7. The results showed AVE for all the constructs and CR meeting the recommended criteria (Farrell, 2010).

Table4: Discriminant Validity

Variables	**PAL**	**SMA**	**SMI**	ACH	
PAL	**0.707**				
SMA	0.532	**0.766**			
SMI	.218	0.305	**0.819**		
ACH	0.618**	0.632	0.412	**0.763**	

** ~ P-value significant at 1% (0.01) √AVE are bold and underline {**Source: Field Survey (2024)}**

From Table 5, the square roots of the Average Variance Extracted (√AVE) for all constructs are greater than their corresponding inter-construct correlations. The least √AVE value (0.752) exceeds the highest correlation coefficient (0.618), indicating that each construct is distinct from the others. Therefore, discriminant validity is established, confirming that the observed items under each construct are appropriate for further analysis.

Path Analysis

The study employed covariance-based SEM using AMOS v23 to estimate path coefficients. The results are presented in Table 7 and illustrated in Figure 3.

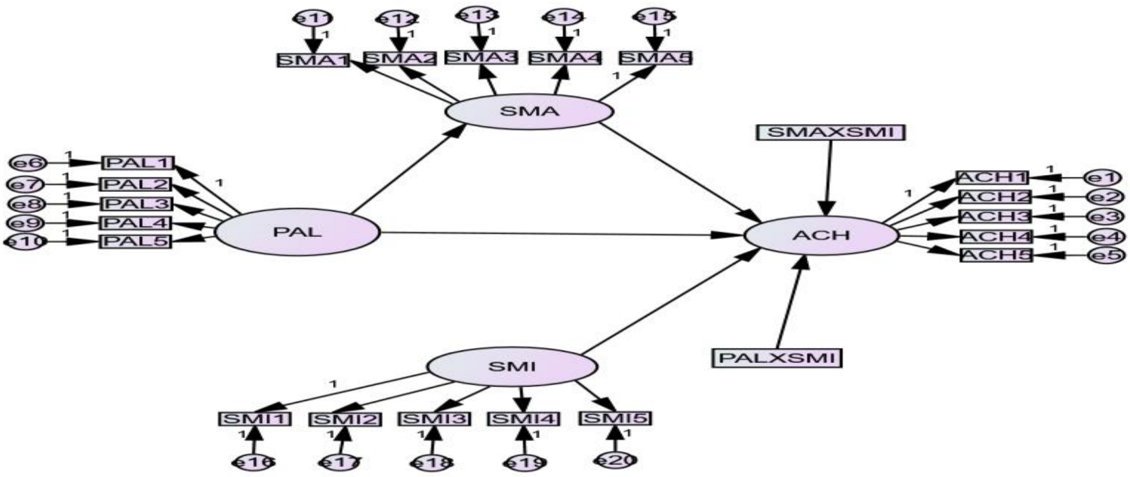

Figure 2: Diagram depicting the path Analysis

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Table 5: Path Coefficient of Hypotheses.

Path	Estimate (β)	S.E.	C.R.	p-value	Significance
PAL → SMA	**0.917**	**0.144**	**6.365**	**< .001**	*****
SMA → ACH	**0.473**	**0.072**	**6.531**	**< .001**	*****
PAL → ACH	**0.758**	**0.143**	**5.292**	**< .001**	*****
SMI → ACH	**0.215**	**0.061**	**3.525**	**< .001**	*****
SMA X SMI	**0.186**	**0.067**	**0.2776**	**<.001**	*****

Table 6 Indirect, Direct, and Total Effects with Confidence Intervals (Standardized)

Effect	Estimate	Lower Bound	Upper Bound	p-value
Indirect Effect				
PAL → SMA → ACH	0.434	0.317	0.551	< .001
Direct Effects				
PAL → ACH	0.758	0.478	1.038	< .001
SMA → ACH	0.473	0.332	0.614	< .001
SMI → ACH	0.215	0.096	0.334	< .001
Total Effect				
PAL → ACH (Total)	1.192	0.795	1.589	< .001

The Effect of Peer-Assisted Learning on Students' Mathematics Achievement

This path represents **Hypothesis 1 (H1): Peer-assisted learning positively influences students' mathematics achievement.** From the Table , the path estimation results of the AMOS structural equation modeling revealed that **peer-assisted learning** is a **significant positive predictor** of students' mathematics achievement in the two study areas. The results indicate that **β = 0.758**, **C.R = 5.353**, and **p < 0.001**. This finding implies that **peer-assisted learning contributes approximately 75.8%** to students' mathematics achievement. The critical ratio (C.R), equivalent to the t-test statistic, exceeds the threshold value of **1.96**, confirming statistical significance. Consequently, the null hypothesis is **rejected**, and it is concluded that peer-assisted learning has **a** significant positive influence on students' mathematics achievement.

