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Optimizing High School Mathematics Achievement through the Lens of Realistic Mathematics Education: The Mediating Role of Teacher Self-Efficacy

Ernest Frimpong Akosah
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Ghana

Yarhands Dissou Arthur
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Ghana

Benjamin Adu Obeng
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Ghana

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Abstract

This study examines the relationship between teaching quality, teacher self-efficacy, and students' mathematics achievement among junior high school students in Ghana, utilizing Realistic Mathematics Education and Self-Determination Theory as frameworks. A stratified purposive sample of 507 junior high school mathematics teachers from eight regions was selected, employing a correlational cross-sectional survey design. Structural Equation Modeling (SEM) tested the hypotheses that teaching quality positively affects mathematics achievement, teacher self-efficacy influences teaching quality, and self-efficacy mediates the relationship between teaching quality and achievement. Results confirmed that high-quality teaching significantly improves mathematics achievement, especially when contextualized with RME principles. Teacher self-efficacy emerged as a critical factor in enhancing teaching quality and directly influencing student outcomes. Mediation analysis showed that teacher self-efficacy strengthens the effect of teaching quality on achievement. These findings highlight the need for educational policies to focus on professional development that boosts teachers' efficacy and promotes realistic, student-centered instructional strategies.

Introduction

Education serves as a means of guidance provided by experienced and knowledgeable individuals to facilitate the growth and maturity of students (Darling-Hammond et al., 2020). The aim is to equip students with the skills necessary to manage their lives independently. Education produces talented individuals with bright ideas, ability, skills, and experience in preparation for a better future (Fitriyah et al., 2017). High-quality education is crucial for a nation's development because it lays the groundwork for a capable workforce, which subsequently fuels economic growth (Bondar-Pidhurska et al., 2021). Mathematics, as a field, is fundamental in developing critical thinking and problem-solving skills, both of which are essential for a country's socio-economic progress (Anderson, 2024). Mathematics achievement, in particular, has been a central concern for educators and researchers due to its role in academic success and future opportunities in fields like science, technology, engineering, and mathematics (STEM) (Thurm et al., 2024). Additionally, the achievement of students in mathematics has become a growing concern among stakeholders, given its implications for national development

(Baker et al., 2022). Mathematics is more than just an academic subject; it is a gateway to critical thinking and problem-solving, closely connected to scientific and technological advancements. Described as a universal language, mathematics reflects the logic and patterns that underlie our world (Kashyap, 2021). Mathematical intelligence refers to the ability to comprehend, apply, and explain mathematical concepts in everyday contexts (Prastika, 2021; Kobandaha et al., 2019). It involves deep learning, the development of critical skills, and fostering a strong interest in the subject (Chasanah, 2021). The significance of mathematics extends beyond the classroom, contributing to economic development and individual career opportunities, particularly in fields such as engineering and technology (OECD, 2018).

Despite its importance, student performance in mathematics continues to decline, especially at the junior high school level (Kiemer et al., 2015). International assessments, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), have highlighted significant gaps in mathematical literacy and problem-solving abilities worldwide (OECD, 2018; TIMSS, 2019). This underachievement is especially evident in developing countries like Ghana, where inadequate resources and teacher training exacerbate the problem (Eze, 2021). Teaching quality is increasingly recognized as a crucial factor in students' mathematics achievement, but the psychological mechanisms, like self-efficacy, that may mediate this relationship require further exploration (Arthur et al., 2017).Realistic Mathematics Education (RME), developed in the Netherlands, offers a valuable approach to improving mathematics outcomes by linking mathematical concepts to real-world contexts, thus making learning more engaging and relevant (Van den Heuvel-Panhuizen, 2020). By grounding mathematics in everyday experiences, RME enhances students' conceptual understanding and problem-solving abilities, addressing the common struggle students' face in relating abstract concepts to practical applications.

Self-Determination Theory (SDT) complements RME by suggesting that students are more motivated and perform better when their basic psychological needs for autonomy, competence, and relatedness are met (Deci & Ryan, 2000). In the context of mathematics education, SDT proposes that when students feel capable, autonomous in their learning, and connected to their teachers and peers, they engage more deeply and achieve greater success (Jansen et al., 2022). Teacher self-efficacy, a central element of SDT, plays a significant role in creating an environment that meets these needs. Teachers with high self-efficacy are more likely to adopt innovative strategies, manage classrooms effectively, and foster a supportive environment that encourages autonomy and competence in students (Hidayat & Patras, 2024). While SDT has contributed valuable insights, the teacher behaviors most conducive to academic success still require further research (Musadad, et al., 2022).
In Ghana, integrating RME and SDT into mathematics education could help address ongoing challenges in student achievement. By emphasizing real-world applications and fostering a supportive, student-centered learning environment, this approach has the potential to improve both teaching quality and teacher self-efficacy. Although the connection between teaching quality and student achievement is well-established, the mediating role of teacher self-efficacy, particularly at the junior high school level, remains under-researched.

This study aims to explore how teacher self-efficacy mediates the relationship between teaching quality and students' mathematics achievement, using RME and SDT as theoretical frameworks. Employing Structural

Equation Modeling (SEM), the research seeks to offer a detailed analysis of the complex dynamics involved, providing insights that could inform more effective educational strategies aimed at improving both teaching and student outcomes in mathematics.

