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Research Article

Moderating effect of teacher efficacy on the relationship between students' perception of mathematics and students' mathematics achievement

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This study examined the moderating effect of teacher efficacy on the relationship between students' perception of mathematics and students' mathematics achievement. A descriptive survey design, which is anchored on the quantitative research approach, was utilized in the study, with a sample of 300 form 1 and form 2 senior high school students from Bolgatanga Senior High School and Zamse Senior High Technical School in Ghana. Prior to the main model's estimation, preliminary analyses were conducted, such as internal consistency, convergent validity, discriminant validity, and confirmatory factor analysis. Amos was used to perform Structural Equation Modelling in order to test the various hypotheses. The results showed that students' perception of mathematics and teacher efficacy all had a positive effect on students' mathematics achievement and were all statistically significant. Furthermore, teacher efficacy had a positive effect and was statistically significant as well on students' perception of mathematics. Moreover, teacher efficacy moderated the relationship between students' perception of mathematics and students' mathematics achievement. Thus, this study provided evidence in favor of all the four hypotheses.

Keywords: Students perception of mathematics, Mathematics achievement, Teacher Efficacy

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1. Introduction

Mathematics is one of the most fascinating and useful subjects that humans have ever created, mathematics has enormous practical significance in daily life (Agyei, 2018). According to Oppong et al. (2023), living a normal life in many parts of the world would be difficult without mathematics, and life without it is nearly impossible. It has long been understood that a solid foundation in mathematics is essential for future professional opportunities, cognitive growth, and academic success (Agyei, 2018). The significance of mathematics has also been highlighted by the National Council of Teachers of Mathematics (2000), stating, "Those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their future" (p. 5). In today's technologically advanced world, every student needs to study mathematics for personal development and achievement (Cetintav & Yilmaz, 2023). Worldwide, a strong mathematical performance is one of the prerequisites for pursuing additional academic and professional advancement in many fields (Thurm et al., 2024).

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According to Hagan et al. (2020), the bases of technological knowledge and science, which is prized by societies across the world, is mathematics. It is believed to be a tool for advances in politics, science, technology, and society. Hagan et al. (2020) added that, more than its apparent applications to the acquisition of basic numeracy skills, mathematics is important. From ancient times, mathematics has been seen as the best subject to help students develop their higher-order cognitive abilities and logical reasoning (Moote et al., 2020). Furthermore, the study of physics, engineering, statistics, and many other scientific fields all depend on mathematics. Because of its applicability and continued relevance, mathematics is considered one of the most important subjects in education and a foundational part of the curriculum in all societies (Widana, 2018).

Nevertheless, even in developed nations, students routinely perform below average in the subject (Efa & Frimpong, 2023). Students' educational progress and achievement in Ghana are significantly impeded by their poor performance in mathematics (Agyei et al., 2024). Both job prospects and access to higher education may be hampered by arithmetic failure (Woldegiorgis & Chiramba, 2024). So that they can receive the training and assistance they need to succeed in mathematics, it is crucial to determine the factors that influence Ghanaian students' performance in this subject.

Moreover, there are difficulties in the field of mathematics learning especially when it comes to the different attitudes and perceptions that students have about mathematics (Majeed- Imoro, 2017). While some students may struggle with feelings of anxiety, self-doubt, and negative perceptions about the subject, others may show strong interest, confidence, and positive beliefs about their mathematical abilities (Oppong-Gyebi et al., 2023). These variations in how students view mathematics can have a big impact on how well they actually perform in the subject (Oppong-Gyebi et al., 2023). Studies have revealed that, students who think of mathematics as manageable, interesting, and relevant to their lives are more likely to succeed academically than those who think of it as challenging, dull, or cannot relate it to real life situations (Arthur, 2019; Tambunan et al., 2021). Mathematical achievement has been found to be significantly impacted by students' positive perception of mathematics (Appiah et al., 2023; Arthur, Appiah, et al., 2022; Mensah & Koomson, 2020).

Furthermore, in this equation of mathematics learning and students' mathematics achievement, the importance of teacher's efficacy cannot be underestimated. Students' motivation, engagement, and academic success have been connected to teacher efficacy, which is defined as teachers' beliefs in their capacity to positively impact student learning outcomes (McGarrigle et al., 2023). A growth mindset can be instilled in students, and a supportive learning environment that promotes mathematical achievement can be created by teachers who are competent, confident, and effective in their teaching practices (Agyei, 2018). Several research has shown that the relationship between students' perceptions and mathematical achievement is greatly influenced by the instructional procedures and strategies used by teachers, which are in turn determined by their efficacy beliefs (Hidayatullah & Csíkos, 2024; Karakose et al., 2023; Olawale & Hendricks, 2024). Innovative teaching strategies like inquiry-based learning and guided discovery learning are frequently used by effective teachers (Arthur, Appiah et al., 2022). With continued use, these techniques can improve students' views of mathematics and consequently their achievement in the subject (Abroampa, 2017; Arthur , Appiah et al., 2022; Asare, 2020; Kuyini et al., 2020; Ntarmah et al., 2019; Opoku et al., 2022).

Despite the increasing amount of research on students' perceptions of mathematics and their achievement in the subject, there is still a knowledge vacuum regarding the moderating role of teacher efficacy in the nexus between students' perception of mathematics and students' mathematics achievement. The degree to which teachers' efficacy and beliefs interact with individual factors like; students' attitudes and beliefs and their academic performance is well established. Although some few studies have added third variable to the direct relationship (Barksdale et al., 2021; Gomes et al., 2020; Suren & Kandemir, 2020), however, less research has been done on this relation regarding a third variable on a moderation model. The researcher therefore intended to investigate the moderating role of teacher efficacy on the nexus between students' perception of mathematics and students' mathematics achievement.