The Mediating Effect of Students' Mathematics Attitude Between Peer-Assisted Learning and Students' Academic Achievement

The second hypothesis (H2) proposed that students' mathematics attitude mediates the relationship between peer-assisted learning and students' academic achievement. As shown in Table 7, peer-assisted learning had a significant positive direct effect on students' mathematics attitude (β = 0.917, C.R. = 6.365, p < .001). Similarly, students' mathematics attitude also exerted a significant positive direct effect on students' academic achievement ($\beta = 0.473$, C.R. = 6.531, $p < .001$).

The indirect effect of peer-assisted learning on students' academic achievement through students' mathematics attitude was statistically significant (Estimate = 0.434, 95% CI [0.317, 0.551], $p < .001$), as shown in Table 4. Since the confidence interval does not include zero, mediation is confirmed.

These results indicate that students' mathematics attitude partially mediates the relationship between peer-assisted learning and academic achievement. In other words, peer-assisted learning enhances students' attitudes toward mathematics, which in turn improves their academic achievement. Therefore, the null hypothesis is rejected, confirming that students' mathematics attitude significantly mediates the relationship between peer-assisted learning and students' academic achievement.

The Moderating Effect of Students' Mathematics Interest on the Relationship Between Students' Mathematics Attitude and Achievement

This phase of the analysis tested Hypothesis 4 (H4), which proposed that students' mathematics interest moderates the relationship between their mathematics attitude and mathematics achievement.

As shown in Table 7, the moderating effect of students' mathematics interest on the relationship between mathematics attitude and achievement (represented by the interaction term SMA × SMI) was statistically significant ($\beta = 0.186$, S.E. = 0.067, C.R. = 2.776, $p < .001$).

The positive coefficient indicates that higher levels of students' mathematics interest strengthen the positive relationship between their mathematics attitude and achievement. In other words, students with greater interest in mathematics benefit more from positive attitudes toward the subject in terms of achievement.

Consequently, the null hypothesis is rejected, confirming that students' mathematics interest significantly moderates the relationship between mathematics attitude and mathematics achievement.

DISCUSSION OF THE RESULTS

The results from Table 5 show clear relationships among peer-assisted learning (PAL), students' mathematics attitude (SMA), mathematics interest (SMI), and achievement (ACH). The findings confirm that peer-assisted learning, supported by positive attitudes and interest, significantly improves students' mathematics achievement both directly and indirectly.

The first hypothesis (H1) examined the effect of peer-assisted learning on mathematics achievement. The analysis revealed a strong, positive, and significant effect ($\beta = 0.758$, $p < .001$), indicating that students who learn collaboratively perform better in mathematics. This finding supports Vygotsky's (1978) Social Constructivist Theory, which emphasizes learning through social interaction. It is also consistent with studies by Johnson and Johnson (2017) and Ginsburg-Block et al. (2006), who found that peer collaboration enhances understanding and achievement. More recent studies, such as Gillies (2019) and Kumi-Yeboah and Kim (2020), also confirm that cooperative learning fosters deeper conceptual understanding and improved performance.

The second hypothesis (H2) tested the mediating role of students' mathematics attitude between peer-assisted learning and achievement. Results showed that attitude significantly mediates this relationship ($\beta = 0.434$, $p < .001$), indicating that peer learning not only improves achievement directly but also enhances students' confidence and motivation toward mathematics, which in turn boosts performance. This supports Bandura's (1997) Social Learning Theory and aligns with the findings of Mensah et al. (2013), Nesmith and Cooper (2020), and Ramdass and Masithulela (2022), who emphasized that positive attitudes and motivation contribute significantly to academic success.