The novelty of this study lies in its sequential analysis of how teaching quality and teacher self-efficacy influence junior high school students' mathematics achievement. Building on previous research, this study examines the mediating role of teacher self-efficacy within the framework of RME and SDT. The findings will contribute to the development of new models for enhancing teacher-related variables in mathematics education. By offering an empirical analysis of how teaching quality and self-efficacy can be improved, this study aims to motivate educators and institutions to implement meaningful and sustainable changes in the educational system.

Research Aims

This study aims to investigate the mediating role of teacher self-efficacy in the relationship between teaching quality and students' mathematics achievement within the framework of Realistic Mathematics Education (RME) and Self-Determination Theory (SDT). Specifically, the study seeks to:

1. Examine the direct effect of teaching quality on students' mathematics achievement through the lens of RME, focusing on how contextualized, real-world problem-solving impacts students' understanding and performance.
2. Explore the relationship between teacher self-efficacy and teaching quality**,** utilizing SDT to understand how teachers' beliefs in their own capabilities influence their teaching practices and, consequently, student outcomes.
3. Analyze the mediating role of teacher self-efficacy in the relationship between teaching quality and students' mathematics achievement**,** integrating RME's emphasis on contextual learning and SDT's focus on psychological needs for autonomy, competence, and relatedness.

Hypotheses

Given the aims of the study, the following hypotheses are proposed:

1. **H1:** *Teaching quality positively affects students' mathematics achievement, particularly when teaching is grounded in RME principles that connect mathematics to real-world contexts* (Van den Heuvel-Panhuizen, 2020).
2. **H2:** *Teaching quality positively influences teacher self - efficacy quality, with high self-efficacy leading to the implementation of more effective, student-centered teaching practices as outlined by SDT* (Deci & Ryan, 2000; Hidayat & Patras, 2024).
3. **H3:** *Teacher self-efficacy significantly mediates the relationship between teaching quality and students' mathematics achievement, amplifying the impact of high-quality teaching on student outcomes* (Onyishi & Sefotho, 2020; Olawale et al., 2021).

Literature Review

Teaching Quality and Mathematics Achievement

Over the years, researchers have examined various frameworks to identify the characteristics and practices of teachers which are effective in their teaching (Arthur et al., 2021). However, inconsistencies in terminology across studies pose challenges, as similar concepts are often labeled differently, and the same terms can refer to different ideas (Seaton et al., 2014). For example, terms like teaching quality (Fauth et al., 2019), quality of teaching (Hattie, 2009), teaching effectiveness (Oppong-Gyebi, et al., 2023), instructional quality (Arthur et al., 2021), teaching style (Russo, et al., 2021), and instructional style (Lhechukwu., 2020) are often used interchangeably. Within the context of SDT, "teaching quality" refers to specific teacher behaviors that support students' needs for autonomy, competence, and relatedness (Deci & Ryan, 2000). The relationship between teaching quality and students' academic achievement has been well-documented in educational research. Teaching quality encompasses various dimensions, including instructional clarity, teacher-student interactions, and the ability to engage students in meaningful learning experiences (Stronge et al., 2018). Studies have consistently shown that effective teaching practices significantly enhance students' understanding and retention of mathematical concepts, which in turn improves their academic performance (Olawale et al., 2021). Additional studies have shown that quality teachers who can provide hands-on learning opportunities like RME for students are instrumental in improving learning outcomes for students (UIS, 2016; Witoszek, 2018).

Realistic Mathematics Education (RME) provides a compelling framework for understanding and improving teaching quality in mathematics. Developed in the Netherlands, RME emphasizes the importance of connecting mathematical concepts to real-world contexts, thereby making learning more relevant and engaging for students (Van den Heuvel-Panhuizen, 2020). By situating mathematics in everyday experiences, RME seeks to improve students' conceptual understanding and problem-solving abilities, which are critical for success in mathematics. Research has shown that when students see the relevance of mathematics in their daily lives, they are more likely to engage with the subject matter and achieve higher levels of academic success (Thurm et al., 2024).

Teacher Self-Efficacy and Its Impact on Teaching Quality

Teacher self-efficacy, defined as teachers' beliefs in their ability to influence student outcomes, plays a crucial role in determining their instructional practices and effectiveness (Bandura, 1997; Onyishi & Sefotho, 2020). Teachers with high self-efficacy are more likely to implement innovative teaching strategies, manage classrooms effectively, and foster a supportive learning environment that encourages student autonomy and competence (Hidayat & Patras, 2024).Self-Determination Theory (SDT) posits that individuals are more motivated and perform better when their basic psychological needs for autonomy, competence, and relatedness are met (Deci & Ryan, 2000; Li et al., 2019). In the context of education, SDT suggests that when teachers feel competent in their abilities and autonomous in their teaching processes, they are more likely to engage in effective teaching practices that positively impact student outcomes. Recent research has demonstrated that teachers with high self-efficacy are more likely to create learning environments that support students' psychological needs, leading to better academic performance (Jansen et al., 2022).