2. Literature Review

2.1. Teacher Efficacy and Students Perception of Mathematics

Within the domain of education, it is essential to comprehend how students' perceptions of mathematics and teacher efficacy relate to each other (Hwang & Son, 2021). A classroom atmosphere that is encouraging and supportive is more likely to be created by teachers who have high efficacy beliefs in their ability to teach mathematics, which in turn increases student engagement and interest in the subject. Improved student performance and achievement in mathematics may follow from this (Hwang & Son, 2021). Moreover,

academic performance of students in mathematics is greatly influenced by their perception of mathematics and the effectiveness of their teachers (Nunes et al., 2023). According to research, significant influence on students' mathematics performance from teacher-student relationships (Yulianto et al., 2023; Juandi & Tamur, 2021; Suren & Kandemir, 2020). Student success depends on teachers' self-efficacy in teaching mathematics, particularly to pupils who have learning disabilities like dyscalculia. Furthermore, Positive factors that impact students' interest in mathematics include teachers' self-efficacy for student engagement, which is important for their academic and emotional growth in the subject. Additionally, it is discovered that students' self-efficacy and how they view mathematics positively affect their achievement in the subject, highlighting the significance of encouraging students to have a positive perspective on mathematics and to have greater confidence in their own abilities (Arifin & Kuningan, 2021; Arthur, Boadu, et al., 2022; Hajovsky et al., 2020; Umar et al., 2021). This hypothesized that;

H1: Teacher Efficacy (TEF) has a direct positive effect on Students Perception of Mathematics (SPMA).

2.2. Teacher Efficacy and Students' Mathematics Achievement

The relationship between teacher effectiveness and students' mathematical achievement has been the subject of numerous studies (Blazar & Kraft, 2017; Kong & Lai, 2023; Susuoroka et al., 2023), emphasizing the important impact that teachers' attitudes and methods have on students' mathematical learning outcomes . For instance, a meta-analysis carried out by Shen et al. (2020) showed a positive correlation between student achievement in mathematics and teacher efficacy. Moreover, teachers who believe in their own efficacy increase the likelihood of using effective instructional techniques, give insightful feedback, and establish supportive learning environments in turn improved student mental health [SMA], and academic achievement according to empirical research (Gulistan et al., 2017; Hajovsky et al., 2020). Furthermore, Anderson et al. (2023) stressed the importance of collective teacher efficacy in fostering advancements in student achievement, including mathematics, across the school. In his study he found that students' advancement in academic achievement in school including mathematics was significantly impacted by teacher efficacy. Again, students' success in mathematics is greatly influenced by their relationships with their teachers. Studies reveal that mathematics achievement is positively impacted by students' self-efficacy and perception of mathematics, but the teacher-student relationship has a negative predictive effect (Hammad et al., 2022; Murray et al., 2021). To increase students' achievement in mathematics, it is therefore crucial to foster positive teacher-student relationships, increase students' self-efficacy, and make use of interactive learning resources. In addition, similar studies suggest that Students' performance in mathematics is greatly influenced by the efficacy of their teachers and the students' perceptions of mathematics (Appiah et al., 2022; Kuyini et al., 2020). Student outcomes are positively impacted by teachers who are highly effective in teaching students who struggle with mathematics (Arthur, Appiah et al., 2022). Furthermore, it has been shown that promoting collective teacher efficacy improves student outcomes, highlighting the significance of professional development initiatives that strengthen teachers' beliefs in their own efficacy (Mensah & Koomson, 2020). Finally, the qualifications, approach, content mastery, punctuality, and relationships that teachers have with their students have a direct effect on the mathematical performance of their students. (Segarra & Julià, 2022). Thus, encouraging teacher efficacy and fostering a good teacher-student rapport can improve students arithmetic performance (Segarra & Julià, 2022). This hypothesized that;

H2: Teacher Efficacy [TEF] has a direct positive effect on Students' Mathematics Achievement [SMAC].

2.3. Students' Perception of Mathematics and Students' Mathematics Achievement

According to Suren and Kandemir (2020) the way that students view mathematics is a major factor in how well they perform in it. Mathematical achievement has been found to be positively impacted by positive attitudes towards mathematics and positive perceptions of the mathematics as documented by Suren and Kandemir (2020). On the other hand, math anxiety impair students' arithmetic performance (Hwang & Son, 2021). Improvements in mathematics achievement have been proposed to come from a variety of teaching approaches, such as the use of cooperative learning techniques and addressing students' perceptions of mathematics (Yulianto et al., 2023). Achievement in mathematics has also been connected to attitudes towards mathematics, including elements like enjoyment, self-concept, confidence, and perceived value. This hypothesized that;

H3: Students Perception of Mathematics [SPMA] has a direct positive effect on Students' Mathematics Achievement [SMAC].

