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Modeling students' interest in mathematics: the role of self-efficacy, mathematics anxiety, cultural and societal perceptions, and relevance of mathematics

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Purpose: The purpose of this study is to determine the direct effect of self-efficacy (SEE), mathematics anxiety (MAA), cultural and societal perceptions (CSP), and relevance of mathematics (REM) on students' interest in mathematics (SIM).

Design/methodology/approach: The study used a descriptive survey, which included 300 samples of students in colleges of education in the Ashanti region in Ghana selected through stratified and simple random sampling techniques. Preliminary analyses, including descriptive analysis, exploratory factor analysis, tests for reliability (Cronbach's alpha), confirmatory factor analysis, convergent validity, and discriminant validity were estimated before the main model estimation. Structural equation modeling (SEM) analysis was performed using Amos (version 26) to test the study's hypotheses.

Findings: The study concluded that SEE, CSP, and REM all had positive and significant effects on SIM. MAA however, had insignificant negative effect on SIM.

Originality/value: This study adopts a comprehensive theoretical modeling approach to explore the multifaceted factors influencing students' interest in mathematics. Rather than examining these variables in isolation, this study is the first to model the complex relationships between self-efficacy, mathematics anxiety, cultural and societal perceptions, and the relevance of mathematics concurrently. The primary value of this work is the creation of a validated, replicable measurement tool that allows for the empirical testing of this multifaceted theory, providing a foundation for more effective and targeted educational interventions.

KEYWORDS

cultural and societal perceptions, mathematics, mathematics anxiety, relevance of mathematics, self-efficacy, structural equation modeling, students' interest

1 Introduction

1.1 Background to the study

Mathematics is regarded as a vital foundation for success in today's modern society; however, it poses significant challenges for many students (Chu et al., 2017). In Ghana, as in numerous other African countries, mathematics is a core component of the educational curriculum at the basic school, senior high school (SHS), and colleges of education (CoE). It is a mandatory subject for all learners at these levels, serving as a crucial gateway for further academic pursuits in the nation (Ampofo, 2019). The low achievement in mathematics has been linked to various factors, including self-esteem, behavioral values, and anxiety (Phiri, 2019; Mwape, 2021).

Studies by Heinze et al. (2005) and Sauer (2012) have explored the relationship between mathematics achievement and interest, indicating that a positive interest in mathematics learning significantly contributes to academic performance. Building on this evidence, students' interest in mathematics is increasingly understood as being influenced not only by achievement outcomes but also by underlying psychological and contextual factors that shape engagement and learning. Consequently, factors such as self-efficacy, mathematics anxiety, cultural and societal perceptions, and relevance of mathematics have gained attention as important determinants of students' interest in mathematics. Self-efficacy is generally defined as a student's belief that he or she is able to successfully accomplish a particular goal or result (Renner et al., 2008). According to research conducted by Arthur (2018), there is a positive correlation between academic achievement and self-efficacy, which presents self-efficacy as a predictor of academic performance. Mathematics anxiety is broadly understood as a state of fear that comes about in mathematical situations, especially when individuals perceive such situations as threatening their self-concept (Uusimaki and Kidman, 2004). Studies also indicated that mathematics anxiety is one of the reasons for students' underachievement in mathematics. The core discomforts associated with mathematics are aversion, concern, and fear, and occasionally behavioral signs of tension, frustration, distress, helplessness, and mental disorganization (Ma and Xu, 2003).

Cultural beliefs and social norms have a tendency to establish expectations about who will excel in math and how mathematics is perceived in a society or community. For instance, mathematics is viewed in some cultures as being of very high value and worth, which motivates students to develop a good attitude and increased interest in the subject (Legewie and DiPrete, 2012). Cultural perceptions, including gender stereotypes and societal expectations, can affect students' interest and participation in mathematics (Khalil et al., 2024). Relevance of mathematics refers to teachers' ability to relate mathematical concepts to real-life applications and other subjects. When teachers effectively link mathematical ideas to phenomena in the world around them, students are more likely to develop a desire to learn mathematics (Retnawati, 2022). Studies have shown that students who recognize the usefulness of mathematics tend to perform better (Leyva et al., 2022). The relevance of mathematics to daily life and other curriculum areas profoundly affects the interest of students in the subject. Mathematical modeling is recognized to increase

student attention, and its teaching and learning can benefit from the diverse educational views that mathematics education and its applications have brought about (Kaiser and Sriraman, 2006).

Integrating modeling into mathematics instruction can significantly improve students' interest by connecting their real-life experiences with mathematical learning. This study seeks to contribute to this growing body of research by modeling factors that influence students' interest in mathematics in colleges of education in the Ashanti region in Ghana.

1.1.1 Contribution to the literature

- First, the study proposed that self-efficacy (SEE) had a direct positive and significant effect on students' interest in mathematics (SIM) as shown in Equation 1.

$$SIM = \alpha_0 + \alpha_1 SEE + \varepsilon^1 \quad (1)$$

- Second, the study proposed that cultural and societal perceptions (CSP) had a direct positive and significant effect on students' interest in mathematics (SIM) as expressed in Equation 2.

$$SIM = \beta_0 + \beta_1 CSP + \varepsilon^2 \quad (2)$$

- Third, the study proposed that relevance of mathematics (REM) had a direct positive and significant effect on students' interest in mathematics (SIM) as expressed in Equation 3.

$$SIM = \lambda_0 + \lambda_1 REM + \varepsilon^3 \quad (3)$$

- Finally, the study proposed that mathematics anxiety (MAA) had a direct negative and insignificant effect on students' interest in mathematics (SIM) as shown in Equation 4.

$$SIM = \gamma_0 - \gamma_1 MAA + \varepsilon^4 \quad (4)$$

1.2 Statement of the problem

The persistent issue of poor performance in mathematics among colleges of education students in Ghana and broader Africa remains a significant educational challenge. Despite various initiatives aimed at improving mathematics education, the disconnect between policy and student engagement persists, leading to a decline in interest and performance (Gray, 2014). Globally, there is a growing concern regarding students' declining interest in mathematics, which has significant implications for their performance (OCED, 2019). In Africa, the situation mirrors global trends, with numerous studies highlighting the challenges faced by students in engaging with mathematics. Studies conducted in Zimbabwe indicated that factors such as teaching methods, societal perceptions of mathematics as a difficult subject, and curriculum relevance significantly influence students' interest in mathematics (Mazana et al., 2019).

