International Journal of Mathematics and Mathematics Education
https://journals.eduped.org/index.php/ijmme
Volume 03, No. 1, 2025

e-ISSN 2986-4534
p-ISSN 2988-0734

The Mediating Role of Teacher Effective Communication on the Relationship between Students' Mathematics Interest and their Mathematics Performance

Paul Agmabire Akendita[1*], Francis Ohene Boateng[2], Yarhands Dissou Arthur[3], Gideon Mensah Banson[4], Maccarthy Abil[5], Marfo Ahenkorah[6]

[1,2,3,5,6]Department of Mathematics Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Ghana
[4]Department of Mathematics and Mathematics Education Syracuse University, United States

*Corresponding author: paulakendita@gmail.com

Article Info

Revised October 27, 2024
Accepted December 30, 2024

Abstract

The study investigated how teacher-effective communication mediated the relationship between students' mathematics interest and performance. The descriptive survey design, which is anchored on the quantitative research approach of the positivism paradigm, was used, and 200 second-year students of a Senior High School in the Talensi district of the Upper East Region were selected through the means of stratified sampling procedures as well as random selections from the strata. A structural equation model (SEM) with bootstrap samples was used to analyze the gathered data, and it was discovered that students' performance in mathematics was positively and statistically impacted significantly on their interest in the subject. In addition, teacher-effective communication was found to have a significant direct positive statistical effect on students' mathematics performance. Furthermore, students' mathematics interests correlated positively with the teacher's effective communication. The findings indicated that there existed a partial mediation effect of teacher-effective communication on the relationship between students' mathematics interest and students' mathematics performance. Teachers should be allowed to grow professionally in teaching mathematics to communicate vividly and efficiently in mathematical concepts. This will strengthen their mathematical communication skills and also imbibe in them the abilities to incorporate different kinds of collaborative learning techniques to aid students in making faster progress in their mathematical proficiency.

Keywords: Mediation analysis; Students' mathematics interest; Students' mathematics performance; Teacher effective communication.

This is an open-access article under the CC BY license.

How to cite: Akendita, P. A., Boateng, F. O., Arthur, Y. D., Banson, G. M., Abil, M., & Ahenkorah, M. (2025). The Mediating Role of Teacher Effective Communication on the Relationship between Students' Mathematics Interest and their Mathematics Performance. *International Journal of Mathematics and Mathematics Education*, 03(1), 1-17, doi. https://doi.org/10.56855/ijmme.v3i1.1214

1. Introduction

Mathematics is the foundation for daily activities globally, encompassing mobile devices, computers, software, art, money, engineering, social sciences, education, medicine, and sports. It is also integral to both ancient and modern architecture (Resnick, 2020). Kuennen and Beam (2020) emphasize that mathematics education should highlight its role as a cornerstone for other academic subjects, fostering critical thjnking skills such as logical reasoning, accuracy, and spatial awareness. Additionally, mathematics strengthens problem-solving abilities, transforming challenging tasks into enjoyable intellectual pursuits (Casey & Ganley, 2021). Akendita et al. (2024), further broaden the discussion by pointing out that mathematics, as a foundational subject, is essential for cognitive growth, professional opportunities, and academic success. Akendita et al. (2024), further noted that mathematics is indispensable for personal development and achievement in today's technologically advanced world.

Despite its significance for national development and aspirations, mathematics performance among Ghanaian Senior High School (SHS) students remains inconsistent. This has become a longstanding concern for parents, educators, policymakers, and other stakeholders (Lafuente-Lechuga et al., 2020). This inconsistency is evident in the performance of Ghanaian students in Core Mathematics during the West African Senior School Certificate Examination (WASSCE) from 2018 to 2023, which has shown notable fluctuations. In 2018, the pass rate was 48.15%, indicating significant student performance challenges. However, there was a considerable improvement in 2019, with the pass rate rising to 64.18%. This positive trend continued in 2020, reaching 65.71%. Unfortunately, in 2021, the performance declined, as the pass rate dropped to 54.11%. In 2022, there was a recovery, with the pass rate increasing to 61.39%, and in 2023, it slightly improved further to 62.23% (Gna, 2023). According to the Ghana Education Sector annual report in 2024, this performance of core mathematics is still low as compared to other core subjects like, English Language, Integrated Science, and Social Studies (Gna, 2023). The statistics reveal a pattern of improvement in some years and setbacks in others, emphasizing the importance of addressing underlying factors affecting mathematics performance. The underperformance of SHS students in mathematics hinders their progression into science, technology, engineering, and mathematics (STEM) fields, which are essential for national industrialization and economic development (Arthur et al., 2022) Consequently, mathematics educators and researchers strive to determine possible factors contributing to students' mathematics performance.

One such factor is students' interest in mathematics, a construct which is often overshadowed by the pursuit of improving performance metrics in Ghana (Arthur, 2022). Students who exhibit an interest in mathematics tend to perform better, as interest directly impacts performance. In more developed regions, research has consistently linked mathematics interest to performance, yet similar studies in Ghana are limited and fragmented. Science, technology, and mathematics education form the backbone of industrialized economies, and fostering interest in mathematics is critical for national progress (Arthur, 2019).

Another key factor influencing performance is teachers' effective communication skills. According to Strayer and Brown (2012) teachers with strong communication skills enable students tounderstand better, conceptualize, and symbolize mathematical concepts. Effective mathematical communication involves presenting mathematical ideas through diagrams, symbols, and formulas, to facilitate students understanding and problem-solving abilities (Anthony & Walshaw, 2009; Septiana, 2018).

Existing research supports the idea that mathematics interest and performance are positively correlated (Hajovsky et al., 2020; Tambunan et al., 2021; Ufer et al., 2017). However, studies also show inconsistencies, with some indicating a negative relationship between attitudes and performance (Banson et al., 2022). Teacher communication skills are often highlighted as a mediating factor in this relationship, yet findings are conflicting (Juandi & Tamur, 2021; Setiyani et al., 2020). While some studies report a positive impact of teacher communication on mathematics interest and performance, others find no significant or even negative correlations (Hajovsky et al., 2020; Lent et al., 1991).