From the hypotheses 1 and 2, it was realized that teacher efficacy has the capacity to influenced student perception of mathematics (Perera & John, 2020). Moreover, teacher efficacy potentially influenced Students Mathematics Achievement. Based on these, it was proposed that;

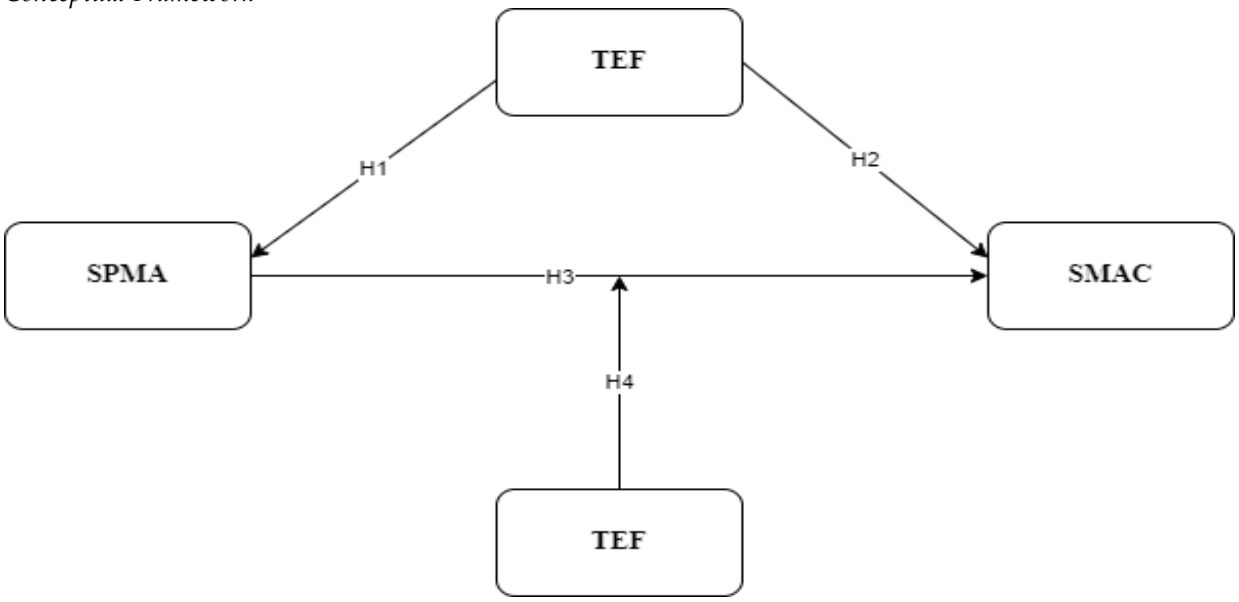
H4: Teacher Efficacy [TEF] moderates the relationship between Students Perception of Mathematics [SPMA] and Students Mathematics Achievement [SMAC].

2.4. Conceptual Framework

The conceptual framework looks at the interactions between teacher efficacy [TEF] and students' perceptions of mathematics [SPMA] to influence students' mathematics achievement [SMAC]. It emphasizes how arithmetic achievement can be directly enhanced by students' positive opinions of the subject. Additionally, as a moderating factor, teacher efficacy strengthens the beneficial impact of students' perspectives on their mathematical achievement. In conclusion, the approach emphasizes how raising teacher efficacy can magnify the positive effects that students' favourably perceptions have on their academic achievement in mathematics.

Figure 1

Conceptual Framework



According to Figure 1, students' perceptions of mathematics [SPMA] has direct effect on student mathematics achievement [SMAC]. Moreover, teacher efficacy [TEF] show a direct effect of students' perceptions of mathematics [SPMA]. In addition, teacher efficacy directly affect students' mathematics achievement. Further, teacher efficacy moderates the connection between students' perceptions of mathematics and their mathematics achievement.

3. Method

3.1. Research Design

The objective of a research, according to Klassen et al. (2016), is to lay out a plan for obtaining empirical data to answer the research questions. The current study made use of the descriptive survey design. This type of research design uses questionnaire to characterize a sample of individual's views, behaviors, perceptions, or characteristics at a specific time are considered descriptive (Creswell, 2012). Wyatt (2014) has shown that quantitative analysis of survey data is a useful tool for measuring the effect of self-efficacy on performance. You can examine the moderating and direct effects hypotheses in your study by using this method. Furthermore, research by Magrath et al. (2019) has demonstrated that survey designs enable findings to be extrapolated to many educational contexts. Moreover, Quaquebeke et al. (2022) study highlighted the usefulness and affordability of survey designs in educational research. When compared to experimental or longitudinal approaches, surveys will allow you to swiftly and affordably collect significant amounts of data. Research has demonstrated the adaptability of surveys in incorporating different question types, resulting in extensive datasets (Wilson & Cook, 2020).

3.2. Participants

A research sample comprises individuals who actively participate in a study and provide data for the purpose of the study (Morgan, 2022) . Out of the 1,207 students which enrolled in Bolgatanga Senior High School [BIG BOSS] and Zamse Senior High Technical School, 300 students in forms 1 and 2 made up the study's sample. Based on Yamane's (1967) formula for calculating the appropriate sample size for any descriptive survey design, the number of samples used in the study is in line with his recommendation. The estimated sample size for the study using the formula was 300 students.

Table 1
Demographics of Respondents (N=300)

Demographics	*Frequency(N)*	*Percent (%)*
Gender		
Male	134	44.7
Female	166	55.3
Age		
11-15 years	19	6.3
16-20 years	277	92.3
20-25 years	3	1.0
Above 25 years	1	0.4
Form		
Form 1	263	87.7
Form 2	37	12.3
Course		
General Arts	67	22.3
Visual Arts	46	15.3
General Science	69	23.0
Technical	35	11.8
Home Economics	64	21.3
Business	19	6.3

Table 1 presents the socio demographic characteristics of the respondents. It shows that out of the 300 students, 44.7% were Males students, while 55.3% were Females students. This shows that the majority of the respondents were Females students. For the age, it is observed that 6.3% of the respondents were between the ages 11 – 15 years, 92.3% were between the ages 16 – 20 years, 1.0% were between the ages 20 – 25 years and .4% were above 25 years. This indicates that the majority of the students were 16 – 20 years. For the form of the respondents, 87.7% were in Form 1 and 12.3% were in Form 2. On the aspect of the course of the respondents. The General Science recorded the highest with 23.0% and the least was Business with 6.3%. The rest were General Arts 22.3%, Visual Arts 15.3%, Home Economics 21.3% and Technical 11.8%.

