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Research Article

Unveiling the nexus: Teachers' self - efficacy on realistic mathematics education via structural equation modeling approach

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This quantitative study examines the mediating role of teacher self-efficacy on the relationship between realistic mathematics education (RME) and learners' mathematics achievement in Ghanaian junior high schools. Data were collected using structured questionnaire from 396 mathematics teachers and 7621 students across four regions: Ashanti, Bono East, Greater Accra, and Volta. Using a correlational cross-sectional descriptive survey design, the study employed structural equation modeling (SEM) run from Amos (ver. 23) to analyze relationships among RME principles, teacher self-efficacy, and students' mathematics achievement. The findings indicate that RME methods directly enhance students' mathematics achievement. Additionally, there is a positive direct relationship between teachers' self-efficacy and students' mathematics achievement. Importantly, teacher self-efficacy was found to mediate the relationship between RME and students' mathematics achievement, highlighting its crucial role in educational outcomes. These results emphasize the significance of both effective pedagogical approaches and teacher confidence in improving mathematics education. The study contributes empirical evidence supporting the integration of RME principles and the importance of fostering teacher self-efficacy to enhance educational practices and student success in Ghanaian junior high schools.

Keywords: Mathematics achievement, Realistic mathematics education, Teacher self-efficacy

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1. Introduction

Learning mathematics involves more than just gaining information; it also involves developing comprehension, skills, and analytical abilities to solve problems daily (Amalia et al., 2017). The importance of mathematics for societies is well-documented, demonstrating its foundational role in various aspects of life (Altaylı, 2012). However, many in the educational community view mathematics as a challenging subject, often leading to anxiety and avoidance (Wang et al., 2020). Effective mathematics teaching requires innovative methods that engage students and make learning relevant to their lives. Numerous classroom variables impact students' mathematical success, including teacher characteristics and pedagogical approaches. In recent years, there has been a shift towards adapting mathematical instruction and curricula to meet the evolving needs of learners. In Ghana, the newly designed junior high school mathematics standard-based curriculum exemplifies this adaptation. This curriculum features a constructivist approach, emphasizing active learning and problem-solving (Ghana Ministry of Education, 2019). It aims to build learners' confidence and foster higher-level thinking by valuing their solutions and promoting creative attitudes.

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One prominent pedagogical strategy is RME, developed by Dutch mathematician Hans Freudenthal. RME emphasizes teaching mathematics through real-world problem-solving, enabling learners to connect mathematical concepts to their everyday experiences (Laurens et al., 2017). Freudenthal argued that formal mathematics should not be taught in isolation but should emerge from practical problem-solving activities (Çakır, 2013). This approach aligns with constructivist principles, suggesting that learners construct their own understanding based on prior knowledge and experiences. RME has shown promise in making mathematics more engaging and accessible to students. Research indicates that RME can improve learner engagement and performance by making mathematics relevant and meaningful (Dickinson et al., 2020). By solving real-world problems and discussing solutions, learners develop a deeper understanding of mathematical concepts and foster a positive attitude toward the subject. However, the effectiveness of RME and other educational innovations depends significantly on teachers' self-efficacy. Self-efficacy, defined as the belief in one's ability to complete tasks and reach goals, is crucial for effective teaching (Bandura, 1997). Teachers with high self-efficacy are more likely to implement innovative teaching strategies, manage classrooms effectively, and persist through challenges (Hidayat & Patras, 2024). In Ghana, the role of teachers' self-efficacy in educational success has been underappreciated, despite its critical impact on learners' outcomes. A teacher's self-efficacy influences their motivation, resilience, and teaching effectiveness, directly affecting learners' academic achievement and attitudes toward learning (Burić & Kim, 2020). 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.

In light of these considerations, this study examines the mediating role of teachers' self-efficacy in the context of RME and its impact on learners' mathematical achievement. Using a Structural Equation Modeling (SEM) approach, this research explores how junior high school mathematics teachers' self-efficacy influences learners' attainment in mathematics and the effectiveness of the RME pedagogical approach during classroom discussions and learning processes. By understanding these relationships, we can develop strategies to enhance mathematics education and teacher preparation programs in Ghana, ultimately improving educational outcomes.

2. The Aim

This study investigates the impact of implementing RME principles in Ghanaian junior high schools during the 2023–2024 academic year. The central question is: "Does teaching mathematics in junior high school using RME principles affect learners' mathematics achievement?" Numerous variables can impact the mathematics achievement of junior high school (JHS) learners during classroom discourse or the learning process. Traditionally, research has focused on learners' poor performance in exams, often neglecting other factors influencing achievement in class. Additionally, previous studies have primarily examined cognitive factors and their direct relationship to achievement (e.g. Chew et al., 2016; Guven & Cabakcor, 2013; Seethaler et al., 2011), overlooking the broader classroom environment and teaching strategies. Pedagogical strategies such as RME (Laurens et al., 2017; Zakaria & Syamaun, 2017) and teacher self-efficacy (Hajovsky et al., 2020) are significant factors in enhancing mathematical achievement. RME, which makes mathematics relevant and engaging, can improve learner performance. However, the success of RME largely depends on teachers' self-efficacy—their belief in their ability to teach effectively. Teachers with high self-efficacy are more likely to implement innovative teaching methods and create positive learning environments (Boeve-De Pauw et al., 2024). This study fills a critical gap in the literature by integrating these variables into a single analysis, using a Structural Equation Modeling (SEM) approach. This method allows for a nuanced understanding of the direct and indirect effects of teacher self-efficacy on the implementation of RME and subsequent learner achievement. The originality and novelty of this research lie in its holistic approach to examining the impact of RME through the lens of teacher self-efficacy. By addressing this gap, the study contributes to the body of knowledge on effective mathematics teaching strategies and offers practical implications for teacher training programs. Ultimately, this research aims to enhance mathematics education in Ghanaian junior high schools, providing a model that can be adapted in similar educational contexts.

In summary, the study aims:

1) To investigate the impact of RME principles on learners' mathematics achievement in Ghanaian junior high schools.

2) To examine the effect of RME principles on teachers' self-efficacy in teaching mathematics.

