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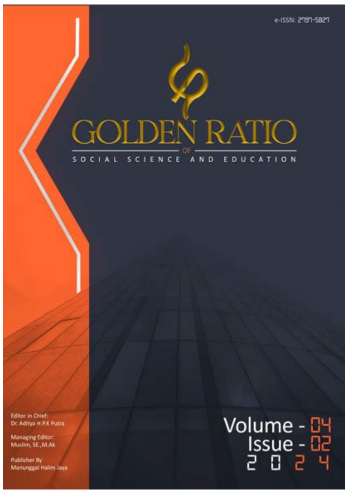

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SOCIAL SCIENCE AND EDUCATION | RESEARCH ARTICLE

Enhancing Student Mathematics Performance Through Teaching Quality, Motivation, and Students Self-efficacy

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Abstract: The current study sought to improve student performance in mathematics by focusing on motivation, student self-efficacy, and teaching quality. The study's descriptive correlation design used a questionnaire to gather data from the intended students. With a sample size of 355 students, the study's population consisted of 3139 students pressuring agric, business, general science, and general arts. Respondents from each stratum were chosen using simple random sampling that was stratified and purposeful. An analysis of the hypothesis routes was conducted using Amos' structural equation model (ver. 23). The student's results showed that improving student performance in mathematics was directly impacted by teaching quality, motivation, and student self-efficacy.

Keywords: Teacher Quality, Motivation, Student Self-Efficacy, Mathematics Performance, Questionnaire.

1. INTRODUCTION

In education, the search for excellence in mathematics instruction is ongoing. Mathematics is a foundation for many academic and professional undertakings, making improving student performance in this subject an important goal. Researchers in the field of mathematics education have investigated several variables that have a significant impact on student mathematics learning and performance. According to several research in mathematics education, peer-supported learning and self-regulatory learning have emerged as the most significant elements influencing student performance in mathematics (Mutawah et al., 2017; Hinnant-Crawford et al., 2016; Santhanalakshmi & Naomi, 2021). However, accomplishing the aim of student performance in mathematics requires a comprehensive strategy that considers the interaction of teaching quality, student motivation, and self-efficacy.

Teaching quality stands as the cornerstone of practical education. Educators serve as guides, illuminating pathways through the intricate landscape of mathematical concepts. Their ability to convey ideas, provide support, and foster a conducive learning environment significantly influences student outcomes. A robust understanding of pedagogical techniques and a commitment to individualized instruction are indispensable in cultivating mathematical proficiency among students. Motivation acts as the driving force behind academic engagement and achievement. In mathematics, intrinsic and extrinsic motivators shape student attitudes and behaviors toward the subject. Whether fueled by a genuine passion for problem-solving or external incentives, motivation catalyzes sustained effort and perseverance in mathematical pursuits.

Furthermore, self-efficacy emerges as a critical determinant of mathematical performance. Rooted in Bandura's social cognitive theory, self-efficacy reflects an individual's belief in their capacity to accomplish specific tasks. In mathematics, self-efficacious students exhibit confidence in their ability to tackle challenging problems, navigate complexities, and persist in facing setbacks. As such, nurturing students' self-beliefs and fostering a growth mindset are integral to promoting mathematical proficiency.

Despite the acknowledged significance of mathematics education in cultivating critical thinking skills and equipping students for future endeavors, many encounter challenges in the subject, leading to subpar performance and dwindling confidence. This highlights the necessity for holistic interventions addressing various facets impacting students' mathematical prowess, encompassing teaching standards, motivation, and self-belief. Filgona et al. (2020) highlighted a positive association between teachers' mastery of content and students' math achievement, underscoring the pivotal role of pedagogical content knowledge (PCK) in fostering comprehension. Effective teaching methods like explicit instruction and constructive feedback have proven instrumental in enhancing students' math outcomes (Selvaraj et al., 2021). Motivation significantly influences students' commitment and resilience in learning math. Those driven by intrinsic motivation, self-assurance, and mastery aspirations tend to excel and grasp mathematical concepts better (Agger & Koenka, 2020). Creating a nurturing environment, kindling interest, and fostering autonomous learning opportunities can amplify students' drive and performance in mathematics (Ruiz-Alfonso et al., 2021). Students' confidence in their mathematical abilities, or self-efficacy, profoundly impacts their motivation, exertion, and success in the subject. Heightened math self-efficacy correlates with extraordinary perseverance, assurance, and academic attainment (Arifin & Kuningan, 2021). Interventions targeting the enhancement of students' math self-efficacy, like offering mastery experiences and supportive feedback, have proven efficacious in bolstering their performance (Falco, 2019). While existing literature extensively examines the individual impacts of teaching standards, motivation, and self-efficacy on students' math performance, there exists a need for studies comprehensively exploring the collective influence of these factors and the efficacy of simultaneous interventions. Addressing this void is imperative for formulating evidence-based strategies to elevate student math achievement and unravel the intricate dynamics among teaching standards, motivation, and self-efficacy in math education.