The Mediating Role of Teacher Self-Efficacy

While the direct relationship between teaching quality and student achievement is well-established, recent studies have begun to explore the mediating role of teacher self-efficacy in this relationship. Teacher self-efficacy has been found to mediate the relationship between various educational inputs and academic outcomes, suggesting that teachers' beliefs in their own capabilities significantly impact their instructional practices and, consequently, student achievement (Bandura, 1997).In mathematics education, the integration of RME and SDT provides a unique lens through which to examine this mediating role. RME emphasizes the importance of connecting mathematical concepts to real-world contexts, while SDT highlights the importance of psychological factors in motivating and engaging students. When teachers with high self-efficacy implement RME-based teaching practices, they are more likely to create learning environments that fulfill students' psychological needs, leading to improved academic outcomes (Hidayat & Patras, 2024; Olawale et al., 2021).

Moreover, studies have shown that teacher self-efficacy not only influences teaching practices but also directly impacts students' academic achievement. For example, teachers who believe in their ability to teach mathematics effectively are more likely to create a positive learning environment and engage students in meaningful mathematical activities (Burić & Kim, 2020). This, in turn, leads to higher levels of student achievement, as students are more likely to feel competent and motivated to succeed in mathematics,Given the importance of both teaching quality and teacher self-efficacy in influencing students' mathematics achievement, it is crucial to understand how these factors interact within the educational context. By examining the mediating role of teacher self-efficacy in the relationship between teaching quality and mathematics achievement, this study aims to provide valuable insights that can inform the design of more effective educational strategies.

Conceptual Framework

Based on the theoretical and empirical foundations discussed, this study proposes a conceptual framework that posits teacher self-efficacy as a key mediator in the relationship between teaching quality and mathematics achievement. The framework suggests that high-quality teaching practices directly enhance students' mathematics achievement. In turn, higher self-efficacy leads to better academic performance, thus reinforcing the impact of teaching quality on achievement. The proposed conceptual framework can be illustrated as follows:

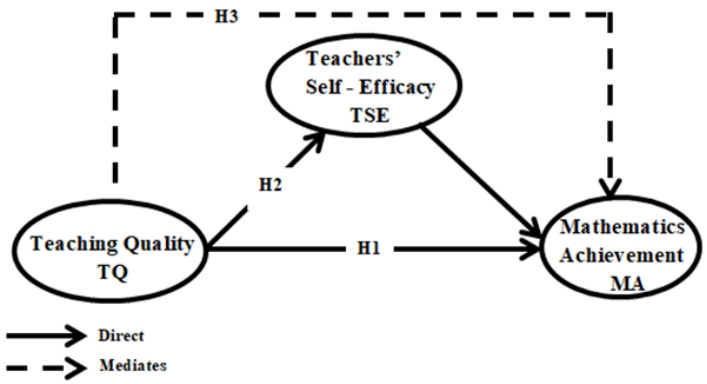

Figure 1. Conceptual Framework of the Study

Methods

Research Paradigm

According to Creswell & Creswell, (2017) a research paradigm offers a framework of presumptions and understandings that a research study's theories and methodologies might be built upon. The data and concepts in this study were rooted in reality (ontology), with an emphasis on the reliability, applicability, and possible sources of knowledge (epistemology), as well as the overarching notion that guides environmental exploration and validates the accuracy of the knowledge gained (methodology) in Ghanaian standard based curriculum. Positivism emphasizes objectivity and generalizable patterns through systematic observation and quantitative methods such as surveys and statistical analysis (Creswell, 2015). Positivists employ more quantitative techniques because of their superior representativeness and good dependability, such as social surveys, structured questionnaires, and public statistics. Researchers in this paradigm formulate and test hypotheses based on empirical data to establish causal relationships and predict outcomes. The study employed a positive philosophy, which makes use of quantitative methodologies since it aims to investigate the relationship between teaching quality and junior high school students mathematics achievement with teacher self – efficacy mediating them.

Research Design

The research design, crucial for structuring and organizing a study, ensures that the research effectively addresses the problem (Kazdin, 2021; Leavy, 2022). The study utilized a correlational cross-sectional descriptive survey design to fulfill the set objectives. When using a correlational cross-sectional descriptive survey design, information is gathered directly from a single point in time without manipulating it and was based on the research hypothesis. The effectiveness with which it examines correlations between variables at a specific time supports this strategy (Babbie, 2018). This approach allows for descriptive and inferential analysis to generalize findings (Gravetter & Forzano, 2018). This design was effective for exploring the relationships between variables and establishing the validity of the structural equation model (SEM). According to Kline (2018), correlational cross-sectional descriptive design data can be used to evaluate the SEM fit to the connections that were detected.

Sample and Sampling Technique

The study gathered data from five hundred and seven (507) junior high school mathematics teachers, selected from a population of twelve thousand nine hundred and eighty (12,980) teachers across eight (8) regions in Ghana: Ashanti, Bono East, Central, Eastern, Greater Accra, Northern, Oti and Volta. These regions were chosen to provide a diverse representation of educational settings in the country. The respondents were selected using a stratified purposive sampling technique to ensure that a comprehensive and representative sample of teachers with varying levels of knowledge, experience, and teaching quality was included. Teachers were chosen based on their active role in implementing the Realistic Mathematics Education (RME) approach, which is integral to the study's focus on examining the impact of teaching quality on students' mathematics achievement. The selection criteria ensured that the teachers were familiar with the RME methodology, thereby allowing for a more accurate assessment of the relationships between teaching quality and student mathematics achievement. The three primary