Investigating students' interest in mathematics is one of the most critical areas that requires immediate attention in our quest to enhance mathematical performance in schools (Chen and Ennis, 2004). Several factors contribute to students' lack of interest in mathematics, and even those who do express interest often do not perform as well as expected (Boadu and Boateng, 2024). While existing research has examined these factors individually, there remains a critical need to investigate their combined effects on student interest in mathematics in colleges of education. Without a clear understanding of these interrelated influences, efforts to enhance students' interest in mathematics may be ineffective. The challenge of identifying how self-efficacy, mathematics anxiety, cultural and societal perceptions, and relevance of mathematics interact to influence students' interest in mathematics remains underexplored in research. There is a pressing need to fill this gap by statistically modeling students' interest in mathematics. Concerted efforts are required to devise strategies that enhance interest in mathematics in colleges of education in the Ashanti region in Ghana, as the issue of poor performance has become increasingly concerning. Therefore, it is essential to create a model that encompasses both global and localized factors that impact students' interest in mathematics. This study aims to develop a model that builds on existing theories in the field to measure and explain the critical, often intangible constructs that determine students' interest in mathematics in colleges of education in Ghana.

2 Literature review

2.1 Theoretical framework

This study is underpinned by an integrated theoretical framework combining the foremost psychological, social, and educational theories. The dominant theories that inform this study are Social Cognitive Theory, Expectancy-Value Theory, and Sociocultural Theory. Bandura's Social Cognitive Theory proposes that human behavior is a product of the interaction of personal factors, behavior, and the environment in a model of triadic reciprocity. Within the context of mathematics, self-efficacy is defined as a student's belief in her or his capability to skillfully organize and execute the actions that are required in order to solve a problem and succeed in mathematics (Bandura, 2002). Social Cognitive Theory posits that students who have a high self-efficacy of mathematics are more willing to attempt difficult tasks, more persistent in the efforts they put in to overcome the challenges they encounter, and more passionate about the subject.

Their performance strengthens the positive self-efficacy belief and hence forms a motivational cycle. An extensive body of work confirms the strong positive mathematical correlation of self-efficacy with interest, engagement, and achievement. In a meta-analysis, Huang (2013) argues self-efficacy to be one of the strongest predictors of a learner's performance in mathematics. In the same manner, Zimmerman (2000) showed that self-efficacy is associated with greater use of cognitive and self-regulatory strategies that sustain interest. This framework includes the emotional aspect mostly through the concept of mathematics anxiety, defined as the tendency to experience fear and apprehension that disrupt the

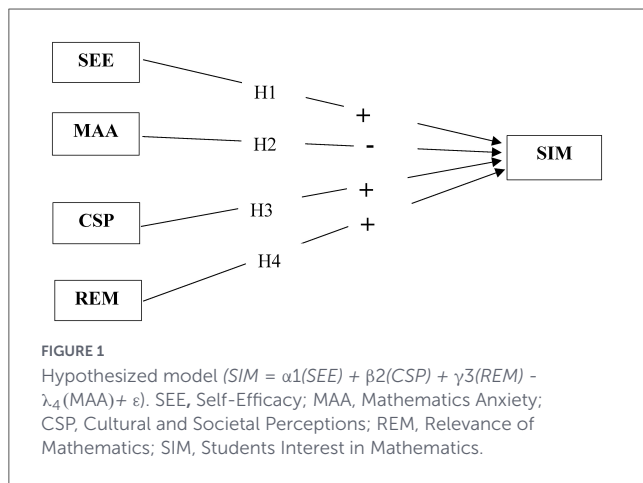
ability to manipulate and solve numerical and other mathematical problems. Mathematics anxiety is posited to have a negative impact on interest via a dual process: it consumes the cognitive resources (working memory) crucial in problem-solving (Ashcraft and Krause, 2007), and it activates negative emotional responses, which result in avoidance behavior. This leads to the negative cycle in which anxiety manifests itself in poor performance, which in turn leads to diminished interest and elevated anxiety. Anxiety, interest, and achievement are known to be inversely correlated.

Wang et al. (2015) reported that mathematics anxiety is a negative predictor of students' interest in pursuing a STEM career. Eccles and Wigfield's Expectancy-Value Theory (2002) offers a comprehensive analytical framework for the concept of interest. The expectation of success (self-efficacy) and the perceived value of the activity are two factors that influence an individual's decision, effort, and outcome, according to the Expectancy-Value Theory. The relevance of mathematics enhances the "value" part of the Expectancy Value Theory, which contains attainment value (the importance of doing well in mathematics for a person's sense of self), utility value (the importance of math for future goals), and intrinsic value (the pleasure that comes from the subject). A student who perceives mathematics to be useful for their life and future will most likely assign to it high utility value and therefore, interest and motivation. Hulleman et al. (2010) demonstrated by experiments that students who were taught to appreciate the utility value of mathematics (for example, writing essays about the relevance of mathematics) showed increased interest and improved performance, which was initially lacking. According to Lev Vygotsky's Sociocultural Theory Vygotsky's (2012), the process of cognitive development, the formation of interests and attitudes in particular, hinges upon direct surroundings and cultural environment. Most of the time, mathematics is considered a difficult subject.

There is a mathematics anxiety stereotype; some people may consider themselves "bad" at math, and some people may think math is only for "brilliant and good" students. As an example, research done by Beilock et al. (2010) illustrated that mathematics anxiety among female teachers may result, by means of social learning, in an impeded performance of girls.