Simple random sampling was used to select the sample. The study used a simple random sampling method, which guarantees that the important traits of the population's individuals are represented in the sample and that each person was picked at random rather than using a bias means. There were 263 form 1 students and 37 form 2 students in the sample.

3.3. Instrument

When the data collection process first started, a letter requesting permission to use the students of the chosen SHS schools, who answered the questionnaire for us, was written. Confidentiality and personal space of the participants were respected. Part A of the research questions was formulated by the researcher based on socio-demographic data, while Part B was formulated according to the three variables under investigation, namely teacher efficacy, students' perception of mathematics, and students' mathematics achievement. The measurement items for teacher efficacy was adopted from the work of Sari and Sumilah (2020). Moreover, the measurement items for students' perception of mathematics was adopted from the work of Arthur, Appiah et al. (2022). In addition, the measurement items for students' mathematics achievement was adopted from the work of Asare et al. (2024). All the measurement items adopted for the study was measured on the 5-point Likert scale ranges from 1 = strongly disagree to 5 = strongly agree (see Appendix 1).

3.4. Data Analysis

Since it will be challenging to understand data collected from the field in its unprocessed state, the data was analyzed to provide context. In order to perform structural equation modelling and address the research hypotheses, the collected data was analyzed using the Statistical Packages for Social Sciences (SPSS v.23) and Analysis of a Moment Structure (Amos v.23).

4. Results

4.1. Descriptive Results

Teacher Efficacy received the mean score of 3.66 from the analysis, Students mathematics achievement had a mean score of 3.85, and students' perception of mathematics had a mean score of 3.75. A 5-point Likert scale was used to evaluate the constructs, with 1 representing strongly disagree and 5 representing strongly agree. A mean score greater than 3 means agree and the maximum mean score that can be obtained is 5. Consequently, all four of the variables under study had mean scores that were high, as shown in Table 2.

Table 2
Descriptive Analysis

Variable	*Item*	*Mean*	*SD*
	Teacher Efficacy [TEF]	*3.66*	*0.977*
TEF3	I understand what my teacher expects of me.	3.61	.977
TEF4	When I do not understand a concept, my teacher goes over it again with me.	3.64	.976
TEF5	My math teacher makes every mathematical concept simple to understand.	3.67	.985
TEF6	My teacher employs a variety of instructional strategies.	3.74	.971
	Students Mathematics Achievement [SMAC]	*3.85*	*1.165*
SMAC3	In my math classes, I perform better and receive good grades.	3.88	1.179
SMAC4	I always accomplish my mathematics task	3.86	1.193
SMAC5	My mathematics achievement improve my analytical skills	3.92	1.127
SMAC6	My mathematics achievement help me make better decisions	3.78	1.181
SMAC7	I typically perform well in mathematics	3.83	1.149
	Students Perception of Mathematics [SPMA]	*3.75*	*1.059*
SPMA2	Learning mathematics in the classroom is made very simple by preparing ahead of time.	3.74	.991
SPMA3	Many formulae in mathematics make learning harder.	3.87	1.029
SPMA4	My overall mathematical achievement is influenced by my perception of mathematics.	3.86	1.087
SPMA5	I find that studying mathematics enhances my capacity for logical thought.	3.53	1.131

4.2. Exploratory Factor Analysis [EFA]

SPSS (version 23) was used to calculate the EFA. EFA was utilized to examine the associated factors in order to ascertain how in which each of the observed variables loaded on its appropriate variable. This was a method used to reduce or eliminate some of the factors on the questionnaire whose loading was off relative to the latent variables, according to Xia et al. (2016). The final EFA findings for the variables that were observed under the appropriate latent variables are shown in Table 3.

In Table 3, the number of observed variables loaded on the corresponding latent variables was determined by analysis. Further data analysis was conducted using observed variables that were greater than .5 and fell in the context of the appropriate latent variable. It was found that the quantity of variables that were observed in the proper definiteness for Students Mathematics Achievement was five (5), Students' Perception of Mathematics of was four (4), and Teacher Efficacy was four (4). The coefficient of the determinant was estimated at 1.446E-6 far greater than the acceptable value of .001. With the Kaiser-Meyer-Olkin which measure sampling adequacy was also .914, greater than the .5 minimum, this demonstrates that there is a strong relationship between the items and is a worthy worth according to Hair et al. (2010). According to the KMO, the variables that were observed loading into the appropriate latent

Table 3
Exploratory Factor Analysis (EFA)

Rotated Component Matrix			
Measurement Items	*Component*		
	1	2	3
TEF3		.873	
TEF4		.896	
TEF5		.885	
TEF6		.866	
SMAC3	.859		
SMAC4	.865		
SMAC5	.865		
SMAC6	.873		
SMAC7	.816		
SPMA2			.834
SPMA3			.870
SPMA4			.842
SPMA5			.802
KMO and Bartlett's Test			
Total Variance Explained			84.151%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy			.914
Bartlett's Test of Sphericity		Approx. Chi-Square	.3951.024
		df	78
		Sig.	<.001
Determinant			1.446E-01

variable construct was 91.4% adequate. Bartlett's Test of Sphericity produced a .000 significant p-value based on a degree of freedom of 78 and a Chi-Square of 3561.344. Additionally, a total Variance of 84.1% was recorded for the three latent variables. The final EFA showing variables listed under their appropriate latent variables are shown in Table 3.