This research delves into the intricate relationship among teaching standards, motivation, and self-efficacy in enhancing students' math performance. Through scrutiny of empirical research and theoretical frameworks, the author aims to elucidate the mechanisms through which these factors shape mathematical outcomes

2. LITERATURE REVIEW

2.1. Teaching Quality and Student Mathematics Performance

The impact of teaching quality on students' mathematics performance is a well-explored area in educational research. Various studies have delved into how different teaching methods, approaches, and teacher attributes affect students' comprehension and competence in mathematics. Research indicates that teachers' profound grasp of mathematical concepts and adeptness in conveying these ideas positively correlate with student achievement (Hill et al., 2005). Moreover, studies have consistently revealed a significant association between teachers' mastery of content and students' mathematics proficiency (Nolan et al., 2015). A meta-analysis conducted by Dumma and Mojeed (2015) confirmed this correlation, emphasizing the importance of teachers' content knowledge in enhancing student outcomes in mathematics. Effective instructional strategies, such as explicit instruction, feedback mechanisms, and scaffolding, bolster students' mathematical comprehension (Hong & Sullivan, 2013). The ability of teachers to translate their content expertise into pedagogically sound instruction, often termed pedagogical content knowledge (PCK), has been identified as a critical factor influencing student learning outcomes. Hill et al. (2008) underscored the significance of teachers' PCK in fostering students' mathematical understanding.

Furthermore, teachers' attitudes and beliefs regarding mathematics and their teaching methodologies also impact student performance. Cross (2009) discussed how teachers' beliefs about mathematics affect their instructional decisions and consequently impact student learning outcomes. The quality of teacher-student interactions has been linked to students' mathematical achievement. Effective communication, positive teacher-student relationships, and classroom discourse encouraging mathematical reasoning have been associated with better student outcomes (Ran et al., 2022). Ongoing professional development opportunities for teachers can enhance their instructional practices and ultimately improve students' mathematical performance (Bognar et al., 2024). Research suggests that sustained, job-embedded professional development focusing on content knowledge and instructional strategies is particularly effective (Balasi & Iordanidis, 2024). Providing timely and constructive feedback to students is critical for their mathematical growth. Balasi and Iordanidis (2024) emphasized the importance of formative assessment practices, highlighting how they can inform teaching and learning, leading to improved student outcomes in mathematics. The classroom environment, including classroom management, organization, and using manipulatives and technology, can impact students' engagement and motivation in mathematics (Nurnberger-Haag et al., 2023).