2.2 Conceptual framework

A conceptual framework is usually a diagrammatical depiction of variables to be researched (Boadu and Boateng, 2024). This is developed based on the relevant theory studied and gaps identified in the empirical study. The conceptual framework, which builds on previous studies in the field, outlines the key factors influencing students' interest in mathematics from the structural equation model (SEM). The hypothesized model succinctly outlines that self-efficacy, mathematics anxiety, cultural and societal perceptions, and the relevance of mathematics all exert influence on students' interest in mathematics. This conceptual framework depicted in Figure 1 was a custom-designed model by the researcher, tailored to address the specific problem at hand and align with the stated hypotheses of the current study. This model emerged from an in-depth review of existing literature, subsequently integrated to form a comprehensive composite.



2.3 Empirical review

2.3.1 The effect of self-efficacy on students' interest in mathematics

The relationship between self-efficacy and students' interest in mathematics has been the focus of modern educational research. Research by Skaalvik and Skaalvik (2006), also confirmed that self-efficacy substantially predicts mathematics motivation among students. Their study found that students with high self-efficacy perceptions enjoyed mathematics more and tended to do more problems voluntarily even beyond the classroom. Students with low self-efficacy are less determined and less inclined to exert effort. They perceive tasks that are demanding as threats to be avoided rather than opportunities for learning and have a pessimistic view, thus lower goals. Low self-efficacy students quickly give up when faced with mathematical problems and perceive the tasks as too difficult or impossible. Such perceptions discourage them and lower their interest in mathematics. High self-efficacy, however, ensures improved academic performance and psychological wellbeing (Živković et al., 2023). According to research conducted by Arthur (2018), there is a positive correlation between academic achievement and self-efficacy, which presents self-efficacy as a predictor of academic performance. It was thus hypothesized that

H1: Self-efficacy has a direct positive effect on students' interest in mathematics in colleges of education.

2.3.2 The effect of mathematics anxiety on students' interest in mathematics

Mathematics anxiety acts as a massive psychological barrier and significantly reduces students' interest in mathematics. This psychological anxiety gives rise to tension, apprehension, and fear toward anything mathematical, which creates a negative emotional undercurrent toward untoward outcomes on performance as well as motivation. It has been demonstrated in research that mathematics anxiety leads to certain behaviors, which in turn reduce the chances of interest development and ultimately engagement with math content (Ashcraft and Krause, 2007). This

level of cognitive math anxiety not only hampers performance but also robs students of the feeling of immersion and achievement, which in turn, fosters intrinsic motivation. When students experience a mathematics task under the control of anxiety, they come to develop negative self-projections. This, in turn, results in decreased motivation toward the subject.

More recent research by Wang et al. (2015) showed that students with mathematics anxiety tend to lose interest in the subject. Their longitudinal study showed that anxious students, in particular, tend to develop negative perceptions and attitudes toward mathematics, deeming the subject to be uninteresting and, as a result, withdrawing from activities associated with mathematics. Deeply rooted mathematics anxiety, however, not only interferes with a student's performance but also distorts their math identity. As a result, students define themselves as "not math people" and shy from math-related opportunities for the rest of their education and professional careers. It was thus hypothesized that

H2: Mathematics anxiety has a direct negative effect on students' interest in mathematics in colleges of education.

2.3.3 The effect of cultural and societal perceptions on students' interest in mathematics

The interest of students in math is deeply shaped by culture and society through intricate social and psychological processes. Nasir and Shah (2011) empirical studies shed light on how the cultural frame of situating the students in identity processes affirmatively or negatively facilitates interest in mathematics. Their study demonstrated that the stronger interest and engagement in mathematics is developed by students who appreciate mathematics as a culture and community practiced and valued. The cross-cultural study by Wang and Degol (2013) on interest in mathematics in different societies showed that the interest of students in a country is greatly influenced by the national attitude toward mathematics. In countries where mathematics is considered important and is believed to be teachable to all learners, interest is remarkably high in all demographic groups. This suggests that societal-level perceptions create learning environments that either nurture or suppress mathematical interest through institutional practices and cultural messaging. For instance, mathematics is viewed in some cultures as being of very high value and worth, which motivates students to develop a good attitude and increased interest in the subject (Legewie and DiPrete, 2012). It was thus hypothesized that

H3: Cultural and Societal Perceptions has a direct positive effect on students' interest in mathematics in colleges of education.

2.3.4 The effect of relevance of mathematics on students' interest in mathematics

The perceived relevance of mathematics serves as a crucial determinant of student interest in the subject, functioning through both cognitive and motivational pathways. Research demonstrates that when students recognize connections between mathematical

concepts and their personal lives, academic goals, or future aspirations, they develop stronger interest and engagement with the subject. When teachers effectively link mathematical ideas to phenomena in the world around them, students are more likely to develop a desire to learn mathematics (Retnawati, 2022). This connection encourages students to see the relevance of mathematics in their daily lives, making the subject more engaging and applicable (Selvianiresa and Prabawanto, 2017). When students see how mathematics is applied in science, technology, and engineering, they are more likely to appreciate its relevance and importance. Integrating mathematics into hands-on projects and real-world problem-solving scenarios can enhance students' understanding and interest. For instance, using mathematical modeling in science experiments or engineering design projects can help students recognize the interconnectedness of these fields (Khalil et al., 2024). It was thus hypothesized that

H4: Relevance of mathematics has a direct positive effect on students' interest in mathematics in colleges of education.

3 Materials and methods

3.1 Research paradigm and research design

This research is based on the positivist paradigm, a framework that supports the discovery of scientific facts through theory testing (Boadu and Boateng, 2024). The core of the positivist research paradigm is built on deductive reasoning, as it involves formulating theories and analyzing them through quantitative computations. Consistent with this view, the study used a descriptive survey design and quantitative methods. This design was chosen for its ability to efficiently collect data suitable for identifying and measuring relationships between variables (Boadu and Boateng, 2024). To ensure methodological transparency and replicability, the philosophical orientation (positivism), logical approach (deductive reasoning), and research design (quantitative descriptive survey) are explicitly stated, allowing future researchers to reproduce the study under similar theoretical and procedural conditions.