4.3. Discriminant Validity Analysis

Numerous methods exist for evaluating discriminant validity; however, the present investigation employs one through a comparison between the inter-correlation coefficients and the square root of AVEs, a technique previously employed in studies like (Arthur, Dogbe, et al., 2022). According to Donnelly et al., (2001) Convergent validity assesses how much measurement items on the same construct correlate with one another, while discriminant validity measures how much measurement items on distinct constructs are uncorrelated.

Using the Amos (v.23) plugin tool, the discriminant validity scores were produced in conjunction with the CFA output. When the least √AVE is larger than the largest correlation coefficient, discriminant validity is considered to have been attained (Arthur, Boadu, et al., 2022). As shown in Table 4, the correlation that was least √AVE was 0.880, and the highest inter- correlation was .603.

Table 4
Discriminant Validity

Variables	*CR*	*AVE*	*MSV*	*MaxR(H)*	*SMAC*	*SPMA*	*TEF*
SMAC	.945	.774	.363	.950	**.880**		
SPMA	.934	.781	.363	.940	.603***	**.884**	
TEF	.948	.820	.327	.955	.463***	.572***	**.905**

Note. √AVE are bold and underlined ***p-value significant at 0.1% (0.001).

4.4. Validity and Reliability Analysis

However, an assessment of the measurement model's psychometric qualities, including validity and reliability, was also conducted. Therefore, in order to evaluate the observed variables' internal consistency, Cronbach's alpha [CA] was also performed. Using the retained items, the CA was computed with SPSS (v. 23). A minimum CA score of .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 .7, indicating that internal consistency had been attained. The CA score for Students Mathematics Achievement was .946, Students Perception of Mathematics was .932, and Teacher Efficacy was .949. To evaluate the observed variables' convergent validity, the Average Variance Extracted was computed. According to Donnelly et al. (2001), Convergent validity assesses the degree to which the new scale's measurement items correlate with those on the same construct. In order to determine that the observed variables achieved convergent validity, the least of AVE and composite reliability must be greater than .5 and .7 respectively, according to the Fornell and Larcker (1981) criteria. According to the results, 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 5.

Table 5
Confirmatory Factor Analysis (CFA)

Model Fit: CMIN = 106.729; DF = 57; CMIN/DF = 1.872; TLI = .983; CFI = .987; GFI = .949; RMR = .033; RMSEA = .054; PClose = .321.		
Teacher Efficacy (TEF): CA = .949; CR = .948; AVE = .820		
Label	*Item*	*Std. Factor Loading*
TEF3	I understand what my teacher expects of me.	.864
TEF4	When I do not understand a concept, my teacher goes over it again with me.	.882
TEF5	My math teacher makes every mathematical concept simple to understand.	.949
TEF6	My teacher employs a variety of instructional strategies.	.925
Students Mathematics Achievement (SMAC): CA = .946; CR = .945; AVE = .774		
SMAC3	In my math classes, I perform better and receive good grades.	.868
SMAC4	I always accomplish my mathematics task	.916
SMAC5	My mathematics achievement improve my analytical skills	.914
SMAC6	My mathematics achievement help me make better decisions	.880
SMAC7	I typically perform well in mathematics	.817
Students Perception of Mathematics (SPMA): CA = .932; CR = .934; AVE = .781		
SPMA2	Learning mathematics in the classroom is made very simple by preparing ahead of time.	.867
SPMA3	Many formulae in mathematics make learning harder.	.926
SPMA4	My overall mathematical achievement is influenced by my perception of mathematics.	.899
SPMA5	I find that studying mathematics enhances my capacity for logical thought.	.839

According to Hair el al. (2010), P-close ought to be higher than .05 and CMIN/DF should be less than 3, TLI and CFI should be at least .9, RMR and RMSEA should be below .8. CMIN calculates the model's minimum discrepancy; RMR and RMSEA are absolute fit indices that evaluate a hypothesized model's deviation from a perfect model; and CFI and TLI are incremental fit indices that evaluate the worst fit by comparing the hypothesized model's fit to the baseline model (Murray et al., 2021). With continuous data, normal-theory maximum likelihood is the basis for both CFI and TLI cutoff values. It is anticipated that P-close will likewise be statistically insignificant at 5% (higher than 0.05). When testing the null hypothesis that the population RMSEA is not higher than .05, *p*-close represents the *p*-value. As shown in Table 5, all of these were accomplished.