constructs found in the study—achievement in mathematics, teachers' self-efficacy, and teaching quality—were taken into consideration when designing the questionnaires. The structural equation model (SEM) was used to examine the questionnaires that were given to the JHS mathematics teachers. A sample of four hundred and seventy (470) should be selected for the study with a confidence level of 95% and a margin of error (degree of accuracy) of .05 for a population size of twelve thousand, nine hundred and eighty (12980). This was done in compliance with Gill et al. (2010) sample selection tables. The study's sample size was also determined using the Slovin's method subsequent to the Gill et al. (2010) sample selection. Using Slovin's technique, the minimum sample size was similarly found to be 388. Due to the researcher's assessment of the likelihood of inaccurate or incomplete questionnaire responses as well as an increase in external validity, the predicted sample size was increased to 520 junior high school mathematics teachers. Since the mathematics teachers were already in their various zones of study, the sample size to be picked in each stratum (Region) was then determined using the proportionate stratified sampling technique. A survey was sent out to 520 junior high school math teachers. Of these, 6 could not return the questionnaires within 3 days, which was considered a non-response. Additionally, the replies of these respondents were excluded from the analysis because two (2) of the forms were incomplete and two (2) of them had missing information and repeated responses. Finally, participants were informed that participation was voluntary and there was no negative effect, if they refused or discontinued participation. 3 of them quitted in the middle of the survey. Therefore, 507 Junior high school mathematics teachers' were considered usable, after the data collection process. This gave a response rate of 97.5 which the researcher deemed as very reliable representation for the study. Table 1 shows the demographic characteristics of the respondents.

Table 1. Demographic Characteristics of the Study Group $(\mathrm{n} = 507)$

Variables	Categories	Frequency(n)	Percentage (%)
Gender	Male	376	74
	Female	131	26
	Total	**507**	**100**
Age	<30	53	10
	30-40	211	42
	41-45	103	20
	46 and above	140	28
	Total	**507**	**100**
Years of Teaching Experience	1-5 years	69	14
	6-10 years	111	22
	>10 years	327	64
	Total	**507**	**100**
Highest Qualification	Cert A	105	21
	Diploma	235	46
	Bachelor's degree	162	32
	Masters	5	1
	Total	507	100

(Source: Field survey, 2024)

Based on Table 1, in terms of the gender distribution, 74% (376) were males, and 26% (131) were females; in terms of age distribution, 10% (53) were less than 30 years old, 42% (211), were 30–40 years old, 20% (103), were 41–45 years old, and 28% (140), were 46 years and above; in terms of years of teaching experience variables, 14% (69), had taught for 1–5 years , 22% (111), had taught for 6–10 years, and 64% (327), had taught for more than 10 years; in terms of highest qualification variables, 21% (105) had Cert A, 46% (235) had diploma, 32% (162) had bachelor's degree and 1% (2) had masters.

Questionnaire and Measures

The study utilized researchers made structured questionnaire as the primary measurement tool to gather data on teaching quality and students' mathematics achievement. The preference for a structured questionnaire was based on its highly efficient for collecting data from large samples, which was crucial given the study's sample size of 507 junior high school mathematics teachers (Creswell & Creswell, 2017). It also allows for the standardized collection of data, ensuring consistency and comparability across respondents.

According to Cohen et al., (2018) the predefined questions and response options enable researchers to quantify responses and perform complex analyses, such as Structural Equation Modeling (SEM), to test hypothesized relationships. This adaptability is particularly beneficial in reaching participants across multiple regions (Bryman, 2016), as in this study. The study focused on teaching quality, teacher self - efficacy and mathematics achievement.

There were one independent variable (teaching quality – TQ), one dependent variable (mathematics achievement – MA) and one mediator (teacher self - efficacy – TQ). These three (3) variables were all measured on a Likert scale weighted 1 (Strongly Disagree) to 5 (Strongly Agree). The teaching quality, teacher self - efficacy, and mathematics achievement all had ten measurement items each. The study also controlled for teachers' age, gender, qualification and years of teaching experience.

Reliability and Validity Analysis

To ensure the validity of the questionnaire, a pilot was conducted testing with a small sample of respondents to assess the clarity, relevance, and comprehensibility of the items. Questionnaire by assessing its internal consistency using statistical measures such as Cronbach's alpha (CA). Using Cronbach's alpha (CA) analysis in SPSS (v.23) software, the internal consistency of the measuring items was evaluated. When the alpha score is at least .7, it is considered to have attained internal dependability or consistency (Pomegbe et al., 2020).

Table 2 shows that the mathematics achievement (MA) had a CA of .927, the teaching quality (TQ) had a CA of .874, and the teacher self-efficacy (TSE) had a CA of .931. Convergent validity was assessed using average variance extracted (AVE) and composite reliability (CR). Fornell and Larcker (1981) recommended an AVE score of .5 and CR score of .7 in order to achieve convergence. The least AVE as reported in Table 2 is .797 (teaching quality) and the least CR score was .892 (teacher self – efficacy).