3.2 Population and sample

A research population encompasses all units or individuals sharing specific traits from which a sample is taken for study (Boadu and Boateng, 2024). The target population for this investigation includes the roughly 1,200 students attending colleges of education in Ghana's Ashanti Region. This group is pertinent to the research objectives, as their firsthand experiences provide valuable insights into the core issues being examined. In research, a sample is a strategically chosen segment of the population intended to represent the whole (Boadu and Boateng, 2024). The validity of generalizing results back to the broader population depends heavily on this representativeness. Accordingly, a sample of 300 students was drawn from the target population. The population frame, geographical scope, and sample size are clearly defined to

enable accurate replication in comparable institutional and regional contexts. The sample size was determined according to the method outlined by Boadu et al. (2023), which provides a systematic approach for calculating the optimal sample size. The formula is

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

Where n = required sample size = 300

N = total population size 1,200

e = margin of error (0.05) confidence level 95%

$$n = \frac{(1200)}{1 + (2100)(0.05)^2}$$

$$n = 300$$

The explicit presentation of the sample size formula, parameters, and computation ensures transparency and allows exact replication of the sampling procedure.

3.2.1 Justification of sample size for structural equation modeling

In addition to the population-based sample size determination, the adequacy of the sample for Structural Equation Modeling (SEM) was further evaluated in relation to model complexity, parameter estimation, and statistical power. SEM sample size requirements depend not only on population size but also on the number of latent variables, observed indicators, and estimated parameters. The proposed model comprised five latent constructs measured by a total of 19 retained indicators after measurement refinement, resulting in an acceptable parameter-to-sample ratio. With a final sample size of 300, the study exceeds commonly recommended minimum thresholds for SEM, which suggest samples of 200 or more for models of moderate complexity to ensure stable parameter estimates and reliable model fit indices.

The obtained sample size therefore provides sufficient statistical power to detect meaningful effects and supports the robustness of both the measurement and structural models estimated in this study. This justification directly addresses SEM-specific sample adequacy, ensuring that the analytical procedures can be reliably reproduced in future studies with similar model specifications. Although students were drawn from different colleges of education, the data structure did not meet the requirements for multilevel estimation, as students were not nested within instructional units with sufficient intra-class correlation to justify multilevel modeling (MLM) or multi-level SEM (MSEM) to account for the potential clustering of students within institutions and to partition the variance appropriately.

3.3 Sampling techniques and data collection instruments

Sampling techniques are the methods researchers use to select participants from a population, ensuring the collected data is valid and reliable (Boadu and Boateng, 2024). This study employed a combination of stratified and simple random sampling. Stratified sampling was first used to ensure adequate representation of

key subgroups within the population. Following this, a simple random sampling technique was applied within each stratum to give every student an equal chance of being selected. The sequential application of stratified sampling followed by simple random sampling is clearly specified to allow exact replication of the participant selection process. The primary instrument for data collection was a structured, self-administered questionnaire. This tool was chosen for its efficiency in gathering quantitative data by allowing respondents to select from predefined options.

The questionnaire was organized into two sections: Section A collected demographic information (e.g., age, gender, class level, and type of basic school attended) using a nominal scale. Section B measured the study's constructs using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire items were adapted from established instruments in previous studies (Arthur et al., 2017; Arthur, 2018; Boadu et al., 2023; Boadu and Boateng, 2024) to align with this study's specific objectives and hypotheses. It measured one dependent variable, Students' Interest in Mathematics (SIM), and four independent variables: Self-Efficacy (SEE), Mathematics Anxiety (MAA), Cultural and Societal Perceptions (CSP), and Relevance of Mathematics (REM), totaling 50 measurement items.

The source, construct mapping, and total number of measurement items are explicitly stated to support replication and content validity assessment. To ensure clarity and validity, a pilot study was conducted with 40 post-college school students. This group was selected for their comprehensive experience with mathematics teaching and learning, making them well-suited to provide feedback. The pilot aimed to identify and rectify any ambiguous or misleading items. Based on this feedback, the questionnaire was refined. The final instrument demonstrated strong internal consistency, with a Cronbach's alpha coefficient of 0.76. The pilot testing procedure, sample size, purpose, refinement process, and reliability outcome are clearly documented to support methodological rigor and reproducibility. Subsequent statistical analysis of the main data revealed a significant positive correlation between the four independent variables and students' interest in mathematics in colleges of education ($r = 0.78, p < 0.005$), a finding consistent with existing literature on active learning strategies. Formal data collection proceeded over 3 weeks. Prior to commencement, an introductory letter from the researcher's department was sent to school authorities to secure permission and schedule sessions at mutually agreeable times, ensuring the process was organized and minimally disruptive. The duration, authorization process, and administration procedures of data collection are specified to ensure procedural transparency.

3.4 Ethical consideration

The researchers formally requested permission from the university to conduct the study in an official request. We confirm that informed consent was obtained from all participants involved in the study. The consent process was written and detailed the nature of the research, ensuring participants were aware of their rights, including confidentiality and the right to withdraw. For participants under the age of 18, we confirmed that parental/guardian consent was obtained prior to participation. The authors stated that the study was approved by the Akenten

Appiah-Menka University of Skills Training and Entrepreneurial Development Institutional Ethics and Research Committee with the reference number AAMUSTED/IERC/2025/023. Written informed consent was obtained from heads of the departments and lecturers, as well as from students. The privacy and anonymity of the participants were respected. The inclusion of ethical approval details, consent procedures, and participant protection measures ensures ethical replicability and compliance with international research standards.

4 Data analysis, results, and findings

The analysis utilized the computer software SPSS (IBM Corp, 2017, version 26) and AMOS (IBM Corp, 2019, version 26) for coding and entering quantitative data to facilitate the study's analysis. Subsequently, a structural equation model was employed to analyze the quantitative data.