2.2. Motivation and Mathematics Performance.

The influence of motivation on students' mathematics performance has been extensively studied in educational research. Motivation is pivotal in shaping students' engagement, persistence, and effort in learning mathematics. Intrinsic motivation, driven by students' internal desires to engage in an activity for its inherent satisfaction, consistently correlates with elevated achievement in mathematics (Howard et al., 2021). Intrinsically motivated students are more inclined to participate in mathematical tasks actively, persist in problem-solving endeavors, and exhibit deeper understanding. Shehzad et al. (2020) introduced the concept of self-efficacy, reflecting individuals' beliefs in their capacity to succeed in specific tasks. In mathematics, students with heightened self-efficacy typically demonstrate superior performance as they approach mathematical challenges with assurance and determination (Hiller et al., 2022). Achievement goal theory distinguishes between mastery goals, centered on learning and understanding, and performance goals, focused on demonstrating ability relative to others. Research indicates that students with mastery goals in mathematics tend to achieve higher levels and grasp concepts better than those with performance goals (Juned et al., 2020). Students' interest in mathematics and perceptions of its relevance significantly influence their motivation and performance. Ong et al. (2020) underscored the importance of cultivating situational interest through engaging tasks and real-world applications, which can augment students' motivation and achievement in mathematics. Teachers play a critical role in nurturing students' motivation in mathematics. Providing constructive feedback, recognizing students' efforts, and fostering a positive learning atmosphere can boost motivation and performance (Taghinejad et al., 2020). Peer interactions and social dynamics within the classroom can also impact students' motivation and mathematics performance. Collaborative learning environments and peer support networks have been shown to cultivate positive attitudes toward mathematics and elevate motivation (Awofala & Lawani, 2020). Cultural beliefs about mathematics and socioeconomic status can additionally influence students' motivation and performance. For instance, research suggests that stereotype threat can undermine the motivation and performance of students from marginalized groups in mathematics (Fogliati, 2012). Providing opportunities for autonomous learning, where students have autonomy over their learning processes and decisions, can enhance motivation and engagement in mathematics (Ambikairajah et al., 2021).

2.3. Self-efficacy and Mathematics Performance

Numerous studies have revealed a positive correlation between students' mathematics self-efficacy and academic performance. For instance, Callaman and Itaas (2020) conducted a meta-analysis of 22 studies, uncovering a moderate to strong association between mathematics self-efficacy and achievement in the subject. Students with heightened mathematics self-efficacy are more inclined to invest effort and persist in tackling mathematical challenges, even amidst obstacles (Czocher et al., 2020). They confidently approach complex tasks and exhibit resilience in overcoming setbacks (Ridgley et al., 2022). Self-efficacy beliefs mediate the relationship between factors (e.g., prior achievement, teacher support) and students' performance in mathematics. For example, Meador and Salazar (2023) demonstrated that mathematics self-efficacy partially mediated the connection between

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students' mathematical background and their performance in college-level mathematics courses. Students' mathematics self-efficacy beliefs are subject to change over time and are influenced by diverse factors, including past experiences, social comparisons, and feedback. Longitudinal studies indicate that students' mathematics self-efficacy tends to decrease as they advance through school, particularly during the transition to middle and high school (Falco & Summers, 2021). Gender differences in mathematics self-efficacy and their impact on performance have also been explored in research. While some studies have identified gender disparities in mathematics self-efficacy beliefs, with males typically reporting higher levels of self-efficacy (Ashlock et al., 2022), the relationship between self-efficacy and performance seems consistent across genders (Matovu, 2020). Interventions targeting the enhancement of students' mathematics self-efficacy have demonstrated improvements in their performance. These interventions often involve opportunities for mastery experiences, social persuasion, vicarious experiences, and emotional arousal (Macafee & Comeau, 2020). For instance, delivering feedback that underscores effort rather than innate ability can help bolster students' mathematics self-efficacy (Agger & Koenka, 2020). Cultural factors can also impact students' beliefs about mathematics self-efficacy. For example, research suggests cultural stereotypes about mathematical ability can influence students' self-efficacy beliefs and subsequent performance (Mozahem et al., 2021).

3. RESEARCH METHOD AND MATERIALS

3.1. Design

A descriptive research design was adopted, which was supported by a quantitative research method.

3.2. Population

The study population consists of all 3139 students at Ambariya Senior High School who are studying agriculture, business, general science, and general arts.

3.3. Sample size

The Yamane (1967) method for sample determination was employed to calculate the sample size for the present study. The procedure for determining the sample size was outlined as follows:

$$n = \frac{N}{1 + Ne^2}$$

Where n is the sample size, N is the total population (3139), and e is the level of significance (set as 0.05).

$$n = \frac{3139}{1 + 3139(0.05)^2} = 355$$

The study's sample size based on Yamane's (1967) formula was 355.

3.4. Sampling Techniques

The method used to choose the necessary sample to reflect the whole population of a specific research is referred to as the sampling procedure. Three sample strategies were utilized in this study: Random sampling, stratified sampling, and purposive sampling. The study's chosen school was chosen through purposive sampling. The associated author teaches at the chosen school, which is why it was chosen. Using stratified sampling, the students were divided into groups according to their courses of study, or stratum, which included general arts, scientific, business, and technical students. The students from each stratum were chosen using the sample random sampling approach.