3) To assess the influence of teachers' self-efficacy on learners' mathematics achievement.

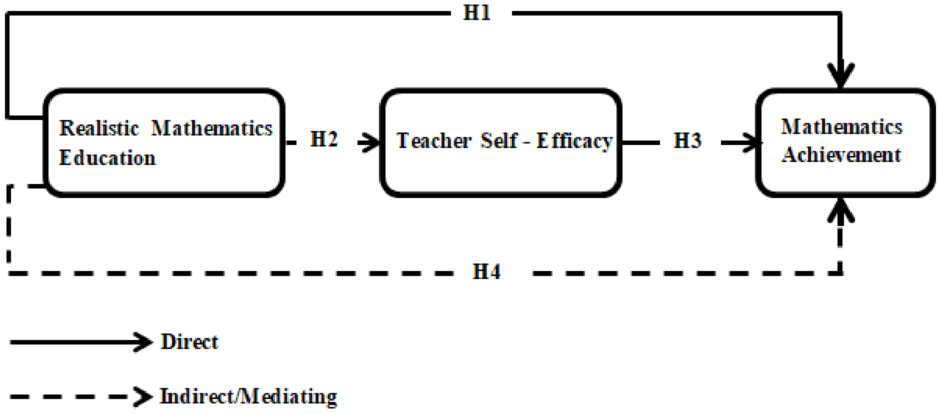
4) To determine the mediating effect of teachers' self-efficacy on the relationship between RME principles and learners' mathematics achievement.

3. Background

3.1. Conceptual Framework

A conceptual framework was created to direct the study following a thorough evaluation of the literature. The theoretical ideas and study factors were shown in a visual way. In this study, MA served as the dependent variable, RME served as the primary independent variable, and TSE served as the mediating variable. According to the conceptual framework, RME directly affects JHS learners' MA. RME is also thought to have an indirect effect on MA through its favorable effect on TSE in mathematics.

Figure 1
Conceptual framework of the Study



3.1.1. Effect of RME on mathematics achievement

Since its inception in the 1960s, Realistic Mathematics Education (RME) has emerged as a transformative approach to mathematics education worldwide. RME emphasizes engaging learners with mathematical concepts through real-world contexts, thereby fostering deeper understanding and enhancing problem-solving abilities (Freudenthal, 1991). Central to RME is the notion that learners actively construct their mathematical knowledge by tackling authentic problems that resonate with their interests and experiences (Hwang & Son, 2021). Empirical research consistently supports the positive impact of RME on students' mathematics achievement (MA). Tamur et al. (2020), in a comprehensive meta-analysis of 72 studies in Indonesia, concluded that RME-based teaching significantly enhances learners' achievement in mathematics. Similarly, Trung et al. (2019) highlighted that embedding learning within meaningful contexts enhances students' capacity for mathematical reasoning and problem-solving. Moreover, studies have demonstrated that RME not only improves students' conceptual understanding but also boosts their motivation to learn mathematics (Turgut, 2021). Compared to traditional instructional methods, RME has shown to better equip students with the skills needed to succeed in standardized mathematics tests (Akosah et al., 2024). Karaca and Özkaya (2019) underscored the importance of aligning curricula to effectively implement RME in mathematics classrooms, emphasizing the need for coherence between instructional practices and educational goals. Recent research by Fitriyah et al. (2018) further validates these findings, demonstrating significant improvements in students' mathematics achievement when taught using RME methods. Fitriyah et al. (2018) specifically observed enhanced performance among students exposed to RME, highlighting the method's efficacy in promoting a deeper conceptual grasp of mathematical concepts and improving problem-solving skills. Building upon the foundational research on RME, this study hypothesizes:

H1: Realistic Mathematics Education principles positively influences learners' mathematics achievement.

3.1.2. Effect of RME principles on teachers' self-efficacy in mathematics

One of the pivotal factors influencing instructional practices is teachers' self-efficacy, defined as their belief in their capacity to influence student learning outcomes effectively (Bandura, 1997). The theory of self-efficacy posits that teachers' confidence in their instructional abilities significantly impacts their teaching practices and student outcomes (Bandura, 1997). Implementation of Realistic Mathematics Education (RME) has been shown to bolster teachers' self-efficacy. According to Bandura (1997), teachers' confidence in their ability to facilitate learning can be strengthened by engaging them in meaningful and contextually relevant instructional tasks. Wulandari et al. (2019) found that educators using RME reported higher levels of self-efficacy, particularly in cultivating learner-centered learning environments. This heightened self-efficacy was associated with improved student outcomes and more effective teaching methodologies. In a Ghanaian context, Arhin and Gideon (2020) observed significant increases in teachers' self-efficacy through professional development programs focused on RME. As teachers felt more competent and assured in applying RME strategies, they demonstrated higher levels of effectiveness in engaging students with real-world mathematical challenges, thereby enhancing student achievement. Research underscores that exposure to innovative teaching methods, such as RME, not only enhances teachers' confidence but also encourages them to adopt more adaptable and inclusive instructional approaches (Burić & Kim, 2020; Hoy & Spero, 2005). This alignment between RME principles and effective teaching practices suggests a synergistic relationship where teachers' enhanced self-efficacy contributes to improved educational outcomes. Based on the evidence presented, this study proposes:

H2: Realistic Mathematics Education principles positively influences teachers' self-efficacy in teaching mathematics.

3.1.3. Effect of teachers' self-efficacy on learners' mathematics achievement

Teacher self-efficacy plays a crucial role in shaping learner achievement outcomes. Educators with high levels of self-efficacy are more inclined to employ innovative teaching techniques, effectively manage classroom challenges, and persist in overcoming obstacles (Özdemir, 2020). Research by Asare et al. (2023) indicates that students taught by teachers with strong self-efficacy tend to achieve higher academic success and exhibit more positive attitudes toward learning. Similarly, Peker (2016) identified instructors' self-efficacy as a significant predictor of student engagement and academic achievement, underscoring its pivotal role in educational settings. Moreover, a study conducted by Arhin and Gideon (2020) in Ghana found that teachers with high levels of self-efficacy were more likely to implement student-centered instructional strategies, resulting in improved mathematics performance among students. Teacher self-efficacy has consistently demonstrated a strong association with students' academic performance across diverse educational contexts (Özdemir, 2020; Klassen & Tze, 2014). When educators possess confidence in their ability to foster effective learning environments, students are more likely to achieve higher levels of academic success (Klassen & Tze, 2014). Given the substantial impact of teachers' self-efficacy on educational outcomes, it is plausible to propose the following hypothesis:

H3: Teachers' self-efficacy has a direct positive effect on learners' mathematics achievement.