4.1 Demographics of students

The demographic information depicted in Table 1 collected from participants provides a clear picture of the individuals involved in this study on factors influencing mathematics interest. The data reveals distinct patterns across gender, age, class level, and educational background. The study included 300 participants, with a notable majority being male.

Specifically, 210 male respondents accounted for 70% of the sample, while 90 female participants represented 30% of the total. This distribution indicates a significant gender imbalance within the participant group, which may influence the generalizability

TABLE 1 Demographics of students.

Demographics	Frequency (N)	Percentages (%)
Gender		
Male	210	70.0
Female	90	30.0
Total age		
15–18 Years	20	6.7
19–22 Years	240	80.0
23–26 Years	30	10.0
27 years and above	10	3.3
Total class level		
First year	50	16.7
Second year	200	66.6
Third year	50	16.7
Total	300	100.0
Basic school attended		
Public school	230	76.7
Private school	70	23.3
Total	300	100.0

Source: Researcher Fieldwork (2025).

of findings across gender lines. The substantial male majority suggests that any gender-based analysis should be interpreted with caution, as female perspectives are underrepresented in this sample. Given the SEM modeling focus and the absence of population-level weighting benchmarks for colleges of education in the Ashanti Region, poststratification weighting was not applied. Participant ages showed a strong concentration in the young adult category. The largest group consisted of 240 students between 19 and 22 years old, representing 80% of the total sample. Younger participants aged 15–18 years accounted for 20 students (6.7%), while those aged 23–26 years comprised 30 participants (10%). The smallest age group included only 10 respondents (3.3%) who were 27 years or older.

This age distribution suggests that most participants are at a stage where they are making important educational and career decisions, particularly regarding mathematics. The distribution across academic levels showed a pronounced concentration in the second year of study. Exactly 200 participants (66.6%) were in their second year, forming a clear majority. First-year and third-year students were equally represented, with 50 participants each (16.7%, respectively). This distribution indicates that most respondents have some college experience but have not yet reached the final stage of their program, potentially influencing their perspectives on mathematics interest and application. The type of basic school attended revealed a substantial majority of participants coming from public educational institutions. Specifically, 230 respondents (76.7%) attended public schools, while 70 participants (23.3%) received their basic education from private institutions. This significant difference may reflect broader educational patterns in the region and could influence participants' prior exposure to mathematics instruction and resources. The demographic characteristics are summarized in [Table 1](#).

4.2 Descriptive statistics

A descriptive analysis was conducted to examine the distribution of responses and assess the normality of the data collected through the questionnaire.

Normality testing is a statistical process used to evaluate if a dataset approximates a normal distribution, which is a symmetrical, bell-shaped curve commonly found in various natural and social phenomena ([Boadu and Boateng, 2024](#)). The findings from [Table 2](#) showed that respondents rated all measurement items positively, with each obtaining a mean score above the midpoint of three. The calculated means and standard deviations for every construct fell within acceptable thresholds, indicating that the data met the assumptions of normality. As illustrated in [Table 2](#), the distribution of scores across all survey questions did not significantly deviate from normality, supporting the use of subsequent parametric statistical methods.

4.3 Exploratory factor analysis

A variable reduction method called exploratory factor analysis (EFA) is used to identify the latent constructs and underlying factors that determine a set of variable structures ([Boadu and Boateng, 2024](#)). Finding the factors that represent the measurement

TABLE 2 Descriptive analysis.

Construct variables	Mean	SD
I enjoy attending mathematics classes (SIM 1).	3.90	1.085
I often study mathematics beyond what is required for class (SIM 2).	3.95	1.062
I feel a sense of accomplishment when solving math problems (SIM 3).	3.86	1.004
I believe mathematics is important for my future career (SIM 4).	3.75	1.091
I believe that consistent practice will enhance my mathematics abilities (SEE 4).	3.85	0.978
I am able to help my classmates solve their maths problems (SEE 6).	3.86	1.054
I am very excited about learning new mathematical concepts (SEE 7.)	3.85	1.096
I am motivated to explore advanced mathematics topics beyond the curriculum (SEE 9).	3.94	1.038
Community leaders motivate students to excel in mathematics (CSP 7).	3.66	1.156
Cultural stories regarding mathematics shape my desire to learn (CSP 8).	3.56	1.066
The perception of mathematics shapes my interest (CSP 9).	3.64	1.189
I predominantly receive positive remarks regarding the role of mathematics in society (CSP 10).	3.66	1.159
I understand the importance of mathematics in other fields (REM 3).	3.87	1.046
I like to relate mathematics concepts to real life (REM 4).	3.94	1.068
My instructors emphasize the applicability of mathematics (REM 5).	4.11	0.987
I view mathematics as a pathway to critical thinking and decision making (REM 8).	3.94	0.993
I become anxious when taking a mathematics test (MAA 1).	3.64	1.234
I experience physical symptoms (e.g., sweating, fast heart rate) when faced with mathematics problems (MAA 3).	3.67	1.240
It is difficult for me to relax while doing mathematics homework (MAA 4).	3.68	1.297
I avoid responding to mathematics questions because my answer may be wrong (MAA 5).	3.76	1.228
I fear that worrying ruins my work in mathematics (MAA 7).	4.00	1.236
I believe my mathematics anxiety limits my enthusiasm for the subject (MAA 10).	3.85	1.173

Source: Researcher Fieldwork (2025).

variables is the main goal of EFA. Factor analysis aims to clarify the connections between the complete collection of variables rather than forecast results ([Boadu and Boateng, 2024](#)). The EFA results are depicted in [Table 3](#). The factor structure of the data

TABLE 3 Exploratory factor analysis.