Research on these dynamics in Ghana is sparse, and few studies have explored the mediating role of teacher communication within a structured mediation model. Most studies addressing these relationships were conducted outside Africa (Du et al., 2021; Gürefe & Bakalım, 2018; Lazarides et al., 2019), leaving a significant gap in the Ghanaian context. This study, therefore, focuses on Senior High School (SHS) mathematics education in Ghana. It employs structural equation modeling (SEM) to examine how teacher communication mediates the relationship between students' mathematics interest and their performance.

This study aimed to examine the mediating role of effective teacher communication and the relationship between students' interest in mathematics and their performances. The study also established the effect of teacher-effective communication on students' mathematics performance. This study uniquely examined teacher effective communication as a mediating variable, offering fresh insights into how it bridges the relationship between students' interest in mathematics and their academic performance. Doing so uncovers pathways and interactions that have not been comprehensively explored in existing literature. SEM introduces a novel methodological perspective, allowing for the precise analysis of both direct and indirect effects. This advanced analytical approach provides a rigorous framework for understanding the mediating role of teacher effective communication, enhancing the study's contribution to the field.

2. Methods

2.1. Research Design and Instruments

Research design refers to the process of selecting specific methods for collecting and analyzing data (Jongbo, 2014). This study employed a quantitative research approach and adopted a descriptive survey design. The descriptive survey design was suitable because it involves the systematic collection and analysis of data to describe existing phenomena or conditions at a particular point in time (Jongbo, 2014). This design required engaging individuals whose traits, behaviors, and perceptions were relevant to the research objectives.

The study's population consisted of Senior High School students in the Talensi District, of the Upper East Region of Ghana, where mathematics is a core subject for all students from basic to senior high school. The study focused on students in SHS 2, as they represented the target population with sufficient exposure to mathematics at the secondary level.

The sample size was determined using Yamane's (1967) formula: $n = \frac{N}{1+Ne^2}$ Where n is the sample size, N is the population size, which is 400 and e is the error (0.05) confidence level 95%. Given that N = 400, the population of the SHS 2;

$$n = \frac{N}{1+Ne^2} = \frac{400}{1+400\times(0.05)^2} = \frac{400}{1+400\times(0.0025)} = \frac{400}{1+1} = \frac{400}{2} = 200.$$

Thus, 200 students were selected for the study. A two-stage sampling process was employed. First, stratified sampling was used to divide the population into homogeneous subgroups based on the courses offered by students (Visual Arts, Business, Home Economics, General Science, General Arts, and Technical). This ensured that students from all courses were represented. Next, random sampling was applied within each stratum to select students in their classrooms during the data collection process by ensuring that every participant had an equal chance of selection to minimise bias.

Table 1 - Students' Background Information

Background	Frequency(N)	Percent (%)
Age	**200**	**100.0**
17-19	18	9.0
20-22	60	30.0
23 or above	122	61.0
Gender	**200**	**100.0**
Male	104	52.0
Female	96	48.0
Course	**200**	**100.0**
Visual Art	7	3.5
General Science	21	10.5
General Art	45	22.5
Business	19	9.5
Home Economics	70	35.0
Technical	38	19.0

Source: Field Survey (2024)

A summary of the study respondents' demographic data is provided in Table 1. Males comprised 52.0%, and Females comprised 48.0% of the total sample. For their ages, 18 (9.0 %) were between the ages of 17 – 19 years, 60(30.0 %) were between the ages of 20- 22 and 122(61.0%) were age 23 and above. Regarding the courses offered by the students, 3.5% offered Visual Art, 10.5% offered General Science, 22.5% offered General Arts, 9.5% offered Business, 35.0% offered Home Economics, and 19.0% offered Technical.

2.2. Research Hypotheses

1. **H_0.** Students' mathematics interests do not significantly predict their performance.
   H_1. Students' mathematics interest significantly predict their performance.
2. **H_0.** Teacher-effective communication does not significantly predict students' mathematics performance.
   H_1. Teacher-effective communication significantly predicts students' mathematics performance.
3. **H_0.** Students' mathematics interests do not predict their teacher's effective communication.
   H_1. Students' mathematics interest predicts their teacher's effective communication.
4. **H_0.** Effective teacher communication does not mediate the relationship between students' mathematics interests and mathematics performance.
   H_1. Teacher effective communication mediates the relationship between students' mathematics interests and students' mathematics performance.

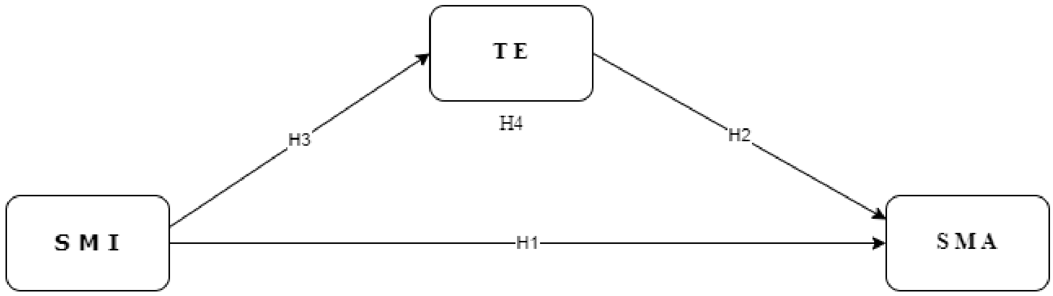

Figure 1 The Conceptual Framework

Source: Authors Constructs (2024)

2.3. Instrument and Measure

A structured questionnaire was employed as the primary instrument for data collection to ensure uniformity and consistency in the responses obtained. The questionnaire was divided into four sections. The first section focused on gathering demographic information from respondents, including gender, age, and the courses they were enrolled in. The subsequent sections addressed the study's three main variables: students' mathematics interest, teacher effective communication, and students' mathematics performance. Responses were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire items were adopted from validated instruments in existing literature to enhance their reliability and applicability across different contexts. Specifically, the sections on teacher effective communication and students' mathematics interest were derived from the works of Kalpana and Malathi (2019) and Arthur (2022) respectively. This approach not only ensured the validation of the measured iems, but also facilitated the generalizability of the constructs to various settings and demographics.