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3.5. Questionnaire and Measures

In this study, data collection utilized questionnaires. The questionnaire was structured based on the constructs under investigation: teacher quality, motivation, student self-efficacy, and mathematics performance. The measurement items for teaching quality were adapted and refined from the research of Arthur et al. (2022). Similarly, the measurement items for motivation were drawn and refined from the work of Arthur et al. (2022). Furthermore, the measurement items for student self-efficacy were adapted and refined from the study by Appiah et al. (2022). The measurement items for mathematics performance were sourced from Bright's (2024) research and those of Asare et al. (2023). All measurement items were assessed using a five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree).

3.6. Data Analysis Procedure

The data analysis for this study was conducted across four distinct categories. Firstly, exploratory factor analysis (EFA) was employed to identify the number of measurement items loaded onto their respective constructs, utilizing a minimum threshold of 0.5. Secondly, confirmatory factor analysis (CFA) was conducted to ascertain whether the identified measurement items strongly aligned with their respective constructs, assessing model fit against established criteria in the literature (Bamfo et al., 2018; Dogbe et al., 2020). Thirdly, discriminant validity analysis was performed to clarify the constructs intended to be measured, comparing the square root of the average variance extracted to the intercorrelated variables. Finally, path analysis, the fourth category, was executed to evaluate the research hypotheses and determine whether to accept or reject the stated hypotheses.

3.7. Data Analysis

The data analysis was performed using SPSS (ver. 23) and Amos Graphic (ver. 23).

3.8. Exploratory Factor Analysis (EFA)

With SPSS (ver. 23), exploratory factor analysis (EFA) was carried out. The EFA aimed to ascertain how many measurement items were loaded at the correct construct and whose loading was higher than the 0.5 minimum criterion (Marsh et al., 2020). According to EFA Table 1, there was more loading than the minimal criterion of 0.5 for the number of measurement items under the corresponding constructs. Additionally, there were four measuring factors for teacher quality with loadings greater than 0.5. There were five measurement items with loadings over 0.5 for motivation, three with loadings above 0.5 for student self-efficacy, and five with loadings above 0.5 for mathematical performance.

Table 1. Exploratory Factor Analysis (EFA)

Rotated Component Matrix				
Measurement Items	Component			
	1	2	3	4
TQ2			.896	
TQ3			.913	
TQ4			.912	
TQ5			.901	
MO1	.742			
MO2	.871			
MO3	.881			
MO4	.860			
MO5	.839			
SSE2				.906
SSE3				.913
SSE4				.933

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Rotated Component Matrix				
MP1		.810		
MP2		.810		
MP3		.860		
MP4		.862		
MP5		.877		

KMO and Bartlett's Test		
TVE		80.4155
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.852
Bartlett's Test of Sphericity	Approx. Chi-Square	4665.186
	df	153
	Sig.	0.000
Determinant		6.60E-08

Extraction Method: Principal Component Analysis.
a. Four components were extracted.

Moreover, the determinant coefficient was 6.60E-08, accompanied by a Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) of 0.852. In 85.2% of cases, the KMO elucidated why the observable variables loaded appropriately onto the latent variables. Bartlett's Test of Sphericity indicated a significant p-value of 0.000, with a Chi-square value of 4665.186 and 153 degrees of freedom. Alongside the exploratory factor analysis (EFA), the four latent variables collectively accounted for a total variance of 80.42%. However, any observed variables that did not align correctly on the rotated component matrix were subsequently removed. Table 2 presents the final EFA results, plotting the observable variables against the corresponding latent variables.

3.9. Confirmatory Factor Analysis (CFA)

Following the EFA analysis, Confirmatory Factor Analysis (CFA) was conducted using Amos Graphics (ver. 23). CFA aimed to ascertain whether the measurement items adequately aligned with their respective constructs and fit the model. As outlined by Bamfo et al. (2018), a well-fitting model should exhibit CMIN/DF less than 3, CFI and TLI values exceeding 0.9, RMR and RMSEA values not surpassing 0.6, and a statistically insignificant PClose value (PClose > 0.5). Comparing the model fit indices in Table 1 to Bamfo et al.'s (2018) CFA model fit criteria, the measurement items within their respective constructs were deemed to fit the model. Table 1 and Figure 2 present the results of the confirmatory factor analysis.