3.1.4. Mediating effect of teachers' self-efficacy on the relationship between RME and learners' mathematics achievement

Extensive research has explored the pivotal role of teachers' self-efficacy as a mediator in the relationship between learners' mathematics achievement and Realistic Mathematics Education (RME). According to Thomson et al. (2017), teachers' self-efficacy significantly influences their interactions with students and their implementation of instructional practices. Educators with higher self-efficacy are more likely to effectively integrate and sustain RME techniques, thereby enhancing student performance in mathematics. Similarly, Marsh et al. (2019) found that teachers' self-efficacy mediated the positive effects of RME on student achievement. Teachers who demonstrated confidence in their ability to employ RME methods reported improved student outcomes, highlighting the importance of bolstering teacher self-efficacy to optimize the benefits of RME and enhance learning outcomes. Theoretical frameworks, such as Bandura's social cognitive theory (1977) and Hill and France (2020) conceptualization of teacher self-efficacy, propose that educators' beliefs in their instructional capabilities play a crucial role in shaping student outcomes. This theoretical perspective is supported by empirical evidence suggesting that higher levels of teacher self-efficacy enhance the effectiveness of instructional practices and contribute to improved student achievement (Hill & France, 2020). Drawing from the theoretical frameworks and empirical findings, this study proposes:

H4: Teachers' self-efficacy mediates the relationship between Realistic Mathematics Education (RME) principles and learners' mathematics achievement.

4. Method

4.1. Research Design

The study utilized a quantitative correlational cross-sectional descriptive survey design, which involves collecting data at a single point in time without experimental manipulation, aligned with the research hypothesis. This approach is effective for examining correlations between variables within a specific timeframe (Babbie, 2016). Such a design is well-suited for exploring relationships between variables and validating the structural equation model (SEM), as it allows for evaluating how well the SEM fits the identified connections (Kline, 2018).

4.2. Participants and Procedure

The study involved 396 junior high school mathematics teachers sampled from four regions in Ghana: Ashanti, Bono East, Greater Accra, and Volta, with a total target population of 7,621 individuals. The study focused on three main constructs: mathematics achievement, teachers' self-efficacy, and principles of realistic mathematics education, guiding the questionnaire design. Structural equation modeling (SEM) was employed to analyze the data collected from the junior high school teachers. To determine the sample size, guidelines from Gill et al. (2010) were followed, utilizing a confidence level of 95% and a margin of error (accuracy level) of 0.05. The recommended sample size was initially calculated using Slovin's method, yielding a minimum of 380 participants. To account for potential non-response and enhance external validity, the sample size was increased to 400 teachers. Proportionate stratified sampling was then used to select participants from each region. A total of 396 junior high school mathematics teachers completed and returned the surveys within the stipulated timeframe.

The demographic characteristics of the participants, as shown in Table 1, indicated that 70% (276) were male and 30% (120) were female. Regarding age distribution, 8% (33) were under 30 years old, 31% (121) were aged 30–40, 36% (144) were aged 41–45, and 25% (98) were 46 years and older. In terms of teaching experience, 17% (69) had 1–5 years of experience, 28% (111) had 6–10 years, and 55% (216) had more than 10 years of teaching experience. Lastly, with respect to educational qualifications, 3% (12) held Cert A, 58% (230) held diplomas, 38% (152) held bachelor's degrees, and 1% (2) held master's degrees.

Table 1
Demographic Characteristics of the Study Group

Variables	*Frequency*	*Percentage*
Gender		
Male	276	70
Female	120	30
Age		
< 30	33	8
30-40	121	31
41-45	144	36
46 and above	98	25
Years of Teaching Experience		
1 - 5 years	69	17
6 – 10 years	111	28
>10 years	216	55
Highest Qualification		
Cert A	12	3
Diploma	230	58
Bachelor Degree	152	38
Masters	2	1

4.3. Reliability Analysis

Reliability in measurement refers to its consistency over time and across different users. Cronbach's alpha reliability testing was employed to assess the internal consistency of the questionnaire. Utilizing SPSS (v.23), Cronbach's alpha (α) analysis evaluated the reliability of the measurement items. A Cronbach's alpha score of at least 0.7 indicates acceptable internal consistency (Pomegbe et al., 2020). Table 1 displays the Cronbach's alpha coefficients: mathematics achievement (MA) had α = 0.981, realistic mathematics education (RME) had α = 0.945, and teacher self-efficacy (TSE) had α = 0.931 (see Table 2).

Table 2
Construct Reliability

Constructs	*Cronbach Alpha*	*Composite Reliability*	*Number of Items*
Realistic Mathematic Education (RME)	.945	.913	4
Teacher Self - Efficacy (TSE)	.931	.892	3
Mathematics Achievement (MA)	.981	.941	10

4.3.1. Exploratory Factor Analysis (EFA)

The EFA was calculated using SPSS (ver. 23) to find out how many observable variables are loaded onto the corresponding latent variables on the right is shown by the analysis in Table 2. The reliability coefficients of the questionnaire ranged from 0.931 to 0.981, indicating high reliability based on responses from junior high school teachers. All reliability coefficients exceeded the minimum threshold of 0.7 for each construct in the study: realistic mathematics education (4 items), teacher self-efficacy (3 items), and mathematics achievement (10 items). The determinant's coefficient was determined to be 1.06E-07, with a Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) of .886, which explained why the observable variables were loading in the correct dimension on the latent variables in 88.6% of the cases. Based on a Chi-square of 4457.787 and 136 degrees of freedom, Bartlett's Test of Sphericity produced a significant p-value of .000. Along with the EFA, the four latent variables showed a cumulative variance of 87.137%. However, all other observed variables that were misplaced on the rotated component matrix were eliminated. The final EFA is displayed in Table 3, where the observed variables are paired with the proper latent variables.