Rotated Component Matrix ^a					
	Component				
	1	2	3	4	5
MAA1					0.766
MAA3					0.745
MAA7					0.724
SEE4			0.736		
SEE6			0.813		
SEE7			0.797		
SEE9			0.774		
SIM1	0.766				
SIM2	0.780				
SIM3	0.828				
SIM4	0.801				
CSP7		0.823			
CSP8		0.793			
CSP9		0.825			
CSP10		0.780			
REM3				0.684	
REM4				0.768	
REM5				0.788	
REM8				0.749	
Total variance explained					64.204%
Kaiser-Meyer-Olkin measure of sampling adequacy					0.785
Bartlett's test of Sphericity			Approx. Chi-Square	2001.606	
			Df	171	
			Sig.	<0.001	
a. Determinant					0.001

was examined using SPSS (version 26) for this analysis, which also evaluated internal reliability and provided insights into the relationships between the variables. The researcher assessed how each observed variable loaded onto its matching latent variable during the EFA process. As indicated in Table 3, the Kaiser-Meyer-Olkin (KMO) measure of sample adequacy was found to be 0.785, over the acceptable threshold of 0.5. A Strong correlation between the components is indicated by this exemplary value (Arthur et al., 2022; Boadu and Boateng, 2024).

With a chi-square value of 2001.606 and 171 degrees of freedom, Bartlett's test of sphericity also produced a significant result with a *p*-value of 0.000, suggesting that there are enough correlations to warrant factor analysis. Five factors were identified by the analysis; they were then taken out and rotated. With a determinant value of 0.001, these factors accounted for 64.204% of the total variation. A rotated component matrix using the varimax rotation technique is shown in Table 3. This method was used because it simplifies the factors and makes interpretation easier. In order to guarantee optimal model performance, items with weak factor loadings were methodically eliminated, with each deletion being followed by an evaluation of the fit indices. Items with factor loadings below 0.50 were considered weak and sequentially

removed. After each deletion, model adequacy was reassessed using standard fit indices (KMO, Bartlett's test, total variance explained, and rotated factor structure) to ensure construct stability and theoretical consistency.

4.4 Confirmatory factor analysis results

Confirmatory Factor Analysis (CFA) was conducted using AMOS (IBM Corp, 2019, version 26) to validate the five latent constructs: Students' Interest in Mathematics (SIM), Self-Efficacy (SEE), Cultural and Societal Perceptions (CSP), Relevance of Mathematics (REM), and Mathematics Anxiety (MAA). The results indicate that the measurement model demonstrates an excellent fit to the data: The Chi-square Minimum Discrepancy (CMIN = 172.631, DF = 138) measures the difference between observed and model-implied covariances, with smaller values indicating better fit.

The normed chi-square (CMIN/DF = 1.251) adjusts for model complexity, with values below 3.0 indicating good fit. The Comparative Fit Index (CFI = 0.982) and Tucker-Lewis Index (TLI = 0.977) compare the proposed model with a baseline model, with values above 0.90 indicating acceptable fit. The Goodness-of-Fit Index (GFI = 0.944) and Adjusted Goodness-of-Fit Index (AGFI = 0.923) reflect the proportion of variance explained by the model, with higher values indicating better fit. The Root Mean Square Residual (RMR = 0.049) shows the average difference between observed and predicted covariances, with lower values preferred. The Root Mean Square Error of Approximation (RMSEA = 0.029) assesses fit per degree of freedom, with values below 0.05 indicating close fit, and the *p*-close statistic (PClose = 0.998) tests whether RMSEA is ≤ 0.05, where non-significant values indicate close fit. Collectively, these indices confirm that the measurement model is well specified and suitable for structural analysis. All retained indicators loaded significantly on their respective latent constructs, with standardized factor loadings exceeding acceptable cutoffs.

Items with weak factor loadings (below 0.50) were systematically removed to improve construct validity. As a result, six items were removed across SIM, SEE, CSP, and REM, while seven items were removed from MAA. The final model retained four indicators each for SIM, SEE, CSP, and REM, and three indicators for MAA. The CFA results confirm convergent validity of the constructs, as each indicator demonstrated strong loadings on its intended factor, and the overall model exhibited minimal error variance. The validated five-factor measurement model therefore provides a robust foundation for subsequent structural equation modeling. The final CFA model is presented in Figure 2, and detailed factor loadings and fit indices are reported in Table 4.

4.4.1 Methodological clarification of the EFA and CFA sequence

The sequential application of Exploratory Factor Analysis (EFA) followed by Confirmatory Factor Analysis (CFA) was guided by established measurement development procedures. EFA was initially employed to explore the underlying factor structure and refine measurement items, while CFA was subsequently used to