Table 2. Construct Reliability

Variable	Cronbach alpha (CA)	Composite reliability (CR)	Number of Items	The average variance extracted (AVE)
Teaching Quality	.874	.962	6	.809
Teacher Self - Efficacy	.931	.892	3	.797
Mathematics Achievement	.927	.981	10	.837

Field survey, 2024

Ethical Considerations

The research presented in this article has been conducted in accordance with the highest ethical standards and guidelines. The study was approved by the AAMUSTED Institutional Ethics and Research Committee of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) on 9th May, 2024 (Approval code: AAMUSTED/IERC/2024/004). Written informed consent was obtained from the Chairman of Institutional Ethical Review Committee, Heads of the Departments of mathematics education and lecturers, as well as from the teachers. Again, sought consent from respondents before administering the questionnaire and ensure that their privacy and confidentiality are protected.

Data Analysis Approach

The hardcopy questionnaires were coded and then imported into IBM-SPSS 23 and IBM-AMOS 23 for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), respectively.

Exploratory Factor Analysis (EFA)

As indicated by Hair et al., (2010), the EFA was used to generate the Kaiser-Meyer-Olkin (KMO) statistics of .886, whose work on connected factors was much greater than 0.5 for the necessary factor value. According to Kaiser's (1974) research, a KMO score greater than 0.80 indicated a more favorable correlation between the items and component analysis. The data's Chi-square score of 4457.787 and 136 levels of freedom were utilized to demonstrate significance using Bartlett's sphericity test, which has a significant p-value of .000 less than .001 and implies a substantial correlation to enable component analysis. The three components explained 87.137% of the overall variation in squared loadings of the rotation sum.

The number of complex factors was decreased while the average yield was raised using the rotating varimax approach. Pomegbe, et al.,(2020) assert that assessing the capacity of the components used in an instrument depends critically on the internal consistency of the measurement scale. The researchers then utilized the rotated component matrix to assess and choose which item(s) should be kept or removed before doing a CFA on the constructs using the AMOS-23 program.

Table 2. Final EFA (Rotated Component Matrix)

Variables	Components		
	1	2	3
Teaching Quality (RME)			
TQ1		.788	
TQ2		.709	
TQ3		.809	
TQ4		.823	
TQ5		.816	
TQ6		.756	
Teacher Self – Efficacy (TSE)			
TSE1			.912
TSE2			.931
TSE3			.909
Mathematics Achievement (MA)			
MA1	.921		
MA2	.926		
MA3	.927		
MA4	.909		
MA5	.896		
MA6	.915		
MA7	.903		
MA8	.910		
MA9	.893		
MA10	.918		

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Confirmatory Factor Analysis (CFA)

Researchers used CFA to evaluate their theories about whether there was a relationship between the components under study and the load factor, as described by Dogbe et al., (2020) and Lahey et al., (2012). Before employing an analytical diagram to identify the latent and construct variables, the CFA was instructed to evaluate the metrics used during the EFA and make an attempt to validate a hypothesis. The measurement items with poor factor loadings (less than 0.5) were deleted from further analysis. Four (4) measurement item were deleted from teaching quality, while seven (7) measurement items was deleted from teacher self - efficacy. Mathematics achievement had all its ten measurement items properly fitting, so none was deleted.

Model Fit

Another important consideration when CFA is run is the fitness of the model estimated. As part of the fitness

checks, CMIN/DF is supposed to be less than 3, CFI is all expected to be greater than .9, RMSEA and RMR are also expected to be less than 0.08, while P-Close is also expected to be statistically insignificant at 5% (greater than .05) (Hair et al., 2010). The results presented in Table 2 indicate that the CFA model for the constructs appropriately fits the data. Figure 2 presents the CFA in a diagrammatic form.

Table 3. Confirmatory Factor Analysis

MFI:CMIN=219.758;df=160;CMIN/df=1.373;GFI=0.949;CFI=0.960;TLI=0.994; RMR=0.063;RMSEA=0.128;P-value=0.060	
Variables	
Teacher Quality: CA=.874; CR=.962; & AVE=.809	**Factor Loadings**
TQ1: I do often incorporate feedback from students to enhance the quality of my teaching.	.938
TQ2: I always stay updated on best practices in mathematics education to maintain high teaching quality.	.870
TQ3: I often collaborate with colleagues to share successful teaching strategies and enhance teaching quality.	.910
TQ4: I prioritize student-centered approach in maintaining the quality of my mathematics instruction.	.913
TQ5: I address diverse learning styles within my classroom to maintain a high level of teaching quality.	.874
TQ6: I ensure that my teaching methods align with the learning needs and abilities of my students.	.892
Teacher Self - Efficacy: CA=.913; CR=.922; & AVE=.797	
TSE1: My self-efficacy impacts my willingness to try innovative teaching methods including RME in many ways.	.888
TSE2: I feel that my self-efficacy is influenced by the support I receive from colleagues and administrators.	.944
TSE3: My self-efficacy influences my decision-making in adopting new teaching approaches.	.844
Mathematics Achievement: CA=.927; CR=.981; & AVE=.837	
MA1: I believe my self-efficacy influences students' mathematics achievement in my class.	.922
MA2: I think my teaching methods contribute to students' understanding of realistic mathematics concepts.	.931
MA3: Per my experience, self-efficacy played a role in mediating the relationship between realistic mathematics education and students' mathematics achievement.	.934
MA4: I employ realistic mathematics education strategy to support students in overcoming challenges in mathematics learning.	.909
MA5: Am aware of the impact of my self-efficacy on the overall quality of my	.900

MFI:CMIN=219.758;df=160;CMIN/df=1.373;GFI=0.949;CFI=0.960;TLI=0.994; RMR=0.063;RMSEA=0.128;P-value=0.060	
Variables	
Teacher Quality: CA=.874; CR=.962; & AVE=.809	**Factor Loadings**
teaching and its potential mediation effect on students' achievement.	
MA6: My teaching experience makes my student get good marks in mathematics.	.920
MA7: My students usually do well in mathematics.	.906
MA8: Realistic mathematics education helps my students to understand mathematics and other subjects.	.912
MA9: My students feel happy when answering mathematics questions.	.891
MA10: I often foster a growth mindset among my students, and this usually impact the mediation of self-efficacy in mathematics achievement.	.923

Source: Survey Data, 2024.