Table 2. Confirmatory Factor Analysis (CFA)

Model Fit Indices: CMIN = 158.439; DF = 103; CMIN/DF = 1.538; CFI = .987; TLI = .983; RMR = .043; RMSEA = .043; GFI = .941; PClose = .798;	**Fact. Loadings**
Teacher Quality (QT): CR = 0.945; CA = 0.942; AVE = .812;	
TQ2: A skilled instructor will methodically explore mathematical concepts.	.925
TQ3: When teachers involve students in their leisure time, the quality of mathematics instruction and learning is enhanced.	.820
TQ4: Instructors provide many opportunities for practice so that I can assess my comprehension of the material being covered in class.	1.004
TQ5: My math instructor gives insightful criticism to help me grasp.	.844
Motivation (MO): CR = 0.924; CA = 0.921; AVE = .710;	
MO1: I frequently look for opportunities to learn new techniques for handling mathematical difficulties.	.723
MO2: I feel successful when I finish a math assignment.	.885

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MO3: The fact that mathematics is necessary in all facets of life inspires me to study it.	.893
MO4: I study mathematics in order to advance personally.	.871
MO5: My parent and mathematics teacher motivate me to learn mathematics.	.827
Student Self-Efficacy (SSE): CR = 0.921; CA = 0.936; AVE = .796;	
SSE2: When it comes to arithmetic, I feel secure.	.853
SSE3: With confidence, I can assist others with their arithmetic challenges.	.995
SSE4: I score well in math classes.	.818
Mathematics Performance (MP): CR = 0.917; CA = 0.924; AVE = .690;	
MP1: I currently know a lot about math.	.741
MP2: When I can solve arithmetic questions, I am delighted.	.755
MP3: It is simple to pass mathematics.	.828
MP4: I can better grasp other topics because of math.	.890
MP5: I have a more robust enthusiasm for mathematics than many classmates.	.924