2.4. Data Analysis

The Data was analyzed using SPSS (Version 23) and AMOS (Version 23). The initial step involved coding and entering responses into SPSS for processing. Descriptive statistics, including frequencies and percentages, were computed to provide a preliminary overview of the data. The reliability of the measured items were assessed using reliability analysis, and the underlying factor structure was examined through exploratory factor analysis (EFA). Discriminant validity was also evaluated to confirm the uniqueness of constructs. Finally, path analysis was performed in AMOS to test the structural relationships and hypotheses proposed in the study. These analytical methods ensured robust and comprehensive data analysis, aligning with the research objectives.

3. Results and Discussion

3.1. Results

3.1.1 Findings of Exploratory Factor Analysis (EFA)

The results of the EFA are summarized in Table 2. A method that emphasizes interrelated factors is an exploratory factor analysis (EFA). According to Sterner et al. (2024) EFA is a variable decrease method that distinguishes between factors supporting a set of variable attributes and latent variables. According to Table 2, the sampling adequacy measured by Kaiser-Meyer-Olkins is 0.923, which is considerably greater than the necessary scaling threshold of 0.5. It is worthy and worthwhile, to suggest that the items are strongly related, Hair et al. (2010). Bartlett's Sphericity Test yielded a significant result, with a Chi-square value of 2915.321 and 105 degrees of freedom. A significant p-value of .000 was found for Bartlett's test.

Table 2 - Exploratory Factor Analysis

Rotated Component Matrix			
Measurement Items	**Component**		
	1	**2**	**3**
TE2			.814
TE3			.842
TE4			.807
TE5			.804
SMP1	.733		
SMP2	.720		
SMP3	.847		
SMP4	.849		
SMP5	.850		
SMP6	.847		
SMP7	.828		
SMI2		.849	
SMI3		.881	
SMI4		.868	
SMI5		.846	
KMO and Bartlett's Test			
Total Variance Explained			80.328%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy			.923
Bartlett's Test of Sphericity		Approx. Chi-Square	2915.321
		df	105
		Sig.	0.000
Determinant			2.789E-7

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. *Rotation converged in 5 iterations.*

(Source: Field Survey, 2024)

Since the determinant of 2.789E-7 in Table 2 is significantly greater than zero, it is also considered quite good. The questionnaire's instructions called for three variables to be extracted, which the researcher found factor analysis usable. Table 2 was used to select and rotate three components, resulting in an 80.328 percent cumulative variance explained. In addition to the rotated component matrix, a turn varimax and factor loading were also displayed. It was employed since the rotational varimax approach could increase the normal yield while lowering the number of complex parameters. Their significance and applicability were assessed to decide whether to keep or remove the items. Items loaded at different components and those with low factor loadings were eliminated iteratively, and each time an item was removed, the fit indices were checked. 15 items were dropped according to the Rotated Component matrix, because the items in that load were in various developmenal measures (Xia et al., 2016). This was also applied in similar studies like that of Akendita et al. (2024). It was identified that the number of observed variables in their right definiteness for students' mathematics interest (SMI) was four (4), Teacher effective communication (TE) was four (4), and students' mathematics performance (SMP) was seven (7). Table 2 shows factor loadings for each component greater than 0.5.

3.1.2 Descriptive Analysis

The descriptive statistics are displayed in Table 3 below. Students' Mathematics Interest (SMI) received a mean score of 3.628 from the analysis; Teacher Effective Communication (TE) had a mean score of 3.696, while Students' Mathematics Performance (SMP) had a mean score of 4.106.

Table 3 - Descriptive Analysis

Variables	Mean	Std.Dev.
SMI	3.628	0.978
TE	3.696	1.060
SMP	3.838	1.123

Source: Field Survey (2024)

The study employed a five-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree), to measure the responses; a mean score greater than 3 means agree.

3.1.3 Discriminant Validity Analysis

Many techniques are available to assess discriminant validity; this study used one via a comparison between the inter-correlation coefficients and the square root of AVEs (√AVEs), a method that has been used in earlier research like Arthur et al. (2022). Donnelly et al. (2001) state that Convergent validity evaluates the degree of correlation between measured items on the same construct, while discriminant validity evaluates the degree of distinction between measured items on different constructs.

Table 4 - Discriminant Validity

Variables	CR	AVE	SMP	SMI	TE
SMP	0.943	0.703	0.838		
SMI	0.941	0.798	0.513***	0.894	
TE	0.929	0.767	0.640***	0.620***	0.876

*Note: ***p-value significant at 0.1% (0.001), with √AVE bolded and underlined.*

Using Amos (v.23) plugin tool, the discriminant validity results were produced in conjunction with the CFA results. When the least √AVE is larger than the largest correlation coefficient, discriminant validity is considered to have been attained (Arthur & Kwaku, 2022). As shown in Table 4 above, the least √AVE was 0.838, and the highest inter-correlation was 0.640.

3.1.4 Validity and Reliability Analysis

Regardless the psychometric properties of the measurement phase or model, reliability and validity were also evaluated. Therefore, in order to evaluate the observed variables' internal consistency, Cronbach's alpha (CA) was performed. Using the retained items, the CA was computed with SPSS (v. 23). A minimum CA score of 0.7 indicates that the observed variables are reliable (Henseler et al., 2012). It was determined by the analysis in Table 5 that all latent variables had CAs greater than 0.7, demonstrating the achievement of internal consistency (Taber, 2018). The scores from CA for SMP was 0.946, SMI was 0.941, and TE was 0.927.

Table 5 - Reliability Analysis

Variables	Number of Items	Cronbach's Alpha Value
SMP	7	.946
SMI	4	.941
TE	4	.927

Note: *SMP =Students Mathematics Performance; SMI= Students Mathematics Interest; TE= Teacher effective communication*

The Average Variance Extracted (AVE) was computed to evaluate the observed variables' convergent validity. According to Donnelly et al. (2001), Convergent validity evaluates how well the new scale's measured items correlate with other measures on the same construct. In order to determine that the observed variables obtained convergent validity, the least of AVE and composite reliability (CR) must be respectively 0.5 and 0.7, based on the criteria established by Fornell and larcker (1981). According to the findings, the study appears to have achieved convergence validity, as the CR and the AVE values of all the constructs were within the acceptable thresholds (Fornell & larcker, 1981) as shown in Table 6.