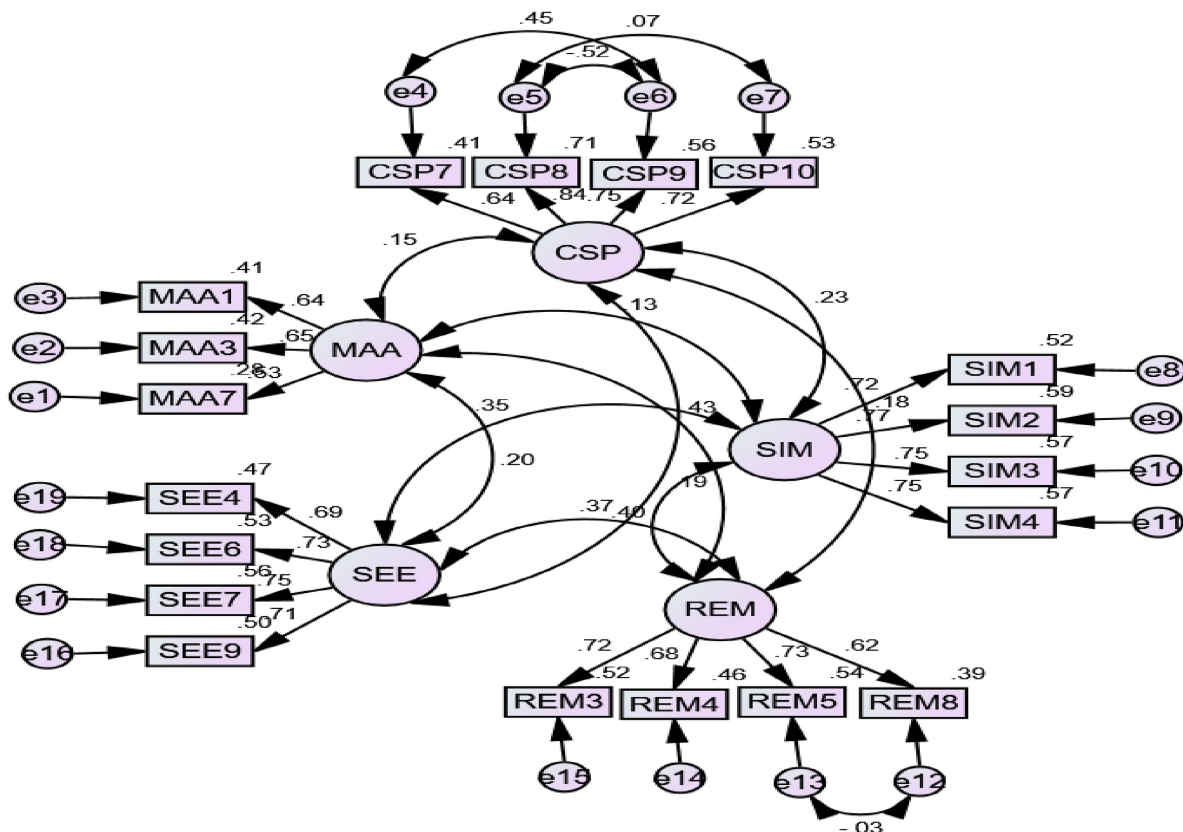


FIGURE 2
Diagrammatic presentation of confirmatory factor analysis.

confirm the theoretically specified measurement model. Although both analyses were conducted on the same dataset, the CFA was theory-driven, relied on a reduced and purified item set, and demonstrated strong model fit and construct validity.

This approach is consistent with empirical research practices where strong CFA results, supported by satisfactory fit indices and validity evidence, provide adequate confirmation of the measurement structure prior to structural model estimation.

4.5 Validity (convergent and discriminant) analysis

4.5.1 Convergent validity

Following the initial data reduction achieved through Principal Component Analysis (PCA), the next critical step is to evaluate the convergent validity of the measurement scale. To determine convergent validity, it is essential that the indicators of the constructs share a significant proportion of variance (Boadu and Boateng, 2024). Three criteria are utilized to assess convergent validity: the factor loadings should be > 0.50, the composite reliability measure is expected to exceed 0.70, and finally the average variance extracted (AVE) for each construct should achieve a value above the recommended threshold of 0.50. The results of AVE and CR values are depicted in Table 5. By computing the Average Variance Extracted (AVE) and Composite Reliability (CR), the researcher evaluated the observed variables' convergent

validity. The degree of correlation between measurement items within the same construct is known as convergent validity (Boadu and Boateng, 2024). Convergent validity was confirmed in this investigation since all constructs' AVE and CR values fell within specified ranges. In particular, the study effectively achieved convergent validity, as evidenced by the lowest AVE of 0.55532 for students' interest in mathematics and the lowest CR of 0.78889 for mathematics anxiety as depicted in Table 5.

4.5.2 Discriminant validity

Discriminant validity evaluates how distinctive a measure is and how much it does not merely reflect other factors. Each construct dimension should be distinct, although there may be some overlap (Arthur et al., 2022). The determination of discriminant validity primarily relies on the AVE, which is a common method used. Another method of evaluation is to compute the square root of the AVE for each construct and look at the cross-loadings of each indicator within the construct. All of the items are anticipated to have stronger cross-loadings on their particular construct than on other model constructs. Furthermore, the correlations between the constructs should be less than the square root of the AVE for all components. Using the plugin tool in Amos (version 26), the discriminant validity scores were obtained from the CFA output. When the smallest square root of AVE is greater than the maximum correlation coefficient, discriminant validity is verified (Boadu et al., 2023).

TABLE 4 Confirmatory factor analysis.

Model fit indices: CMIN = 172.631; DF = 138; CMIN/DF = 1.251; CFI = 0.982; TLI = 0.977; RMR = 0.049; RMSEA = 0.029; PClose = 0.998; GFI = 0.944; AGFI = 0.923		Std. factor loading
Student interest in mathematics (SIM)		
I enjoy attending mathematics classes (SIM 1).		0.72
I often study mathematics beyond what is required for class (SIM 2).		0.77
I feel a sense of accomplishment when solving math problems (SIM 3).		0.75
I believe mathematics is important for my future career (SIM 4).		0.75
Self-efficacy (SEE)		
I believe that consistent practice will enhance my mathematics abilities (SEE 4).		0.69
I am able to help my classmates solve their maths problems (SEE 6).		0.73
I am very excited about learning new mathematical concepts (SEE 7).		0.75
I am motivated to explore advanced mathematics topics beyond the curriculum (SEE 9).		0.71
Cultural and societal perceptions (CSP)		
Community leaders motivate students to excel in mathematics (CSP 7).		0.64
Cultural stories regarding mathematics shape my desire to learn (CSP 8).		0.84
The perception of mathematics shapes my interest (CSP 9).		0.75
I predominantly receive positive remarks regarding the role of mathematics in society (CSP 10).		0.72
Relevance of mathematics (REM)		
I understand the importance of mathematics in other fields (REM 3).		0.72
I like to relate mathematics concepts to real life (REM 4).		0.68
My instructors emphasize the applicability of mathematics (REM 5).		0.73
I view mathematics as a pathway to critical thinking and decision making (REM 8).		0.62
Mathematics anxiety (MAA)		
I become anxious when taking a mathematics test (MAA 1).		0.64
I experience physical symptoms (e.g., sweating, fast heart rate) when faced with mathematics problems (MAA 3).		0.65
I fear that worrying ruins my work in mathematics (MAA 7).		0.53

Source: Researcher Fieldwork (2025).