Table 3
Final EFA

Rotated Component Matrix				
	Components			
	1	2	3	4
Realistic Mathematics Education (RME)				
RME1			.920	
RME2			.934	
RME3			.901	
RME4			.892	
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			

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

4.3.2. Confirmatory Factor Analysis (CFA)

The researchers employed theoretical knowledge, empirical study, or both to construct a priority connection pattern (Hair et al., 2010). The study employed AMOS (version 23) to conduct the CFA as part of the reliability and validity assessment. Because CFA can estimate a wide range of statistical tests, it has more applications than other statistical research (Dogbe et al., 2020; Lahey et al., 2012). The measurement model was tested using the principal component estimate in a confirmatory factor analysis using IBM SPSS Amos (v.23) software. The measurement model was conducted, and all the produced fit indices were found within their required threshold values, as follows: CMIN =134.142; df = 80; CMIN/df being 1.677 (≤3.000), TLI=.969;

CFI=.949; RMSEA=.041; RMR=.050; P-close=.060; GFI = .956. The model, therefore, has a good fit with observed data. Table 4 and Figure 2 are a summary of the measurement model fit indices.

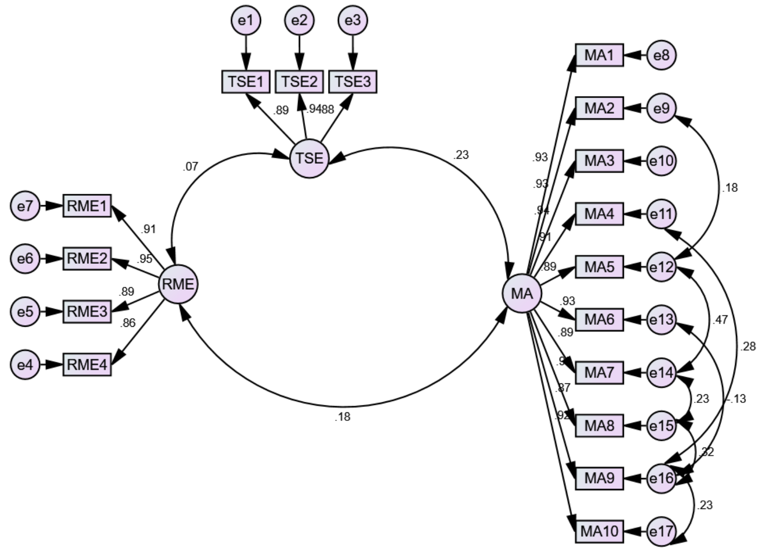
Table 4
Confirmatory Factor Analysis

Variable	
Realistic Mathematics Education: CA=.946; CR=.928; & AVE=.765	**Factor Loadings**
RME1: I often use hands-on activities that connect mathematics to real-life situations in my teaching.	.910
RME2: In my own opinion, realistic mathematics education contribute to students' understanding of abstract mathematical concepts.	.944
RME3: I frequently update my teaching materials to include real-world applications of mathematical concepts.	.890
RME4: I assess the effectiveness of realistic mathematics education in improving students' conceptual understanding.	.862
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 teaching and its potential mediation effect on students' achievement.	.900
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

Note. Source: Survey Data, 2024.

The CFA findings are shown in Table 5. We did not include in our analysis any variables that were detected but had factor loadings that were less than .5. Since it was expected that factor values of at least .5 would be achieved, measurement items with factor scores of less than .5 were deleted (Amoako et al., 2020; Arthur et al., 2022). While MA began with twelve measurement items, RME and TSE began with ten each. The observed variables in RME, TSE, and MA were all reduced by 6, 7, and 2, respectively, after applying the CFA approach. Therefore, throughout the CFA, factor loadings were assessed for every indication on the scale. Guaranteed were factor loadings greater than .50 (>.50). Twenty-one items were removed due to their lower factor loadings. One important consideration was making the model more fit.

Figure 2
Diagram of Confirmatory Factor Analysis



4.3.3. Convergent and Discriminant Validity Analysis

Convergent Validity. The degree of correlation between two measures of the same idea is evaluated by convergent validity. Composite reliability (CR) and average variance extracted (AVE) were used to evaluate the convergent validity. Composite reliability (CR), according to Hair et al. (2010), is an important indicator of convergent validity and should be more than .70. The average variance extracted (AVE), which needs to be more than .50, is another crucial metric. By using these criteria, it is ensured that a significant amount of the variance is captured and that the items used to test a construct are appropriately associated. In the provided data, the CR and AVE values for the constructs were as presented in Table 5.

Table 5
Convergent Validity Assessment

Construct	*CR*	*AVE*
RME	.928	.765
TSE	.922	.797
TK	.944	.740
MA	.981	.837

Discriminant Validity. Discriminant validity compares the square root of AVE (√AVEs) values with the correlations coefficients of constructs to determine how different a construct is from other constructs. Discriminant validity is achieved when the least √AVE is larger than the highest correlation coefficient (Arthur et al., 2021, Sarsah et al., 2020). From Table 6, the least √AVE was .875, 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 convergent and discriminant validity analyses. 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). Table 6 shows the summary of the constructs' discriminant validity analysis.

Table 6
Discriminant Validity Assessment

Construct Pair	Correlation (r)	AVE	√AVEs
RME		.765	.875
TSE		.797	.893
MA		.837	.915
RME ↔ TSE	.120		
MA ↔ TSE	.253		
MA ↔ RME	.153		

5. Results

5.1. Structural Model

Following the evaluation of the measurement model's fit, the data underwent additional analysis by looking at the presumed relationship between the endogenous and exogenous variables of the study's framework. To test the direct relationships, this was done by estimating various structural models in IBM SPSS Amos 23. The estimates for the test of direct relationships are shown visually in Figure 3 and Table 7, respectively.