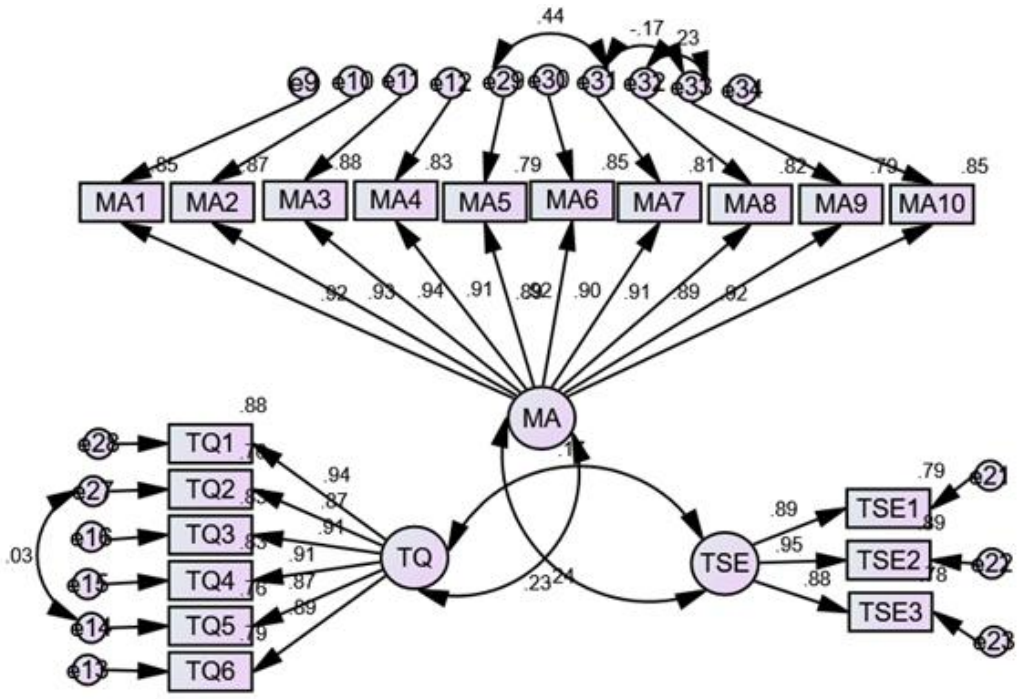

Figure 2. Diagram of Confirmatory Factor Analysis

Discriminant Validity

As presented in past studies such as Bamfo et al. (2018), this study assessed discriminant validity by comparing the square root of the AVE (√AVEs) values with the inter-correlation scores. To achieve discriminant validity, the least √AVE were supposed to be greater than the highest correlation coefficient (Arthur et al., 2021, Sarsah et al., 2020). From Table 5, the least √AVE was 0.893, which the highest correlation coefficient was .253, which suggests discriminant was achieved by this study. The study's measuring methodology is robust, as evidenced by the discriminant validity analysis. Since the largest correlation coefficient was also less than .7, which might have

introduced confounding effects into the model estimation process, it was concluded that there was no multicollinearity (Dogbe et al., 2020). Below is a summary of the constructs' discriminant validity analysis:

Table 5. Discriminant Validity Assessment

Construct Pair	Correlation (r)	AVE	√AVEs
TQ		.809	.899
TSE		.797	.893
MA		.837	.915
TQ ↔ MA	.049		
TSE ↔ MA	.253		

Source: Field survey, 2024

Results

The link between the independent variable factors and the dependent variable was tested using structural equation modeling, as was the mediating role of teacher self – efficacy. The Bias-Corrected (BC) percentile technique of bootstrapping was used to examine these variables in a structural equation model using a 5,000 bootstrap sample and a 95% confidence level. Similar to the CFA in Tables 2 and 3, the structural equation model satisfied the different fit indices suggested.