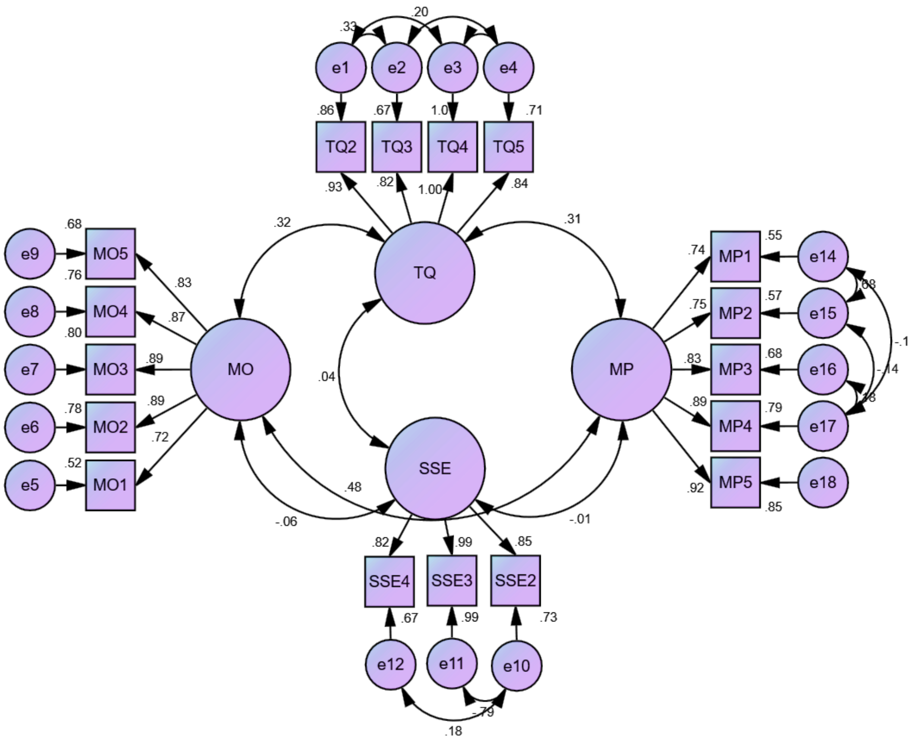

Figure 1. Confirmatory Factor Analysis

3.10. Discriminant Validity

Discriminant validity is achieved when the Average Variance Extracted (AVE) square root surpasses the inter-correlation scores (Bamfo et al., 2018; Shrestha, 2021; dos Santos & Cirillo, 2021). Before the comparison, the inter-correlation coefficients were assessed to determine whether there was a significant connection between any of the variables, notably the independent variables. Higher than 0.7 absolute correlation coefficients are considered high. The statistically highest correlation coefficient in Table 3 was 0.467 (between motivation and mathematics performance). When the AVE is compared to the inter-correlation coefficients, it is evident that the AVE was consistently more significant than the corresponding correlation coefficients in the columns. As a result, every variable achieved discriminant validity. For the control variables, there was no AVE to compare. To verify the convergence validity of the CFA measures based on their factor loadings, we employed average variance extracted (AVE). An AVE value greater than 0.5, according to Roemer et al. (2021), shows sufficient convergent validity and uni-dimensionality. The fact that all AVEs were more significant than 0.5 in Table 3 showed that our conceptions had enough convergent validity.

Table 3. Discriminat Validity

Variables	CR	AVE	TQ	MO	SSE	MP
TQ	0.945	0.812	0.901			
MO	0.924	0.710	0.321***	0.842		
SSE	0.921	0.796	0.040	-0.063	0.892	
MP	0.917	0.690	0.305***	0.476***	-0.013	0.831

4. RESULTS AND DISCUSSION

Path analysis involves dissecting correlations or covariations between two variables within a structural equation model to determine the extent of covariance resulting from a theoretically proposed causal relationship between one variable and another. It provides a means to untangle the relationship between various independent factors and the dependent variables, thereby corroborating previous hypotheses posited by other researchers. Table 4 evaluates the distinct direct effects of the study's hypotheses, with analysis conducted using the Amos Structural Equation Model (SEM) (ver. 23). The outcomes of the independent variables (motivation, self-efficacy, and teaching quality) about the dependent variable (mathematics performance) are presented in Table 4.

Table 4. Hypothesized Paths Analysis

Direct Effect	Estimate	S.E.	C.R.	P
TQ→MP	.144	.049	2.912	.004
MO→MP	.440	.071	6.212	< 0.01
SSE→MP	.006	.049	.125	.900

Research Hypothesis One (1): *Teacher quality has a direct positive effect on student mathematics performance.*

Research hypothesis one (H1a) aimed to investigate the impact of teaching quality on student mathematics performance, assessed through the direct relationship of (T.Q. → SMP). According to the findings presented in Table 4, teaching quality demonstrates a direct, positive, and statistically significant effect on student mathematics performance, with a p-value less than 1% (β = .144, C.R. = 2.912). This indicates that teaching quality accounts for a 14.4% variance in student mathematics performance. Thus, the study's results support hypothesis one (H1a), proposing a direct positive effect of teacher quality on student mathematics performance. This finding aligns with the research conducted by Asare et al. (2024), which similarly identified a direct positive and statistically significant effect of teacher quality on mathematics performance. Fosu et al. (2022) also observed a direct positive effect of teaching quality on mathematics achievement in their study involving 300 students from selected schools in Ghana. Similarly, Arthur et al. (2022) found a direct positive effect of mathematics teaching quality on the mathematics performance of first-year undergraduate students at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) (β = 0.185; C.R. = 3.882).

Research Hypothesis Two (2): *Motivation has a direct positive impact on student mathematics performance.*

Research hypothesis two (H1b) aims to ascertain the direct positive impact of motivation on student mathematics performance, assessed through the direct relationship of (MO → M.P.). According to the findings presented in Table 4, motivation exhibits a direct positive and statistically significant effect on student mathematics performance, with a p-value less than 1% (β = .440, C.R. = 6.212). This indicates that motivation explains 44% of the variance in student mathematics performance. Therefore, the study's results support hypothesis two (H1b), proposing a direct positive effect of motivation on student mathematics performance. This finding corroborates with the study conducted by SIVRIKAYA (2019), which similarly identified a strong positive and significant relationship between motivation and student mathematics performance.

Additionally, Tella (2007) found in their study that motivation directly impacted students' academic achievement at Osun State College of Education, Nigeria. Similarly, Steinmayr et al. (2019) examined the importance of motivating students to improve their academic performance with a

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sample of 345 11th and 12th-grade students. They concluded that motivation had a significant impact on student academic performance.