4.5. Structural Model

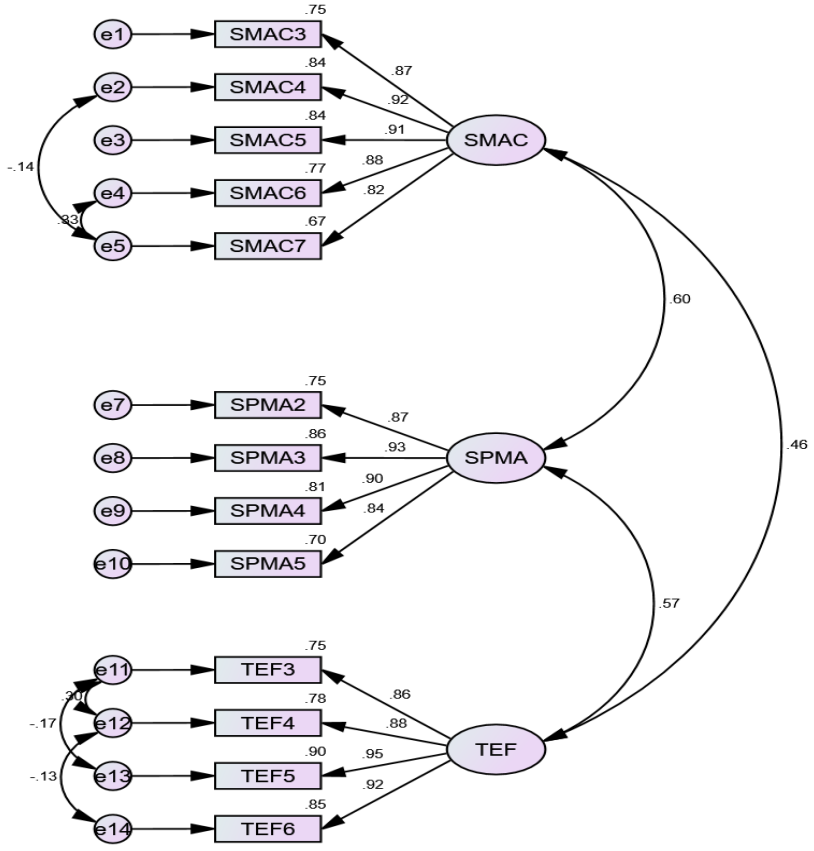
Following the evaluation of the measurement model fit, in Amos (v.23), Structural equation modelling was employed in the study to assess the different hypothesized paths. The estimates for the test of direct relationships and the moderating effect of Teacher Efficacy on the relationship between Students Perception of Mathematics and Students Mathematics Achievement (the interaction term SPMA_TEF). In addition, the control variables were included into the analysis and are presented in Table 6 and graphically depicted in Figure 2. Overall, the model shows a good fit.

Table 6
Path Summary

Direct effect	*Estimate*	*S.E.*	*C.R.*	*p-value*
Gender →SMAC	−.022	.097	−.227	.664
Age →SMAC	−.007	.167	−.042	.899
Form →SMAC	.129	.148	.872	.492
Course→SMAC	−.006	.030	−.200	.902
TEF →SPMA	.572	.060	9.533	***
TEF →SMAC	.077	.074	1.041	.048
SPMA→SMAC	.411	.076	5.408	***
SPMA_TEF→SMAC	.217	.008	27.125	***

Note. ***p <.01.

Figure 2
Confirmatory Factor Analysis



From the Table 6, the result showed that Gender of the respondents had a negative effect on Students Mathematics Achievement and is statistically insignificant with 2.2% negative impact (β= −*0.022.; CR* = −*.227; p*=*.664*). Age had a negative effect on Students Mathematics Achievement and is statistically insignificant with 0.7% negative impact (β= −*.007; CR* = −*.042; p*=*.899*). For the Form of the respondent effect on Students Mathematics Achievement, it is positive and statistically insignificant with 12.9% positive impart (β= *.129; CR* = *.872; p*=*.492*). In addition, the Course of the respondents had a direct negative effect on Students Mathematics Achievement and statistically insignificant with 0.6% negative impact on Students Mathematics Achievement (β=*0.006; CR* = −*.200; p*=*.902*).

Results on the hypothesized paths (see Figure 3) indicated that Teacher Efficacy had a direct positive effect on students' perception of mathematics and statistically significant with a 57.2% positive impact on Students Mathematics Perception (β = *.572; CR = 9.533; p = .001*). That is, about 57.2% improvement on Students Perception of Mathematics is attributed to teacher efficacy. This indicates that teacher efficacy

influences positively, the perception of mathematics by students. **H1:** Teacher Efficacy has a direct positive effect on Students Perception of Mathematics was thus supported.

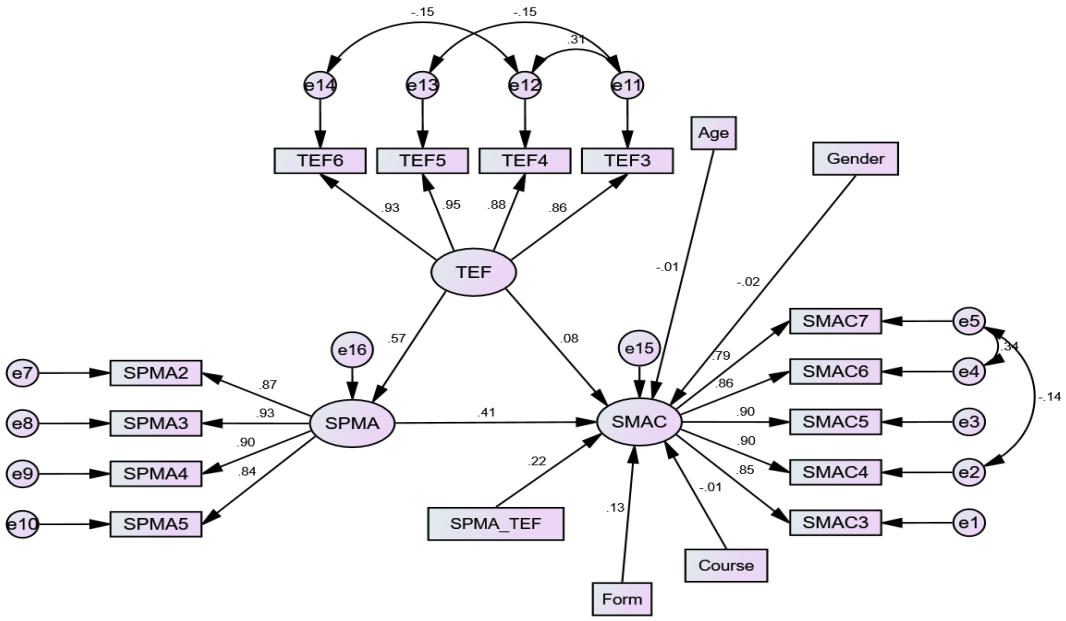
Furthermore, Teacher Efficacy had a direct positive and statistically significant effect on Students Mathematics Achievement with a 7.7% positive impact on Students Mathematics Achievement ($\beta = 0.077$; $CR = 1.041$; $p = .048$). Therefore, **H2:** which states that Teacher Efficacy has a direct positive effect on Students' Mathematics Achievement was thus supported.