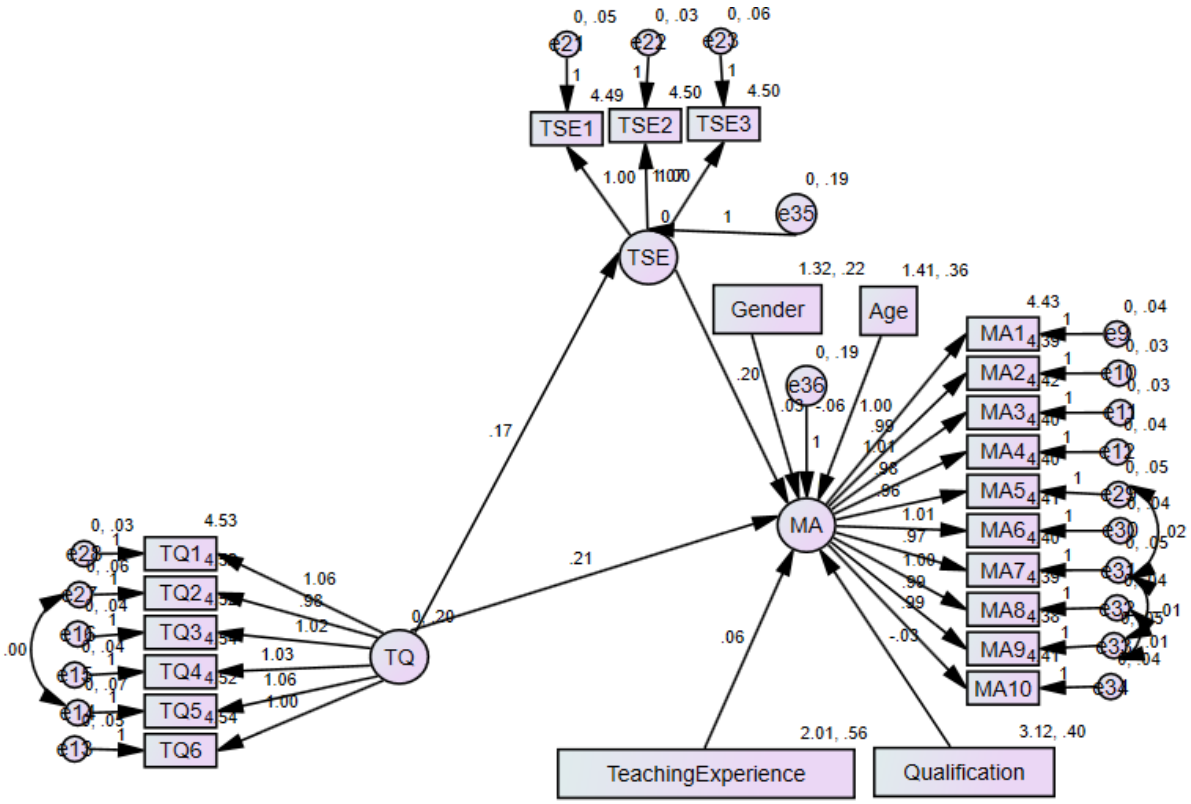

Figure 3. Diagram of Path Estimates

Table 4. Direct Path Estimate

Direct paths	Unstandardized estimate (β)	CR	SE	p-value
Gender → MA	.040	1.218	.061	.223
Age → MA	−.042	−1.634	.026	.102
Qualification → MA	−.029	−1.218	.024	.233
Teaching Experience	.059	.020	2.872	.004
TQ → MA	.194	3.909	.050	.001
TQ→ TSE	.25	11.205	.045	.002

Note. Model Fit Indices: *CMIN = 219.758; df = 160; CMIN/df = 1.373; CFI = .960; TLI = .994; RMR = .063; RMSEA = .128; PCLOSE = .000; GFI = .949*

Table 5. Mediating Path Estimates

Mediating Path	Estimate (β)	Standard Error	Lower bias - corrected	Upper bias - corrected	P - value
TQ → TSE → MA	.042	.015	.022	.084	<.01

Note. Bias –corrected percentile method; 5,000 bootstrap; 95% confidence level and significant at the .01 level.

Hypothesis H1: "Teaching quality positively affects students' mathematics achievement, particularly when teaching is grounded in RME principles that connect mathematics to real-world contexts."

The hypothesis that teaching quality positively affects students' mathematics achievement, particularly when teaching is grounded in RME principles was accepted. The unstandardized estimate ($\beta = .194$, $p < .001$) indicates a strong positive relationship. This suggests that as the quality of instruction in the classroom becomes better, students' mathematics achievement is likely to be enhanced by about 19.4%, and vice versa. This result aligns with existing literature suggesting that high teaching quality, characterized by effective instructional strategies and classroom management, contributes to better student outcomes in mathematics.

Hypothesis H2:"Teaching quality positively influences teacher self - efficacy quality, with high self-efficacy leading to the implementation of more effective, student-centered teaching practices as outlined by SDT".

The hypothesis that teaching quality positively influences teacher self - efficacy quality, with high self-efficacy leading to the implementation of more effective, student-centered teaching practices as outlined by SDT was also accepted. The unstandardized estimate ($\beta = .25$, $p < .001$) signifies a meaningful positive impact. This on the other hand suggest that when teachers' teaching quality increase with RME teaching techniques, their self-efficacy in teaching mathematics is likely to increase by approximately 25%. This result aligns with existing literature suggesting that high teaching quality, characterized by effective instructional strategies and classroom management, contributes to better teachers' self – efficacy.

Hypothesis H3: "Teacher self-efficacy significantly mediates the relationship between teaching quality and

students' mathematics achievement, amplifying the impact of high-quality teaching on student outcomes."

To assess the mediating effect of teacher self - efficacy, in the relationship between teaching quality and student mathematics achievement, the effect of teaching quality on teacher self - efficacy was first tested. The results indicated that teaching quality had a positive and statistically significant effect on teacher self – efficacy ($\beta = .25$, $p < .001$). The coefficient of the indirect path was 0.042 which was statistically significant. The results show that teacher self – efficacy is partially mediating the relationship between teaching quality and mathematics achievement as indirect effects are statistically significant. Based on these results, hypothesis H3 'teacher self-efficacy significantly mediates the relationship between teaching quality and students' mathematics achievement' was therefore accepted.