5.2. Path Estimates

5.2.1. Direct effect

Path analysis is a method for analyzing correlations or covariance's between two variables in a model of SEM to ascertain the proportion of this covariance that is due to a theoretically implied causal influence of one variable on another. Covariance-based SEM Amos (v.23) software was employed to determine the route coefficients. A bootstrapping technique called bias-corrected (BC) percentile was utilized, using 5,000 bootstrap samples and a 95% confidence level. Table 8 displays the outcomes of the independent factors' direct influence on the dependent variable MA. The direct path arrows indicates that, realistic mathematics education (RME), teacher self - efficacy (TSE), and teacher knowledge (TK) have a direct effect on mathematics achievement (MA).

The route estimate of .40 for the postulated paths for RME →MA was found to show a statistically highly significant positive direct influence of RME on MA (β =.176; p<.05) indicating that as learners become more involved in RME learning approach, their mathematics achievement is expected to increase by roughly 17.6%, and the opposite is also likely to be true.

H1: "*Realistic Mathematics Education principles positively influences learners' mathematics achievement*" was therefore accepted by this study.

Additionally, the analysis demonstrated a significant positive direct effect of Realistic Mathematics Education (RME) on Teacher Self-Efficacy (TSE) in mathematics. Specifically, the route estimate of β = .073 (p < .05) indicates that the relationship is statistically significant. This suggests that when teachers engage students more frequently with RME teaching techniques, their self-efficacy in teaching mathematics is likely to increase by approximately 7.3%. Consequently, the hypothesis

H2*:* "*Realistic Mathematics Education principles positively influences teachers' self-efficacy in teaching mathematics*" is supported by the findings of this study.

Furthermore, the study revealed that the path estimate of .194 for SE→MA similarly indicates a statistically highly significant positive direct effect of TSE on MA (β=.224; p<.05). This suggest that 22.4% increase in teachers self – efficacy is likely to assist learners to attain mathematics achievement. Hence the hypothesis:

H3: "*Teachers' self-efficacy has a direct positive effect on learners' mathematics achievement*" was accepted.

Table 7
Direct Path Estimate

Direct paths	*Unstandardized estimate (β)*	*CR*	*SE*	*p-value*
RME → MA	.176	3.714	.047	.001
TSE → MA	.224	4.837	.046	.001
RME → TSE	.073	1.515	.049	.003

Note. Model Fit Indices: CMIN =134.142; df = 80; CMIN/df being 1.677 (≤3.000), TLI=.969; CFI=.949; RMSEA=.041; RMR=.050; *p*-close=.060; GFI = .956.

5.3. Mediating Path Estimate of Self–efficacy

The mediation impact of TSE was calculated as additional hypothesis path in the exploration. The association between RME and the influence of RME towards MA was initially explored to determine the mediating role of students' TSE. Table 9 indicates that the association between RME and MA may had a statistically highly significant positive mediating impact of TSE in mathematics (β =.20; *p* >.01). This suggests that using RME in the classroom increased learners' MA by roughly 20% and vice versa. Hence the hypothesis:

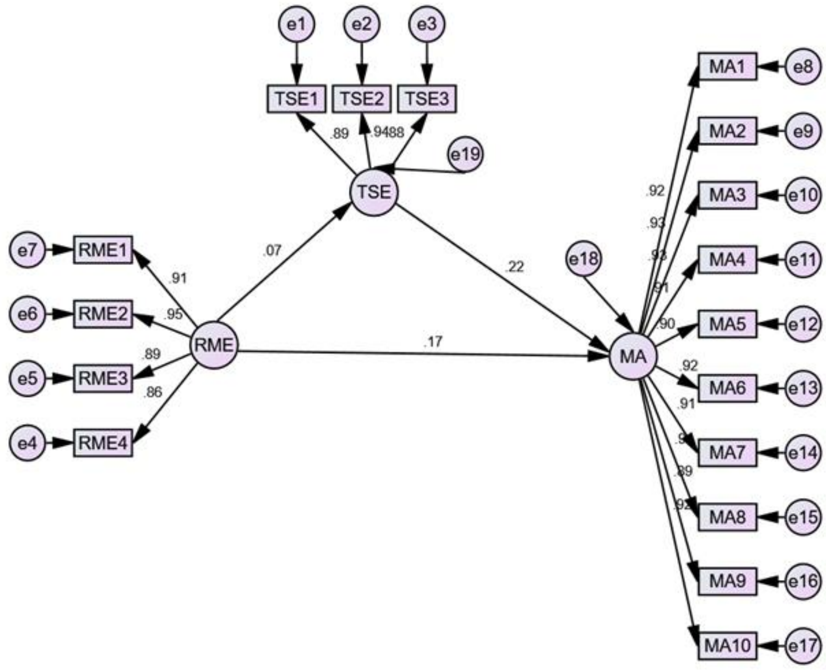
H4: "Teachers' self-efficacy mediates the relationship between realistic mathematics education principles and mathematics achievement" was confirmed.

Table 8
Mediating Path Estimates

Mediating Path	*Estimate* (β)	*Standard Error*	*Lower bias - corrected*	*Upper bias - corrected*	*p - value*
RME → TSE → MA	.056	.018	.026	.096	<.01

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

Figure 3
Diagram of Mediating Path Estimates



6. Discussion

This study demonstrated the influence of Realistic Mathematics Education (RME) on students' mathematics achievement (MA) and teacher self-efficacy (TSE). The findings illuminate the significant role of TSE in enhancing students' MA and highlight the potential benefits of incorporating RME into mathematics education. This research adds originality to the existing body of literature on educational approaches in Ghanaian mathematics education by examining how these variables interact. The major results of this study are summarized as follows:

1) Accepted Hypothesis 1: Realistic Mathematics Education principles positively influences learners' mathematics achievement.

2) Accepted Hypothesis 2: Realistic Mathematics Education principles positively influences teachers' self-efficacy in teaching mathematics.

3) Accepted Hypothesis 3: Teachers' self-efficacy has a direct positive effect on learners' mathematics achievement.

4) Accepted Hypothesis 4: Teachers' self-efficacy mediates the relationship between Realistic Mathematics Education (RME) principles and learners' mathematics achievement.