3.1.5 Confirmatory Factor Analysis (CFA)

Table 6 provides an overview of the CFA outcomes. The measurements chosen during EFA were convinced to be approved by CFA. After gathering 200 samples, AMOS 23.0 was used to test all three elements of the measurement model.

Table 6 - Confirmatory Factor Analysis

Model Fit indices: CMIN= 141.394; DF = 85; CMIN/DF = 1.633; TLI= .976; CFI = .981; RMR = .047; RMSEA = .058; PClose = .216;		**Sd. Factor Loadings**
Students Mathematics Performance (SMP): CA = .946; CR = .943; AVE = 703;		
SMP1	I perform well on my mathematics tests and exams.	.758
SMP2	I usually complete my mathematics assignments correctly and on time.	.746
SMP3	I have a strong understanding of the mathematical concepts taught in class.	.866
SMP4	I find it easy to solve new mathematics problems.	.895
SMP5	I consistently score above average in mathematics.	.914
SMP6	I feel that my mathematics skills are improving each term.	.874
SMP7	I rarely struggle with mathematics homework or classwork.	.799
Students Mathematics Interest (SMI): CA = .941; CR = .941; AVE = .798;		
SMI2	Mathematics is one of my favorite subjects.	.859
SMI3	I look forward to attending my mathematics classes.	.880
SMI4	I find mathematics to be exciting and interesting.	.927
SMI5	I am curious about how mathematics applies to real-life situations.	.906
Teacher Effective Communication (TE): CA =.927; CR = .929; AVE = .798;		
TE2	My teacher uses examples that are easy to understand.	.871
TE3	My teacher encourages questions and participation during class.	.912
TE4	My teacher makes sure all students understand before moving on to a new topic.	.885
TE5	My teacher gives feedback that helps me improve my math skills.	.833

According to Hair el al. (2010), when CMIN/DF = 1.633,it Indicates a good fit (well below the threshold of 3.0). TLI = .976, anExcellent fit (above the threshold of .95). CFI = .981; an Excellent fit (above the threshold of .95). RMR = .047; a Good fit (below the threshold of .05). RMSEA = .058; an Acceptable fit (below the threshold of .08). PClose = .216; also Indicates a close fit (greater than .05). CMIN calculates the model's minimum discrepancy. The absolute fit indices are RMSEA and RMR that evaluate the potential model's divergence from the ideal model; and CFI and TLI are incremental fit indices that assess the poorest fit by contrasting the fit of the proposed model with the model that serves as the baseline. (Murray et al., 2021). With continuous data, normal-theory maximum likelihood is the basis for both CFI and TLI cutoff values. When verifying the null hypothesis, according to which the population's RMSEA does not exceed 0.05, P-close stands for the p-value. As shown in Table 5, all of these were accomplished.

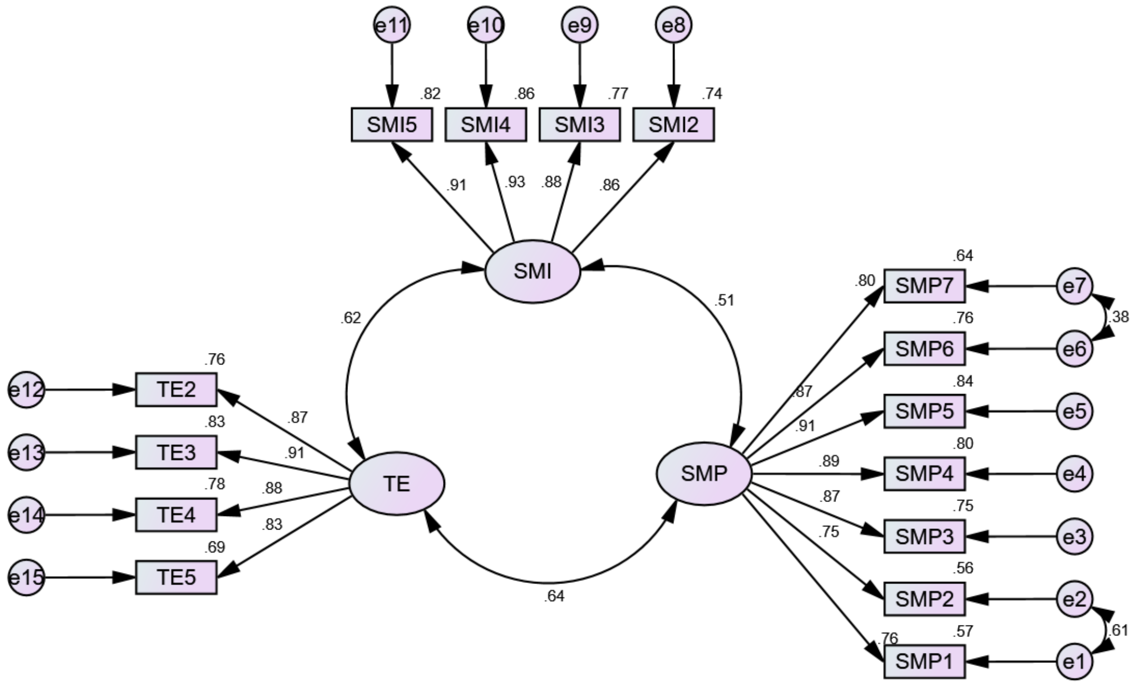

Figure 1 Confirmatory Factor Analysis

3.1.6 Path Analysis

The data was then subjected to additional analyses by looking at the potential relationship between the endogenous and exogenous variables of the framework used for the study, following the evaluation of the measurement model fit using Amos (v.23), Structural equation modelling (SEM). The estimates for the test of direct relationships and the mediating effect of Teacher Effective Communication on the relationship between Students mathematics interest and students mathematics performance. In addition, the control variables were included into the analysis and are presented in Table 7 and graphically depicted in Figure 2. Overall, the model shows a good fit.