Control Variables

The study controlled for gender, age, highest qualification, and years of teaching experience. The effect of gender on mathematics achievement was not statistically significant ($\beta = .040$, $p = .223$), indicating that gender does not play a substantial role in influencing mathematics achievement in this context. Age showed a negative but not statistically significant effect on mathematics achievement ($\beta = -.042$, $p = .102$), suggesting that age differences among students did not significantly impact their mathematics performance. The highest qualification of teachers did not have a significant effect on mathematics achievement ($\beta = -.029$, $p = .233$), indicating that other factors, such as teaching quality and experience, may be more influential. Teaching experience as a control variable had a significant positive effect on mathematics achievement ($\beta = .059$, $p = .004$), reinforcing the importance of experience in teaching efficacy. The acceptance of all three hypotheses underscores the importance of teaching quality and teacher self – efficacy in enhancing students' mathematics achievement through the implementation of RME. These findings suggest that professional development programs aimed at improving these teacher variables could be beneficial. The results also highlight the relatively minor role of demographic factors such as gender, age, and highest qualification compared to the significant impact of teaching-related variables.

Discussion

The present study aimed to investigate the relationship between teaching quality, teacher self-efficacy, and students' mathematics achievement within the frameworks of Realistic Mathematics Education (RME) and Self-Determination Theory (SDT). All proposed hypotheses were accepted, shedding light on the intricate dynamics that contribute to mathematics achievement in junior high schools in Ghana.

Teaching Quality and Mathematics Achievement

Our results affirm that teaching quality positively influences students' mathematics achievement, consistent with previous research (Stronge et al., 2018; Olawale et al., 2021). The results underscore the importance of high-quality teaching practices in enhancing students' understanding of mathematical concepts, particularly when these practices are grounded in RME principles. By situating mathematics within real-world contexts, teachers can

make learning more relevant and engaging for students, thereby improving their academic outcomes (Van den Heuvel-Panhuizen, 2020). The acceptance of hypothesis (H1) highlights that students who are taught by teachers employing effective, contextualized instructional strategies demonstrate higher levels of achievement in mathematics, supporting the notion that RME can be a powerful tool in addressing the persistent gaps in mathematics education.

Teacher Self-Efficacy and Teaching Quality

The study also confirmed that teacher self-efficacy significantly influences teaching quality. Teachers with high self-efficacy were found to be more likely to implement innovative and student-centered teaching practices, which in turn enhanced the quality of instruction. This finding aligns with SDT, which posits that individuals are more motivated and perform better when their psychological needs for autonomy, competence, and relatedness are met (Deci & Ryan, 2000). Teachers who feel confident in their abilities are more likely to create a learning environment that supports these needs, leading to more effective teaching. This relationship suggests that boosting teacher self-efficacy could be a critical lever for improving teaching quality and, by extension, student outcomes in mathematics (Hidayat & Patras, 2024).

The Mediating Role of Teacher Self-Efficacy

Finally, the study confirmed the mediating role of teacher self-efficacy in the relationship between teaching quality and students' mathematics achievement (H4). This finding suggests that teacher self-efficacy amplifies the impact of high-quality teaching on student outcomes, aligning with both RME and SDT frameworks. By integrating real-world contexts into mathematics instruction (as emphasized by RME), teachers with high self-efficacy are better able to engage students and fulfill their psychological needs, leading to improved academic performance (Fosu et al., 2022; Van den Heuvel-Panhuizen, 2020; Deci & Ryan, 2000). This mediation effect provides a nuanced understanding of how teaching quality and psychological factors interact to influence student achievement, offering valuable insights for the design of effective educational interventions.

Conclusion

This study contributes to the growing body of literature on mathematics education by exploring the interplay between teaching quality, teacher self-efficacy, and students' mathematics achievement within the frameworks of Realistic Mathematics Education (RME) and Self-Determination Theory (SDT). The findings suggest that high-quality teaching, particularly when grounded in RME principles, significantly enhances students' mathematics achievement. Furthermore, teacher self-efficacy plays a crucial role in both improving teaching quality and directly influencing student outcomes. The acceptance of all hypotheses underscores the importance of considering both instructional and psychological factors in efforts to improve mathematics education. By fostering teacher self-efficacy and employing teaching practices that connect mathematics to real-world contexts, educators can create a more engaging and effective learning environment that supports students' academic success.

In conclusion, this study highlights the need for educational policies and professional development programs that

emphasize the development of teacher self-efficacy and the adoption of RME-based instructional strategies. These efforts are essential for addressing the persistent gaps in mathematics achievement and ensuring that all students, regardless of their background, have the opportunity to succeed in mathematics. Future research should continue to explore the interactions between teaching quality, teacher self-efficacy, and student outcomes, particularly in diverse educational settings.

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Author Information

Ernest Frimpong Akosah
http://orcid.org/0000-0002-9792-5311
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED)
Ghana
Contact e-mail: *email@email.com*

Yarhands Dissou Arthur
http://orcid.org/0000-0002-8950-1367
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED)
Ghana

Benjamin Adu Obeng
http://orcid.org/0000-0002-8150-2613
Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development (AAMUSTED)
Ghana