6.1. Influence of RME on Students' Mathematics Achievement

This study demonstrated that the implementation of RME significantly enhances mathematics achievement (MA) in junior high school students. These findings are consistent with existing literature that underscores the positive impact of RME on students' mathematical performance. For instance, Nursiddik et al. (2017) observed that RME significantly improved the mathematical understanding abilities of 7th-grade students. Similarly, Harahap et al. (2018), through a meta-analysis, confirmed that RME consistently enhances MA. Ulandari et al. (2019) also reported notable gains in students' MA following the introduction of RME in middle schools. The practical and contextual applications of mathematical concepts emphasized in RME align with the conclusions of Özdemir (2020), who demonstrated that students solving problems in relevant contexts outperformed their peers on mathematics assessments. The theoretical underpinnings of RME can be traced to the works of Piaget (1970) and Vygotsky (1978), who emphasized the importance of active knowledge construction through real-life problem-solving. However, contrasting findings by Turgut (2021) showed that the impact of RME could vary depending on the context and implementation fidelity. Their study in a different cultural setting indicated that while RME has potential benefits, its effectiveness can be moderated by factors such as teacher preparedness and resource availability.

6.2. Influence of RME on Teacher Self-Efficacy

The study also revealed that RME positively influences teacher self-efficacy (TSE) in mathematics, suggesting that RME boosts teachers' confidence in their ability to teach mathematics effectively. This finding aligns with earlier research exploring the relationship between teaching strategies and teachers' self-efficacy. According to Bandura's (1997) theory of self-efficacy, mastery experiences, which are facilitated by RME through real-world problem-solving scenarios, enhance teachers' beliefs in their teaching capabilities. Bandura (1997) posited that engaging in challenging and contextually relevant tasks bolsters self-efficacy beliefs. Supporting this, Nguyen et al., (2021) found that teaching methods promoting active participation positively impact teachers' self-perceptions of their abilities. Contrarily, a study by Gkontelos et al., (2023) indicated that changes in teaching methods alone might not be sufficient to enhance self-efficacy if not accompanied by continuous professional support and development, highlighting the complexity of factors influencing teacher self-efficacy.

6.3. Impact of Teachers' Self-Efficacy on Learners' Mathematics Achievement

The positive correlation between teachers' self-efficacy and learners' mathematics achievement is consistent with findings from Hidayat and Patras (2024), who established that teachers with high self-efficacy are more likely to implement effective teaching strategies and create supportive learning environments. This study extends these findings by demonstrating that teachers’ self-efficacy not only directly impacts learners' achievement but also serves as a critical mediating factor in the success of pedagogical innovations like RME. However, Klassen and Tze (2014) found that while there is a positive relationship between teacher self-efficacy and student outcomes, the strength of this relationship can vary significantly depending on the subject matter and educational context. This suggests that while our findings are robust, the impact of teacher self-efficacy might differ across different teaching scenarios.

6.4. Mediating Role of Teacher Self-Efficacy

Furthermore, the study supports the notion that TSE mediates the relationship between RME and students' MA. Bandura (2006) asserted that self-efficacy beliefs serve as a mediating mechanism between educational interventions and performance outcomes. The finding that TSE mediates the relationship between RME and MA aligns with this theoretical framework. Holenstein et al. (2022) indicated that self-efficacy fully moderates the impact of academic performance on mathematical modeling. Similarly, Chand et al., (2020) affirmed that self-efficacy plays a mediating role in the link between educational techniques and student performance. Schunk and Pajares (2019) highlighted the reciprocal relationship between self-efficacy and academic achievement, suggesting that enhanced self-efficacy leads to improved performance, and vice versa.

7. Implications and Future Research

In the context of education, self-efficacy influences teachers' instructional practices and students' learning outcomes (Hill & France, 2020). The findings of this study align with SCT by demonstrating that teachers' self-efficacy mediates the impact of RME on students' MA, indicating that teachers who believe in their ability to teach mathematics effectively can positively influence their students' achievements. These findings underscore the importance of fostering TSE to enhance students' MA, especially in mathematics, a cognitively and emotionally demanding subject (Jerotichl et al., 2017). Encouraging junior high school students' mathematical SE is crucial, as proposed by Liu and Koirala (2021). Future research should examine the specific mechanisms through which RME enhances SE and identify other moderating factors that could influence this relationship. Additionally, while SE is a significant predictor of academic performance, it is not the only factor. Other variables such as prior knowledge, motivation, and educational quality also impact academic outcomes. Hence, future studies should explore how these elements interact and collectively influence students' mathematics ability.

8. Conclusion

In conclusion, this study confirmed that RME significantly enhances MA and TSE in junior high school mathematics education. The mediating role of TSE between RME and MA highlights the complex interplay between teaching approaches and teacher beliefs in educational outcomes. These findings contribute valuable insights into the field of mathematics education and provide a strong foundation for further research on the efficacy of educational interventions in diverse contexts.

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References

Akosah, E. F., Arthur, Y. D., & Obeng, B. A. (2024). Unlocking the nexus: Teacher variables effect on learners' mathematics achievement via structural equation modeling. *Journal of Pedagogical Sociology and Psychology, 6*(3), 95-110. https://doi.org/10.33902/jpsp.202429145

Altaylı, D. (2012). *Gerçekçi matematik eğitiminin oran orantı konusunun öğretimi ve orantısal akıl yürütme becerilerinin geliştirilmesine etkisi* [The effect of realistic mathematics education on teaching the subject of ratio and proportion and development of proportional reasoning skills]. [Unpublished master's thesis]. Atatürk University.

Amalia, E., Surya, E., & Syahputra, E. (2017). The effectiveness of using problem based learning (PBL) in mathematics problem solving ability for junior high school students. *International Journal of Advance Research and Innovative Ideas in Education*, *3*(2), 3402–3406.

Amoako, T., Zhang, S., Dogbe, C. S. K., & Pomegbe, W. W. K. (2020). Effect of internal integration on SMEs' performance: The role of external integration and ICT. *International Journal of Productivity and Performance Management, 71*(2), 643–665. https://doi.org/10.1108/ijppm-03-2020-0120

Arhin, D., & Gideon, E. (2020). Relationship between students' interest and academic performance in mathematics: A study of Agogo State College. *Global Scientific Journals*, *8*(6), 389–396.