Table 7 - Summary of hypothetical analyses findings

Direct Effect	**Std. Estimates**	**S. E**	**C. R**	**P-Value**
AGE → SMP	.466	.076	6.166	***
GENDER → SMP	.466	.076	6.166	***
COURSE → SMP	.466	.076	6.166	***
SMI → SMP	.182	.070	2.578	.010
TE → SMP	.466	.076	6.166	***
SMI → TE	.635	.072	8.823	***
Indirect Effect	**Std. Estimate**	**Lower Bound**	**Upper Bound**	**P-Value**
SMI → TE→SMP	.323	.208	.467	.001

*Note: ***P = 0.1% significant value of p (0.001)*

Source: Field Survey, (2024)

From Table 7, the result showed that the respondents' gender positively impacted the students' mathematical performance (SMP) but is statistically insignificant with 0.6% positive impact (*β = 0.006.; CR = .068; p =.946*). Students' mathematics performance (SMAP) was negatively impacted by age but is statistically significant with 18.2% negative impact (*β = -.182; CR = -2.729; p=.006*). In addition, Students' performance in mathematics was negatively impacted by the respondents' course and statistically insignificant, with a 2.4% negative impact on Student's Mathematics Performance (*β = -.024; CR = -.794; p=.427*).

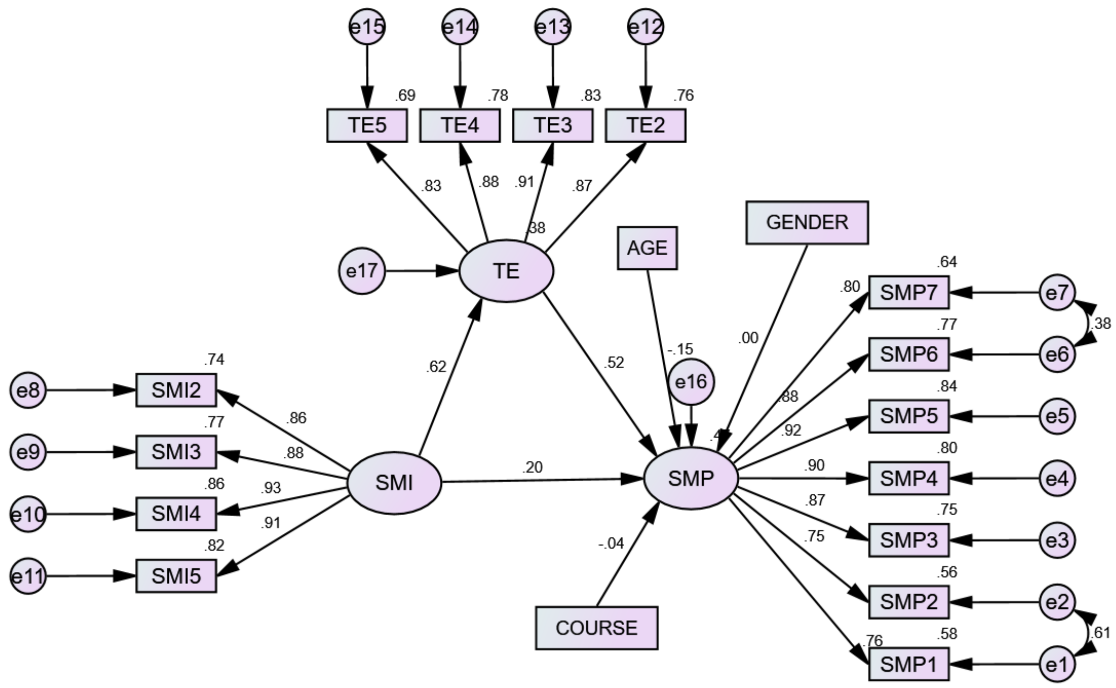

Figure 2 Path Analysis

3.1.7 Hypothesis One

<u>*Hypothesis One*</u>

HO. Students' mathematics interests do not significantly predict students' mathematics performance.

H1. Students' mathematics interest significantly predicts students' mathematics performance.

The goal of this study's hypothesis is to find out if students' interest in mathematics will significantly predict their success in mathematics. Table 7 presents the specific results in detail.

Results on the hypothesized paths, as shown in Table 7, demonstrated how students' interest in the subject of mathematics has had a positive effect on their performance in the subject and this impact was statistically significant, with an 18.2% positive impact on students' math performance (*β =.182; CR = -2.729; p =.010)*. That is, an 18.2% increase in students' mathematics performance can be attributed to their significant interest in the subject. This suggests that students' performance in mathematics is positively impacted when they become interested in the subject. Considering the study's findings, H_0. Students' performance in mathematics is not substantially predicted by their interest in the subject was consequently rejected and accepted H_1. (Their interest in the subject highly predicts mathematics performance among students.)

Hypothesis Two

H0. Teacher effective communication does not significantly predict students' mathematics performance.

H1. Teacher-effective communication significantly predicts students' mathematics performance.

This hypothesis of the study is intended to determine whether Teacher effective communication will significantly predict students' mathematics performance. Table 7 shows the details of the findings.

As indicated in Table 7, the outcomes pertaining to the postulated pathways demonstrated that effective communication by teachers directly enhanced students' performance in mathematics and was statistically significant, with a 46.6% positive impact on Students' Mathematics performance (*β = .466; CR = 6.166; p = .001*). That is, about 46.6% improvement in Students' mathematics performance is attributed to the teacher's effectiveness in communicating mathematical concepts. This indicates that teachers who effectively communicate mathematical ideas or concepts in a clear language in mathematics influences positively, the performance of the students in the subject. Based on the results of the study, H0. Which states that effective communication by teachers will not significantly predict students' mathematics performance. This was thus rejected in favor of H_1. (Teacher-effective communication will significantly predict students' mathematics performance.)

Hypothesis Three

H0. Students' mathematics interest does not predict teacher effective communication.

H1. Students' mathematics interest predicts teacher effective communication.

This study's hypothesis is meant to ascertain whether students' mathematical interest will significantly predict teacher effective communication. Table 7 displays the specifics of the findings.

As indicated in Table 7, findings on the proposed pathways suggested that students' interest in mathematics positively impacted teachers' ability to communicate effectively and was statistically significant, with a 63.5% positive impact on teacher effective communication (*β = .635; CR = 8.823; p = .001*. In light of the study's findings, H0. Students' mathematics interest will not significantly predict teacher effective communication was thus rejected in favor of H1. (Students' mathematics interest will significantly predictteacher effective communication.)