Additionally, student's perception of mathematics had a direct positive effect on Students Mathematics Achievement and statistically significant with a 41.1% positive impact on Students Mathematics Achievement ($\beta = .411$; $CR = 5.408$; $p = .001$). Therefore, **H3**: Which states that Students Perception of Mathematics has a direct positive effect on students' mathematics achievement was thus supported.

The interaction between Students Perception of Mathematics and Teacher Efficacy was critically analyzed. It was revealed that the interaction term had a positive effect and was statistically significant with 21.7% positive impact on Students Mathematics Achievement ($\beta = .217$; $CR = 27.125$; $p = .001$). This indicates that, Teacher Efficacy influences about 21.7% of Students Perception of Mathematics positively. Therefore, **H4:** Which states that Teacher efficacy moderates the relationship between students' perception of mathematics and students' mathematics achievement was thus supported.

The two-way interaction between students' perception of mathematics (independent variable) and students' mathematics achievement (dependent variable), which are impacted by teacher efficacy (moderator), is shown in Figure 4. It was noticed that teacher efficacy mitigates the negative perception of students about mathematics through enhancing the favorable correlation between students' achievement in mathematics (SMAC) and their perception of mathematics (SPMA).

Figure 3
Path Analysis

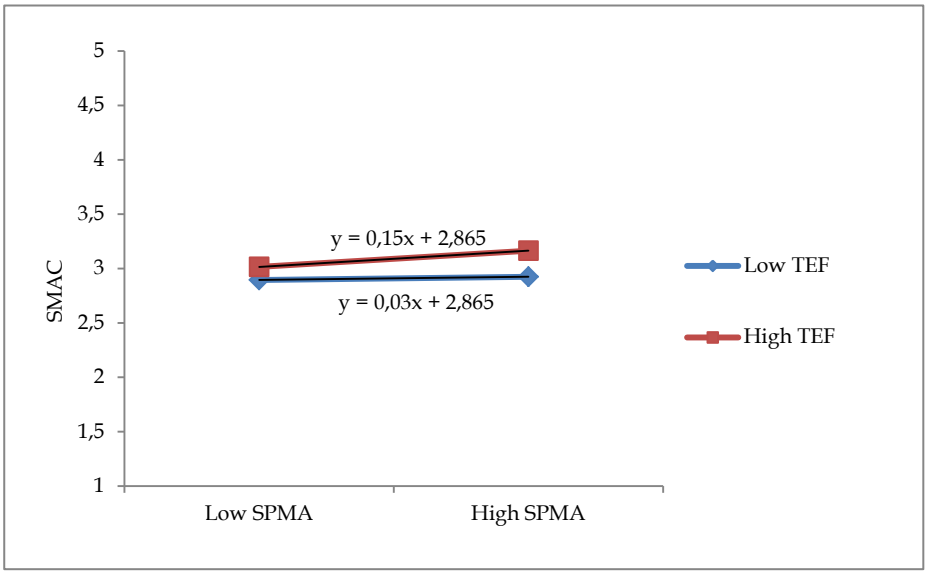


5. Discussion

The aim of this study was to look into how teacher efficacy influenced the relationship between students' achievement in mathematics and their perception of the subject. The study's primary findings show a positive relationship between students' achievement in mathematics and their favourably perceptions of the subject. Furthermore, it was discovered that teacher efficacy significantly moderated this relationship, thereby enhancing the beneficial influence of students' opinions on their academic achievement. In particular, there was a stronger correlation between students' perceptions and their mathematics achievement with high teacher efficacy.

The study's findings showed a statistically significant correlation between teachers' efficacy and students' perceptions of mathematics. This study demonstrated that when the efficacy of teachers is piqued, there is a

Figure 4
Two-way interaction



57.2% increase in students' perception of mathematics positively. The study's findings are in line with related study by Yulianto et al. (2023), and Hwang and Son (2021). They declared in their conclusion that teacher efficacy has a direct or significant influence on students' perception of mathematics. Suren and Kandemir (2020) examined a related study examining the relationship between anxiety students, performance and teacher quality in another study. They found a direct and positive correlation between the variables.

Moreover, the study's findings also concur with the body of research on teacher efficacy, which has shown that high levels of efficacy have a beneficial impact on students' learning and achievement. Teacher efficacy was found to be statistically significant based on the analysis that was done; this supports several writings and addition to the body of literature. Gulistan et al. (2017) for instance, looked at a number of variables, including the connection between achievement and teacher self – efficacy. They came to the conclusion that success in mathematics and teacher self-efficacy were strongly correlated. Arthur, Appiah et al. (2022) investigated how motivation, peer tutoring and teacher quality affected students' math achievement. The study's conclusion revealed a critical relationship between academic success and teacher quality.

In addition, the study's findings demonstrated a clear link between students' achievement in mathematics and their perception of the subject. At .1% significance level, the p-value between student's mathematics perception of mathematics and students' mathematics achievement was 0.001. Yulianto et al. (2023) study used a few variables to predict mathematics performance in relation to students' perception of mathematics. They came to the conclusion, supported by this same study that student's perception and teacher attitudes have a major impact on students' performance. The results of Suren and Kandemir (2020) study, which demonstrated a direct correlation between anxiety and mathematical achievement, are also supported by this investigation.