The third hypothesis (H3) examined the moderating effect of students' mathematics interest on the relationship between attitude and achievement. The results ($\beta = 0.186$, $p < .001$) indicate that mathematics interest significantly moderates this relationship. The positive coefficient suggests that higher levels of interest strengthen the impact of positive attitudes on achievement — students with greater interest in mathematics benefit more from positive attitudes toward the subject. This finding supports studies by Singh et al. (2002), Aremu (2011), and Gillies (2019), which identified motivation and interest as key determinants of mathematics performance.

Overall, the study confirms that peer-assisted learning, attitude, and interest are interrelated factors that jointly predict mathematics achievement. Students who engage in collaborative learning, develop positive attitudes, and maintain interest in mathematics achieve better outcomes. These findings highlight the importance of student-centered and interactive teaching approaches that promote collaboration, nurture positive attitudes, and sustain student interest to enhance mathematics achievement.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Introduction

This chapter presents the summary of key findings, conclusions, and recommendations drawn from the study's results.

Summary

The study examined the influence of **peer-assisted learning (PAL)** on students' mathematics achievement, considering the **mediating roles of students' mathematics attitude (SMA)** and **self-efficacy**, and the moderating role of mathematics interest (SMI**)**.

The research was conducted among senior high school students in the **Sekyere-Kumawu District of the Ashanti Region, Ghana**, involving participants from **Bankoman SHS** and **Dadease Agric SHS**. Using **proportional stratified random sampling**, a total of **350 students** participated in the study, **169 from Bankoman SHS** and **181 from Dadease Agric SHS**. Data were collected using a structured questionnaire adapted from validated instruments measuring five constructs: peer-assisted learning, self-efficacy, mathematics attitude, mathematics interest, and mathematics achievement. Two incomplete responses were excluded prior to analysis.

Data were analyzed using Structural Equation Modeling (SEM) in AMOS version 23, which included Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and path analy**sis** to assess direct, indirect, and moderating effects.

The major findings were as follows:

- **Demographic variables:** Students' age and gender had no significant effect on mathematics achievement, while academic level (form) had a significant effect. Religious affiliation had no significant impact.
- **Peer-assisted learning:** PAL significantly and positively predicted students' mathematics achievement (**$\beta = 0.758$, $p < .001$**).
- **Mediating effect:** Students' mathematics attitude significantly mediated the relationship between peer-assisted learning and achievement (**$\beta = 0.434$, $p < .001$**).
- **Moderating effect:** Mathematics interest significantly moderated the relationship between attitude and achievement (**$\beta = 0.186$, $p < .001$**)

Conclusion

The study concludes that **peer-assisted learning (PAL)** is a powerful and effective instructional approach that substantially enhances students' mathematics achievement. The findings from the SEM analysis confirmed that PAL exerts a strong **direct influence** on achievement and an **indirect influence** through students' mathematics attitude, which serves as a **partial mediator**. Additionally, students' **mathematics interest** significantly moderates the relationship between attitude and achievement, indicating that the strength of this link varies with levels of interest.

Overall, the study establishes that **peer-assisted learning, positive attitudes, and sustained interest** jointly contribute to improved mathematics performance. Encouraging collaborative learning and fostering motivational classroom environments can therefore play a vital role in improving mathematics outcomes among Ghanaian senior high school students.

Suggestions for Further Studies

Future research should:

- Explore **different models or variations of peer-assisted learning**, such as digital or cross-grade peer tutoring, to assess their long-term effects on academic performance..
- Conduct **longitudinal studies** to determine the lasting impact of peer-assisted learning and

Recommendations

Based on the findings, the following recommendations are proposed:

- **Integration of peer-assisted learning:** Schools should incorporate PAL strategies into mathematics instruction to enhance student engagement, critical thinking, and collaboration. Training workshops should be organized for teachers and student leaders on effective peer-learning methods.
- **Promotion of positive attitudes:** Educational stakeholders should develop programs—such as **mentorship, motivational talks, and peer-support clubs**—to cultivate positive attitudes toward mathematics.
- **Enhancement of mathematics interest:** Teachers should employ **real-life applications, technology-driven learning tools, and interactive teaching approaches** to make mathematics more relatable and engaging for students.
- **Policy and curriculum support:** The Ghana Education Service (GES) should consider integrating peer-assisted learning models into the national mathematics curriculum and teacher-training programs to promote learner-centered education.

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