Hypothesis Four

H0. Effective teacher communication does not mediate the relationship between students' mathematics interests and mathematics performance.

H1. Effective teacher communication mediates the relationship between students' interests and mathematics performance.

The Bias-Corrected (BC) percentile bootstrapping method was applied using a 95% confidence level and a 5,000-bootstrap sample. The structural model shown in Table 7 satisfied all of the different fit indices as recommended by Hair et al. (2010), just as the CFA did. Additionally, Figure 2 displays the study's diagrammatic representation of the structural model. This hypothesis aims to ascertain whether Teacher effective communication mediates the relationship between students' mathematics interest and mathematical performance. Table 7 presents the specifics of the findings.

As indicated in Table 7, results on the direct impact of students' interest in mathematics on their mathematics performance are statistically significant, with an 18.2% positive impact on students' mathematics performance (*β = .182; CR = 2.578; p = .010*). This implies that an 18.2% improvement in Students' mathematics performance is attributed to their high interest in mathematics. This indicates that students who develop interest in mathematics influences positively, their performance in the subject. Similarly, the effect of teacher effective communication on the relation between students' mathematics interest and students' mathematics performance was statistically significant (*β = .323; LB = .208; UB = .467; p = .001).* According to the study's findings, H0. Which states that Teacher effective communication will not mediates the relationship between students' mathematics interest and students' mathematics performance was thus rejected in favor of H1. (Teacher effective communication mediates the relationship between students' mathematics interest and students' mathematics performance.). This implies that teacher effective communication explains the relationship between students' mathematics interest and students' mathematics performance. Since the direct effect of students' mathematics interest is significant as well as the indirect impact, teacher-effective communication serves as a partial mediator between the relationship of interest in and performance in mathematics among students.

3.2. Discussion

Some researchers and practitioners believe that having a positive interest in mathematics is essential to succeed in it. Based on the analysis, students' interest in mathematics was found to be statistically significant. This supports several writings and adds to the body of literature. Arthur et al. (2022) For instance, examined several variables, including the connection between maths interest and achievement. It was concluded that success in mathematics and one's interest in maths are correlated. Tambunan et al. (2021) also investigated the connection between pupils' interest in mathematics and their general academic achievement. The study's conclusion revealed a critical relationship between academic success and self-concept.

Additionally, a statistical significant relationship between the mathematical performance of students and teachers' communication skills was found in the study's results. This study demonstrated that when teachers' communication skills are piqued, there is a 46.6% increase in students' mathematics performance. The study's conclusions are consistent with related research by Anthony and Walshaw (2009), who declared in their conclusion that teacher quality have a direct or significant influence on math achievement. Septiana (2018) also embarked on a related study by examining the relationship between achievement and peer tutoring in another study. A direct and positive correlation was found between the variables.

The study's conclusions showed a relationship between students maths interest and teacher effective communication. The correlation between interest and teacher effective communication had a p-value of 0.001 at 0.1% significance level. The quality of instruction was studied by Hajovsky et al. (2020) using a few variables to forecast mathematics performance and students interest. They came to the conclusion that teacher competency and quality of instruction have a big influence on the performance of students, and the results of this study are consistent with those findings. Arthur (2019) study, whose findings indicated a clear and favorable relationship between proficiency in mathematics and quality of instruction is also supported by this study.

Furthermore, the mediating effect, or indirect path, was looked at and shown to be statistically significant in describing how students' performance in mathematics is indirectly impacted by student interest in mathematics through teacher effective communication. It was demonstrated that this had a partial mediating effect. Effective teacher communication plays a pivotal role in mediating the relationship between students' interest in mathematics and their academic achievement in the subject. When teachers communicate effectively, they foster a positive learning environment that enhances students' engagement and understanding. This, in turn, increases students' interest in mathematics, leading to improved performance. Research has shown that students' perceptions of their teachers' communication skills significantly impact their motivation and achievement in mathematics. For instance, a study by Appiah et al. (2022) found that while the teacher-student relationship did not have a significant direct effect on mathematics achievement, students' self-efficacy and perception of mathematics positively influenced their performance. Similarly, Larbi et al. (2024) emphasized the importance of guiding students in using tools like scientific calculators to enhance their mathematics competence. The authors found that clear communication and support from teachers not only improve students' confidence in using these tools but also positively influence their engagement with mathematical concepts.

An additional studies underscore the importance of effective communication in addressing students challenges and enhancing performance. For example, Oppong et al. (2024) analyzed pre-service teachers' errors in solving algebraic tasks in Ghana, emphasizing the role of focused instructional strategies to correct misconceptions. Similarly, Alias et al. (2024) examined the effects of virtual algebra tiles on Year 8 students' ability to solve linear equations, showing that combining digital tools with effective communication can significantly enhance performance. Finally, Kania et al. (2024) explored research trends in higher-order thinking skills in Indonesia, highlighting how clear teacher guidance fosters critical reasoning and problem-solving abilities in students.

The way teachers convey their expectations and feedback also shapes students' interest in mathematics. Positive reinforcement and clear communication about the relevance and applicability of mathematical concepts can make the subject more appealing to students. According to Larbi et al. (2024), integrating tools like calculators into mathematics instruction fosters reflective thinking and problem-solving skills, ultimately motivating students to engage with mathematics. As students' interest grows, they are more likely to invest effort and persist in learning, resulting in higher achievement. Effective teacher communication serves as a crucial mediator between students' interest in mathematics and their academic performance. By fostering a supportive and engaging learning environment through clear and positive communication, teachers can enhance students' interest and self-efficacy in mathematics, leading to improved achievement.

3.2.1 Implication to Research and Practice

This present study has revealed that Teacher Effective Communication is an important mediator between Students' Mathematics Interests and their Mathematics Performance. The findings underline that improving communication practices in the classroom will significantly enhance students' interest in mathematics, consequently enhancing their academic performance. To educational practitioners, improving teacher-student interaction should be one of the priority actions. Secondly, the training programs focused on communication skills, mechanisms of feedback, and use of more engaging instructional strategies can also be utilised to provide teachers with the capacity to make their classrooms a more supportive learning environment.