Arthur, Y. D., Dogbe, C. S. K., & Arthur, Y. D. (2021). Modeling students' mathematics achievement and performance through teaching quality: SERVQUAL perspective. *Journal of Applied Research in Higher Education*, *14*(4), 1509–1523. https://doi.org/10.1108/jarhe-06-2021-0243

Arthur, Y. D., Dogbe, C. S. K., & Arthur, Y. D. (2022). Enhancing performance in mathematics through motivation, peer assisted learning, and teaching quality: The mediating role of student interest. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(2), em2072. https://doi.org/10.29333/ejmste/11509

Asare, B., Arthur, Y. D., & Boateng, F. O. (2023). Exploring the impact of Chatgpt on mathematics performance: The influential role of student interest. *Education Science and Management, 1*(3), 158–168. https://doi.org/10.56578/esm010304

Babbie, E. R. (2016). *The practice of social research* (14th ed.). Cengage Learning Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037//0033-295X.84.2.191

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. Freeman.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Self-Efficacy beliefs of adolescents* (pp. 307-337). Information Age Publishing.

Boeve-De Pauw, J., De Loof, H., Walan, S., Gericke, N., & Van Petegem, P. (2024). Teachers' self-efficacy and role when teaching STEM in high-tech informal learning environments. *Research in Science & Technological Education*, *42*(2), 255-275. https://doi.org/10.1080/02635143.2022.2089873

Burić, I., & Kim, L. E. (2020). Teacher self-efficacy, instructional quality, and student motivational beliefs: An analysis using multilevel structural equation modeling. *Learning and Instruction*, *66,* 101302. https://doi.org/10.1016/j.learninstruc.2019.101302

Çakır, P. (2013). *Gerçekçi matematik eğitimi yaklaşımının ilköğretim 4. sınıf öğrencilerinin erişilerine ve motivasyonlarına etkisi* [The effect of the instruction based realistic mathematics education on 4th graders achievement and motivation]. [Unpublished master's thesis]. Dokuz Eylül University.

Chew, C. S., Forte, J. D., & Reeve, R. A. (2016). Cognitive factors affecting children's nonsymbolic and symbolic magnitude judgment abilities: A latent profile analysis. *Journal of Experimental Child Psychology*, *152*, 173-191. https://doi.org/10.1016/j.jecp.2016.07.001

Dickinson, P., Eade, F., Gough, S., Hough, S., & Solomon, Y. (2020). Intervening with Realistic Mathematics Education in England and the Cayman Islands—The challenge of clashing educational ideologies. In M. van den HeuvelPanhuizen (Ed.), *International reflections on the Netherlands didactics of mathematics* (pp. 341-166). Springer. https://doi.org/10.1007/978-3-030-20223-1_19

Dogbe, C. S. K., Tian, H., Pomegbe, W. W. K., Sarsah, S. A., & Otoo, C. O. A. (2020). Effect of network embeddedness on innovation performance of small and medium-sized enterprises. *Journal of Strategy and Management*, *13*(2), 181–197. https://doi.org/10.1108/jsma-07-2019-0126

Freudenthal, H. (1991). *Mathematics as an educational task.* Dordrecht: Reidel Publishing Company.

Gill, J., Johnson, P., & Stephan, M. (2010). *Research methods for manager*, SAGE Publications.

Gkontelos, A., Vaiopoulou, J., & Stamovlasis, D. (2023). Teachers' innovative work behavior as a function of self-efficacy, burnout, and irrational beliefs: a structural equation model. *European Journal of Investigation in Health, Psychology and Education*, *13*(2), 403–418. https://doi.org/10.3390/ejihpe13020030

Guven, B., & Cabakcor, B. O. (2013). Factors influencing mathematical problem-solving achievement of seventh grade Turkish students. *Learning and Individual Differences*, *23*, 131-137. https://doi.org/10.1016/j.lindif.2012.10.003

Hair, J. F., Anderson, R. E., Babin, B. J., & Black, W. C. (2010). Multivariate data analysis: A global perspective. *Pearson Education*. https://doi.org/10.13140/RG.2.2.16621.26084/2

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

Harahap, S. S., Hasratuddin, & Simamora, E. (2018). The development of learning devices based realistic approach for increasing problem solving mathematics ability of student in SMPS Gema

Hidayat, R. & Patras, Y. E. (2024). Teacher innovativeness: The effect of self – efficacy, transformational leadership, and school climate. *Journal of Pedagogical Research, 8*(1), 208 – 222. https://doi.org/10.33902/JPR.202424547

Hill, J., & France, D. (2020). Innovative pedagogies. In A. Kobayashi (Ed.), *International encyclopedia of human geography* (pp. 331-339). Elsevier. https://doi.org/10.1016/B978-0-08-102295-5.10657-2

Holenstein, M., Bruckmaier, G., & Grob, A. (2022). How do self-efficacy and self-concept impact mathematical achievement? The case of mathematical modelling. *British Journal of Educational Psychology*, *92*(1), e12443. https://doi.org/10.1111/bjep.12443

Hoy, A. W., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teaching and Teacher Education, 21*(4), 343-356. https://doi.org/10.1016/j.tate.2005.01.007

Hwang, S., & Son, T. (2021). Students' attitude toward mathematics and its relationship with mathematics achievement. *Journal of Education and e-Learning Research, 8*(3), 272-280. https://doi.org/10.20448/journal.509.2021.83.272.280

Jerotichl, F., Kurgat, S. J., & Kimutai, C. K. (2017). Business studies curriculum in public secondary schools in Kenya. *Journal of Education and Practice, 8*(14), 1-7.

Karaca S.Y & Özkaya, A. (2019). The effects of realistic mathematics education on students' achievements and attitudes in fifth grades mathematics courses. *International Online Journal of Education and Teaching (IOJET), 4*(2). 185 – 197.