However, the current study adds a novel dimension by focusing on teacher efficacy as a moderating variable, a perspective that is less frequently explored. In this study, the moderator hypothesis was teacher efficacy moderates the relationship between student's perception of mathematics and students' mathematics achievement. A p-value of .001 was reported for the interaction term (SPMA×TEF), which was acting as the moderating effect of the teacher efficacy. The results showed a 5% confidence interval statistical significance. This clarifies why perception of students in mathematics was being moderated by the teacher efficacy. Although Perera and John (2020) talked about how teacher efficacy affects student outcomes, their study did not particularly look at how it influences students' attitudes and achievement.

6. Conclusion

This study examined the moderating role that teacher efficacy plays in the relationship between students' achievement and how they view mathematics. Higher achievement is correlated with favourably perceptions of mathematics, and this association is stronger when teacher efficacy is high. The study

suggests that raising teacher efficacy could greatly improve students' mathematics achievements by highlighting the essential role that effectiveness plays in enhancing the impact of students' positive attitudes on their academic achievement. Overall, the study offers insightful information on how student views and teacher efficacy combine to affect mathematics achievement, with useful implications for future research and instructional strategies.

7. Limitations and Future Directions

The study's findings, which drew from data from the Bolgatanga Municipality specifically from two schools namely Bolgatanga Senior High School and Zamse Senior High Technical School, cannot be applied to other areas of the country to represent student achievement. There were only two schools involved in this study; should more schools had been involved. Based on this study, here are some suggestions for further studies:

1) Longitudinal Research: Monitor how students' attitudes and academic performance evolve over time, and how these changes connect to changes in teachers' efficacy.

2) Study populations from various educational levels, such as those in elementary, middle, and high school, to see whether teacher efficacy has a different moderating function at each level.

3) Cross-National Comparisons: Examine the effects of cultural variations on the relationship between students' perceptions, accomplishment, and teacher efficacy using a larger, nationally diverse sample.

Finally, some suggestions are recommended. First, in order to improve student performance, it was suggested that school administrators implement teaching quality strategies. Should implement high-quality teaching strategies like classroom management, cognitive activation, and a supportive atmosphere. Second, given that the study employed causal analysis, it is advised that longitudinal data analysis be taken into consideration.

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Appendix 1. Questionnaire For Students

Please take the time to go over the items. Your answers will be kept private and used exclusively for academic purposes. We appreciate you taking the time to assist with this study.

Section A: Demographic Data

Please tick [√], where appropriate

1. **Gender:** Male [ ], Female [ ]
2. **Age:** 11-15 years [ ], 16-20 years [ ] 20-25 years [ ] Above 25 years
3. **Form:** Form 1 [ ], Form 2 [ ]
4. **Course**: General Arts [ ], Visual Arts [ ] General Science [ ], Technical [ ], Home Economics [ ] Business [ ].

Section B: Teacher Efficacy

Instruction: There are statements in this section about which you should carefully consider whether you strongly disagree (**SD**), disagree (**D**), neutral (**N**), agree (**A**), or strongly agree (**SA**). To indicate your opinion, use a checkmark [√] next to each statement.

No	Statement	SD	D	N	A	SA
1	My teacher uses a range of techniques for assessment.					
2	My teacher normally craft good questions when teaching.					
3	I understand what my teacher expects of me.					
4	When I do not understand a concept, my teacher goes over it again with me.					
5	My maths teacher makes every mathematical concept simple to understand.					
6	My teacher employs a variety of instructional strategies.					
7	My teacher provides an alternative explanation for example when Students are confused.					
8	My teacher normally foster student creativity.					
9	When one of my students does not seem interested in their schoolwork, my teacher helps them.					
10	In the classroom, my teacher effectively manages disruptive behavior.					

Section C: Students Perception of Mathematics

Instruction: There are statements in this section about which you should carefully consider whether you strongly disagree (**SD**), disagree (**D**), neutral (**N**), agree (**A**), or strongly agree (**SA**). To indicate your opinion, use a checkmark [√] next to each statement.

No	Statement	SD	D	N	A	SA
1	I believe that maths is a useful subject in life.					
2	Learning mathematics in the classroom is made very simple by preparing ahead of time.					
3	Many formulae in mathematics make learning harder.					
4	My overall mathematical achievement is influenced by my perception of mathematics.					
5	I find that studying mathematics enhances my capacity for logical thought.					
6	I am happy with my mathematical skills.					
7	Maths is reserved for highly capable students.					
8	I am among those who simply cannot comprehend maths.					
9	I think maths is a tough subject.					
10	Out of all the subjects, mathematics is my favorite.					

Section D: Students Mathematics Achievement

Instruction: There are statements in this section about which you should carefully consider whether you strongly disagree (**SD**), disagree (**D**), neutral (**N**), agree (**A**), or strongly agree (**SA**). To indicate your opinion, use a checkmark [√] next to each statement.

No	**Statement**	**SD**	**D**	**N**	**A**	**SA**
1	My thinking speed increases when I work with maths.					
2	In maths, I receive excellent scores.					
3	In my math classes, I perform better and receive good grades.					
4	I always accomplish my mathematics task.					
5	My mathematics achievement improve my analytical skills.					
6	My mathematics achievement help me make better decisions.					
7	I typically perform well in mathematics.					
8	The subject of mathematics is simple to pass.					
9	My current level of mathematical knowledge is high.					
10	If I do not give up, I can perform exceptionally well.					