The study adds to the increasing literature on how psychosocial factors, like teachers' communication, influence students' academic performance. Therefore, it extends current knowledge by underlining the mediator's role in educational contexts and encourages further investigation of the potential influence of other classroom dynamics on students' performance. These insights are also useful for policymakers and curricula developers in integrating the aspect of effectiveness in communication within the framework of teacher professional development.

4. Conclusions

The study ascertained the hypothesis that Teacher Effective Communication mediates the relationship between Students' Mathematics Interest and their Mathematics Performance. The results showed that once teachers acted communicatively, it enhanced not only students' interest in mathematics but also ensured a better academic performance . All that underlines the interconnectedness of teacher behavior and student outcomes. These findings present evidence that to improve students' performance in mathematics, efforts should be made to nurture their interest and increase interactions between teachers and students. This study will contribute significantly to educational psychology and pedagogical literature regarding the fact that communication is a pivoting factor in academic performance.

While this study offers new insights, it simultaneously opens up various avenues for further research. For example, other studies may investigate the possible effects of Teacher Effective Communication on other academic subjects but mathematics alone to see if similar mediation patterns would emerge. Longitudinal studies may give a better judgment of exactly how teacher communication impacts students' interest and performance of the subject. Other moderators influencing this relationship could be students' motivation, peers influence, or technological integration. Lastly, research on teachers' communicative role in different educational contexts, such as rural or deprived schools, would enhance the generalizability of findings to other learning contexts.

Conflict of Interest

The authors declare no conflicts of interest.

References

Akendita, P. A., Obeng, B. A., Abil, M., & Ahenkorah, M. (2024). Investigating the effect of socio-constructivist mathematics teaching on students' mathematics achievement: The mediating role of mathematics self-efficacy. *Educational Point*, *1*(2), e110.

Akendita, P. A., Arthur, Y. D., & Asare, B. (2024). *Moderating effect of teacher efficacy on the relationship between students ' perception of mathematics and students ' mathematics achievement*. *6*(1), 1–17.

Alias, N. H., Menengah, S., Muhammad, S., & Shahrill, M. (2024). The Effects of Virtual Algebra Tiles on the Performance of Year 8 Students in Solving Algebraic Linear Equations. *International Journal of Mathematics and Mathematics Education*, *2*(3), 176–193. https://doi.org/10.56855/ijmme.v2i3.1067

Anthony, G., & Walshaw, M. (2009). Characteristics of effective teaching of mathematics: A view from the West. ... *of Mathematics* ..., *2*(2), 147–164. http://knowledgeportal.pakteachers.org/sites/knowledgeportal.pakteachers.org/files/resources/Characteristics of Effective Teaching of Mathematics.pdf

Appiah, J. B., Korkor, S., Arthur, Y. D., & Obeng, B. A. (2022). Mathematics achievement in high schools, the role of the teacher-student relationship, students' self-efficacy, and students' perception of mathematics. *International Electronic Journal of Mathematics Education*, *17*(3), em0688. https://doi.org/10.29333/iejme/12056

Arthur, Y. D. (2019). Students Mathematics Interest in Senior High Schools: Empirical Evidence from Ashanti Region of Ghana. *Asian Research Journal of Mathematics*, *15*(3), 1–14. https://doi.org/10.9734/arjom/2019/v15i330147

Arthur, Y. D. (2022). *Modeling student ' s interest in mathematics : Role of history of mathematics , peer- assisted learning , and student ' s perception*. *18*(10).

Arthur, Y. D., Boadu, S. K., & Asare, B. (2022). Effects of Peer Tutoring, Teaching Quality and Motivation on Mathematics Achievement in Senior High Schools Examples of Projective Resolution of Lengths 3n/4n That Do Not Satisfy Homological Properties of Nakayama

Algebra. View project Modeling mathematic. *Int J Edu Sci*, *37*(1–3), 35–43. https://doi.org/10.31901/24566322.2022/37.1-3.1221

Arthur, Y. D., Simon, C., Dogbe, K., & Asiedu-addo, S. K. (2022). *Enhancing Performance in Mathematics Through Motivation , Peer Assisted Learning , And Teaching Quality : The Mediating Role of Student Interest*. *18*(2).

Arthur, Y., & Kwaku, B. (2022). Effects of Peer Tutoring, Teaching Quality and Motivation on Mathematics Achievement in Senior High Schools Examples of Projective Resolution of Lengths 3n/4n That Do Not Satisfy Homological Properties of Nakayama Algebra. View project Modeling mathematic. *International Journal of Educational Sciences*, *37*(April), 35–43. https://doi.org/10.31901/24566322.2022/37.1-3.1221

Banson, G. M., Bonyah, E., & Boateng, F. O. (2022). Examing attitudinal traits and geometry achievement of the pre-service teachers. *Turkish Journal of Mathematics Education*, *3*(3), 51–57.

Casey, B. M., & Ganley, C. M. (2021). An examination of gender differences in spatial skills and math attitudes in relation to mathematics success: A bio-psycho-social model. *Developmental Review*, *60*(October 2020), 100963. https://doi.org/10.1016/j.dr.2021.100963

Donnelly, D., Burgess, E., Anderson, S., Davis, R., & Dillard, J. (2001). Involuntary celibacy: A life course analysis. *Journal of Sex Research*, *38*(2), 159–169. https://doi.org/10.1080/00224490109552083

Du, C., Qin, K., Wang, Y., & Xin, T. (2021). Mathematics interest, anxiety, self-efficacy and achievement: Examining reciprocal relations. *Learning and Individual Differences*, *91*(19), 102060. https://doi.org/10.1016/j.lindif.2021.102060

Fornell, C., & f. larcke, D. (1981). Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39–50.

Gna. (2023). *WAEC records fluctuating trends in three Core subjects*. Ghana News Agency. https://gna.org.gh/2023/12/waec-records-fluctuating-trends-in-three-core-subjects.

Gürefe, N., & Bakalım, O. (2018). Mathematics Anxiety, Perceived Mathematics Self-efficacy and Learned Helplessness in Mathematics in Faculty of Education Students. *International Online Journal of Educational Sciences*, *10*(3), 154–166. https://doi.org/10.15345/iojes.2018.03.010

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective* (7th Ed). Pearson Education.