Klassen, R. M., & Tze, V. M. C. (2014). Teachers' self-efficacy, personality, and teaching effectiveness: A meta-analysis. *Educational Research Review, 12*, 59-76. https://doi.org/10.1016/j.edurev.2014.06.001

Kline, R. B. (2018). Response to Leslie Hayduk's review of principles and practice of structural equation modeling,1 4th edition. *Canadian Studies in Population*, *45*(3–4), 188–195. https://doi.org/10.25336/csp29418

Lahey, B. B., McNealy, K., Knodt, A. R., Zald, D. H., Sporns, O., Manuck, S. B., Flory, J. D., Applegate, B., Rathouz, P. J., & Hariri, A. R. (2012). Using confirmatory factor analysis to measure contemporaneous activation of defined neuronal networks in functional magnetic resonance imaging. *NeuroImage*, *60*(4), 1982–1991. https://doi.org/10.1016/j.neuroimage.2012.02.002

Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2017). How does realistic mathematics education (RME) improve students' mathematics cognitive achievement? *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 569–578. https://doi.org/10.12973/ejmste/76959

Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2017). How does realistic mathematics education (RME) improve students' mathematics cognitive achievement?. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 569-578. https://doi.org/10.12973/ejmste/76959

Liu, X., & Koirala, H. P. (2021). The effect of mathematics self-efficacy on mathematics achievement of high school students. Paper presented at the annual conference of the Northeastern Educational Research Association, University of Connecticut, Connecticut.

Marsh, H. W., Pekrun, R., Parker, P. D., Murayama, K., Guo, J., Dicke, T., & Arens, A. K. (2019). The murky distinction between self-concept and self-efficacy: Beware of lurking jingle-jangle fallacies. *Journal of Educational Psychology*, *111*(2), 331–353. https://doi.org/10.1037/edu0000281

Nguyen, D., Pietsch, M., & Gümüs, S. (2021). Collective teacher innovativeness in 48 countries: Effects of teacher autonomy , collaborative culture , and professional learning. *Teaching and Teacher Education*, *106*, 103463. https://doi.org/10.1016/j.tate.2021.103463

Nursiddik, N., Rahman, R., & Fatimah, F. (2017). The influence of realistic mathematics education (rme) approach on the mathematical understanding ability of junior high school students. *Journal of Educational Research*, *15*(2), 123-134.

Özdemir, Z. B. (2020). *Türkiye'de gerçekçi matematik eğitiminin matematik başarısına etkisi üzerine bir meta analiz çalışması* [A meta-analysis study on the effect of mathematics achievement on realistic mathematics education in Turkey]. [Unpublished master's thesis]. Marmara University.

Peker, M. (2016). Mathematics teaching anxiety and self-efficacy beliefs toward mathematics teaching: A path analysis. *Educational Research and Reviews*, *11*, 97-104. https://doi.org/10.5897/ERR2015.2552

Piaget, J. (1970). *Science of education and the psychology of the child*. Orion Press.

Pomegbe, W. W. K., Li, W., Dogbe, C. S. K., & Otoo, C. O. A. (2020). Enhancing the innovation performance of Small and Medium-Sized Enterprises through network embeddedness. *Journal of Competitiveness*, *12*(3), 156–171. https://doi.org/10.7441/joc.2020.03.09

Sarsah, S. A., Tian, H., Dogbe, C. S. K., Bamfo, B. A., & Pomegbe, W. W. K. (2020). Effect of entrepreneurial orientation on radical innovation performance among manufacturing SMEs: The mediating role of absorptive capacity. *Journal of Strategy and Management, 13*(4), 551-570. https://doi.org/10. 1108/JSMA-03-2020-0053

Schunk, D. H., & Pajares, F. (2019). Self-efficacy theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 35-53). Routledge.

Seethaler, P. M., Fuchs, L. S., Star, J. R., & Bryant, J. (2011). The cognitive predictors of computational skill with whole versus rational numbers: An exploratory study. *Learning and individual Differences*, *21*(5), 536-542. https://doi.org/10.1016/j.lindif.2011.05.002

Tamur, M., Juandi, D., & Adem, A. M. G. (2020). Realistic mathematics education in Indonesia and recommendations for future implementation: A meta-analysis study. *Jurnal Teori dan Aplikasi Matematika, 4*(1), 17-27. https://doi.org/10.31764/jtam.v4i1.1786

Thomson, M. M., DiFrancesca, D., Carrier, S., & Lee, C. (2017). Teaching efficacy: Exploring relationships between mathematics and science self-efficacy beliefs, PCK and domain knowledge among pre-service teachers from the United States. *Teacher Development*, *21*(1), 1-20. https://doi.org/10.1080/13664530.2016.1204355

Trung, N. T., Thao, T. P., & Trung, T. (2019). Realistic mathematics education (RME) and didactical situations in mathematics (DSM) in the context of education reform in Vietnam. *Journal of Physics: Conference Series*, *1340*(1). https://doi.org/10.1088/1742-6596/1340/1/012032

Turgut, S. (2021). A meta-analysis of the effects of realistic mathematics education-based teaching on mathematical achievement of students in Turkey. *Journal of Computer and Education Research, 9*(17), 300-326. https://doi.org/10.18009/jcer.844906

Ulandari, L., Amry, Z., & Saragih, S. (2019). Development of learning materials based on realistic Mathematics education approach to improve students' mathematical problem solving ability and self-efficacy. *International Electronic Journal of Mathematics Education*, *14*(2). https://doi.org/10.29333/iejme/5721

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wang, Z., Oh, W., Malanchini, M., & Borriello, G. A. (2020). The developmental trajectories of mathematics anxiety: Cognitive, personality, and environmental correlates. *Contemporary Educational Psychology*, *61*, 101876. https://doi.org/10.1016/j.cedpsych.2020.101876

Wulandari, S., Darma, Y., & Susiaty, U. D. (2019). Pengembangan modul berbasis pendekatan realistic mathematics education (RME) terhadap pemahaman konsep [Development of a module based on a realistic mathematics education (RME) approach to understanding concepts]. *Jurnal Pendidikan Informatika Dan Sains*, *8*(1), 143. https://doi.org/10.31571/saintek.v8i1.1179

Zakaria, E., & Syamaun, M. (2017). The effect of realistic mathematics education approach on students' achievement and attitudes towards mathematics. *Mathematics Education Trends and Research, 1*(1), 32-40. https://doi.org/10.5899/2017/metr-00093