Research Hypothesis Three (H_{1c}): *Student self-efficacy has a direct positive impact on their mathematics performance.*

The third research hypothesis aimed to determine the direct positive impact of student self-efficacy on their mathematics performance, assessed through the direct relationship of (SSE → M.P.). However, the analysis results presented in Table 4 indicate that student self-efficacy has a direct positive but statistically insignificant impact on mathematics performance, with a p-value exceeding 5% (β = .006, C.R. = .125). Therefore, hypothesis three (H1c), proposing a direct positive impact of student self-efficacy on student mathematics performance, is not supported by the study's results. This finding contrasts with the study conducted by Appiah et al. (2022), which found a positive effect of student self-efficacy on mathematics achievement. Additionally, Czocher et al. (2020) identified self-efficacy as a critical predictor of study persistence in mathematics learning. Similarly, Meador and Salazar (2023) found that self-efficacy positively moderated the relationship between math anxiety and student academic performance.

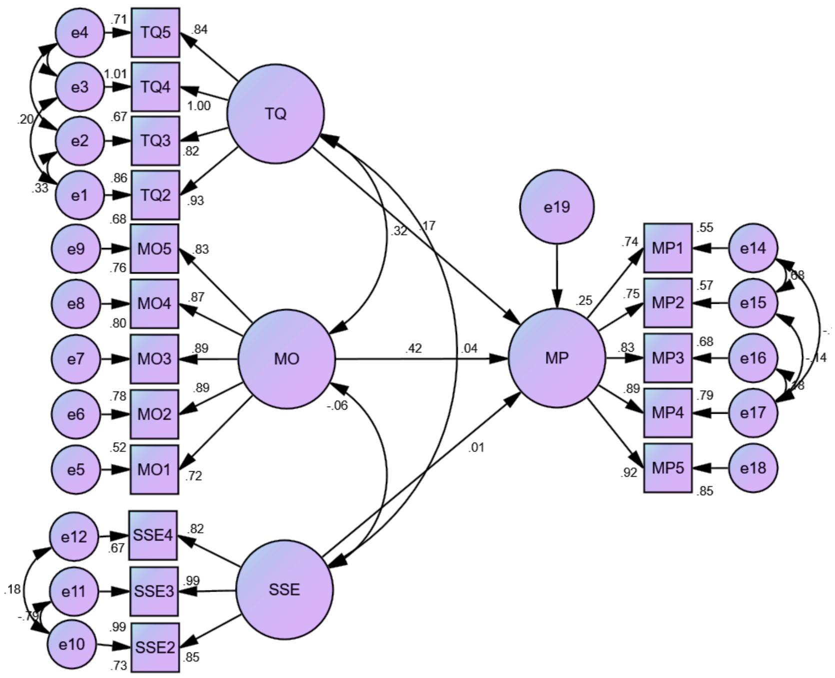

Figure 2. Direct Path Analysis

5. CONCLUSION

Ambariya Senior High School, the site of the current study, had a total enrollment of 3139 students, encompassing programs in agriculture, business, general science, and general arts. The study's sample size was determined using the Yamane (1967) formula, employing simple random and stratified sampling techniques to select respondents. Five-point Likert scales ranging from 1 (strongly agree) to 5 (strongly disagree) were utilized within the three variables of teaching quality, motivation, and student self-efficacy. These scales were adapted from previous similar investigations. The study data were analyzed using Amos Graphics (ver. 23) and SPSS (ver. 23). Various analytical techniques, including structural equation modeling (SEM), exploratory factor analysis, confirmatory factor analysis, discriminant validity, and path analysis, were employed. The study findings indicate that student self-efficacy, motivation, and teaching quality all positively impacted mathematics performance.

The Anbariya Senior High School was the exclusive focus of the research. In order to draw meaningful conclusions, this school's representation of the study population needs to be revised.

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Therefore, future research should examine the effects of selecting more than two senior high schools, such as Anbariya Senior High School. Furthermore, a questionnaire was the sole means of collecting data from the study's student participants. Interviews must be used in future studies to examine how students see the impact of high-quality instruction on their mathematical performance and the significance of motivation in mathematics education.

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