Hajovsky, D. B., Oyen, K. A., Chesnut, S. R., & Curtin, S. J. (2020). Teacher–student relationship quality and math achievement: The mediating role of teacher self-efficacy. *Psychology in the Schools*, *57*(1), 111–134. https://doi.org/10.1002/pits.22322

Henseler, J., Ringle, C. M., & Sarstedt, M. (2012). Using partial least squares path modeling in advertising research: Basic concepts and recent issues. *Handbook of Research on International Advertising*, 252–276. https://doi.org/10.4337/9781781001042.00023

Jongbo, O. C. (2014). The role of research design in a purpose driven enquiry. *Review of Public Administration and Management*, *3*(6), 87–94.

Juandi, D., & Tamur, M. (2021). The impact of problem-based learning toward enhancing mathematical thinking: A meta-analysis study. *Journal of Engineering Science and Technology*, *16*(4), 3548–3561.

Kania, N., Kusumah, Y. S., Dahlan, J. A., Nurlaelah, E., & Arifin, Z. (2024). Research Trends in Higher-Order Thinking Skills in the journal Mathematics Education in Indonesia: from Design to Data Analysis. *International Journal of Mathematics and Mathematics Education*, *2*(3), 193–206. https://doi.org/10.56855/ijmme.v2i3.1048

Kuennen, E. W., & Beam, J. E. (2020). Teaching the mathematics that teachers need to know: Classroom ideas for supporting prospective elementary teachers' development of mathematical knowledge for teaching. *Mathematics Enthusiast*, *17*(2–3), 771–805. https://doi.org/10.54870/1551-3440.1503

Lafuente-Lechuga, M., Cifuentes-Faura, J., & Faura-Martínez, Ú. (2020). Mathematics applied to the economy and sustainable development goals: A necessary relationship of dependence. *Education Sciences*, *10*(11), 1–12. https://doi.org/10.3390/educsci10110339

Larbi, E., Appiagyei, E., & Banson, G. M. (2024). Senior High School Students' Competence in the Use of Calculator in Mathematics Learning. *International Journal of Mathematics and Mathematics Education*, *2*, 74–88. https://doi.org/10.56855/ijmme.v2i2.986

Lazarides, R., Gaspard, H., & Dicke, A. L. (2019). Dynamics of classroom motivation: Teacher enthusiasm and the development of math interest and teacher support. *Learning and Instruction*, *60*(June 2017), 126–137. https://doi.org/10.1016/j.learninstruc.2018.01.012

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics Self-Efficacy: Sources and Relation to Science-Based Career Choice. *Journal of Counseling Psychology*, *38*(4), 424–430. https://doi.org/10.1037/0022-0167.38.4.424

Ms. S. Kalpana | Ms. V. A. Malathi. (2019). A Study on Interest in Mathematics Interest and its Relation to Academic Achievement in Mathematics Among Higher Secondary Students. *International Journal of Trend in Scientific Research and Development*, *3*(4), 1246–1254. https://doi.org/https://doi.org/10.31142/ijtsrd25113

Murray, A. L., Ushakova, A., Wright, H., Booth, T., & Lynn, P. (2021). Structural equation modelling with complex sampling designs and non-random attrition: A tutorial using lavaan and Mplus. *Behavior Research Methods*, *51*(1), 409–428.

Oppong, R. A., Adjei, E. A., Amoah, E. K., Okuleteh, E., & Larri, B. (2024). Analyses of Pre-Service Teachers' Errors in Solving Algebraic Tasks in Ghana. *International Journal of Mathematics and Mathematics Education*, *2*(3), 155–174. https://doi.org/10.56855/ijmme.v2i3.1134

Resnick, L. B. (2020). From Protoquantities to Operators: building mathematical competence on a Foundation of Everyday Knowledge. *Analysis of Arithmetic for Mathematics Teaching*, 373–429. https://doi.org/10.4324/9781315044606-7

Septiana, D. (2018). The influence of emotional intelegence, self-efficacy, and altruism on teacher's competence in inclusion elementary school. *Jurnal Prima Edukasia*, *6*(2), 147–156. https://doi.org/10.21831/jpe.v6i2.14413

Setiyani, Putri, D. P., Ferdianto, F., & Fauji, S. H. (2020). Designing a digital teaching module based on mathematical communication in relation and function. *Journal on Mathematics Education*, *11*(2), 223–236. https://doi.org/10.22342/jme.11.2.7320.223-236

Sterner, P., Roover, K. De, & Goretzko, D. (2024). New Developments in Measurement Invariance Testing : An Overview and Comparison of EFA- Based Approaches New Developments in Measurement Invariance Testing : An Overview and Comparison of EFA-Based Approaches. *Structural Equation Modeling: A Multidisciplinary Journal*, *0*(0), 1–19. https://doi.org/10.1080/10705511.2024.2393647

Strayer, J. F., & Brown, E. (2012). Doceamus: Teaching with High-Cognitive-Demand Mathematical Tasks Helps Students Learn to Think Mathematically. *Notices of the American Mathematical Society*, *59*(01), 1. https://doi.org/10.1090/noti786

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tambunan, H., Sinaga, B., & Widada, W. (2021). Analysis of teacher performance to build student interest and motivation towards mathematics achievement. *International Journal of Evaluation and Research in Education*, *10*(1), 42–47. https://doi.org/10.11591/ijere.v10i1.20711

Ufer, S., Rach, S., & Kosiol, T. (2017). Interest in mathematics = interest in mathematics? What general measures of interest reflect when the object of interest changes. *ZDM - Mathematics Education*, *49*(3), 397–409. https://doi.org/10.1007/s11858-016-0828-2

Xia, Y., Yung, Y. F., & Zhang, W. (2016). Evaluating the Selection of Normal-Theory Weight Matrices in the Satorra–Bentler Correction of Chi-Square and Standard Errors. *Structural Equation Modeling*, *23*(4), 585–594. https://doi.org/10.1080/10705511.2016.1141354

Yamane, T. (1967). Statistics. *An Introductory Analysis*, *Statistics*.