Table 5 shows that the highest correlation coefficient was 0.562, while the smallest $\sqrt{\text{AVE}}$ value was 0.7449. As a result, the dataset exhibits acceptable discriminant validity.

4.6 Reliability analysis

Reliability concerns the consistency and stability of the results produced by the instrument over time and across different contexts. A reliable measure yields similar outcomes when reapplied under

comparable conditions, indicating its dependability (Boadu and Boateng, 2024). Table 6 presents the reliability statistics for the study constructs using Cronbach's alpha (CA) and composite reliability (CR). In this study, internal consistency reliability was assessed using Cronbach's alpha (CA). This statistical test evaluates the extent to which items within a construct measure the same concept. A research instrument is generally considered reliable if results can be replicated using a similar approach (Boadu and Boateng, 2024). The reliability results are depicted in Table 6. Student interest in mathematics (SIM) achieved a CA value of 0.834, self-efficacy (SEE) reached a CA value of 0.810, mathematics anxiety (MAA) recorded a CA value of 0.757, cultural and societal perceptions (CSP) obtained a CA value of 0.831, and relevance of mathematics (REM) attained a CA value of 0.783.

According to the recommendations provided by Boadu et al. (2023), an instrument's acceptability is determined by its Cronbach's alpha score, which should be 0.7 or higher. The CA coefficients for all constructs exceeded the accepted threshold, confirming the instrument's reliability and justifying its use in the study (Bannor et al., 2023). In addition to CA, composite reliability (CR) was computed to further assess the internal consistency of the constructs within the structural equation modeling framework. The CR values recorded were 0.789 for student interest in mathematics (SIM), 0.893 for self-efficacy (SEE), 0.789 for mathematics anxiety (MAA), 0.911 for cultural and societal perceptions (CSP), and 0.871 for relevance of mathematics (REM).

All composite reliability values exceeded the recommended minimum threshold of 0.70, indicating adequate construct reliability and confirming the consistency of the measurement items. The consistency of the measurements supports the credibility of the findings and strengthens confidence in the research outcomes. Both the reliability of individual constructs and the overall instrument were examined. The constructs, along with their corresponding Cronbach's alpha values and number of items, are presented in Table 6. Together, the established validity and reliability form a solid foundation for drawing meaningful conclusions and making informed decisions based on the research results. The items used in this study were self-designed, achieving a minimum Cronbach's alpha reliability coefficient of approximately 0.7, indicating that they are fairly reliable for self-constructed instruments (Arthur et al., 2022).

4.7 Path estimates

One technique for breaking down the covariations or correlations between two variables in a structural equation model is path analysis. The objective of this method is to measure the degree to which a theoretically supported causal relationship between the variables accounts for the covariance. By making it easier to examine relationships between different independent factors and dependent variables, path analysis supports preexisting hypotheses put forth by other academics. The direct effect analysis, which was carried out using Structural Equation Modeling (SEM) using Amos (version 26), is shown in Table 7. The structural model demonstrated a satisfactory fit to the data. The chi-square value (CMIN = 172.631) with 139 degrees of freedom yielded a CMIN/DF ratio of 1.251, which is well below the recommended upper threshold of 3.0, indicating good model parsimony.

TABLE 5 Convergent and discriminant validity.

Variables	AVE	CR	SIM	SEE	CSP	REM	MAA
SIM	0.55532	0.78923	<u>0.7452</u>				
SEE	0.61262	0.89335	0.348**	<u>0.7827</u>			
CSP	0.66227	0.91103	0.230**	0.187**	<u>0.8138</u>		
REM	0.55954	0.87115	0.456**	0.363**	0.163**	<u>0.7480</u>	
MAA	0.55482	0.78889	0.129**	0.194**	0.147**	0.562**	<u>0.7449</u>

**Represents correlation coefficients between constructs. $\sqrt{\text{AVE}}$ is bold and underlined.

TABLE 6 Test of reliability statistics.

Construct	Cronbach alpha (CA)	Composite reliability (CR)
Student interest in mathematics (SIM)	0.834	0.78923
Self-efficacy (SEE)	0.810	0.89335
Mathematics anxiety (MAA)	0.757	0.78889
Cultural and societal perceptions (CSP)	0.831	0.911103
Relevance of mathematics (REM)	0.783	0.87115

Source: Researcher Fieldwork (2025).

The incremental fit indices further confirmed the adequacy of the model, with the Tucker–Lewis Index (TLI = 0.977) and Comparative Fit Index (CFI = 0.982) exceeding the recommended cutoff value of 0.90. In addition, the absolute fit indices showed favorable values, with a Root Mean Square Error of Approximation (RMSEA = 0.029) and Root Mean Square Residual (RMR = 0.049), both below the acceptable threshold of 0.08. The Probability of Close Fit (PClose = 0.998) further supports the conclusion that the model closely approximates the population covariance structure. Collectively, these indices indicate that the proposed structural model provides an adequate and reliable representation of the observed data. The standardized structural path estimates are presented in Figure 3.

4.8 Direct effect

The relationship between two variables that happens independently of any other variables in the model is referred to as a direct effect (Boadu and Boateng, 2024). Researchers can ascertain the degree to which one variable influences another

by assessing direct impacts, which can be crucial for developing hypotheses and theories. Specific path coefficients are used in structural equation modeling (SEM) to describe direct effects. These coefficients shed light on the strength and importance of the connections. While a non-significant direct effect can suggest that the relationship is not as strong, a strong direct effect implies that the variables are closely related.

4.8.1 Direct effect of self-efficacy on students’ interest in mathematics

The unstandardized estimate for the path from Self-Efficacy to Students’ Interest in Mathematics (SEE → SIM) is 0.247, suggesting a positive influence. The critical ratio (C.R.) of 3.341 suggests that the effect is indeed strong. The relationship is statistically significant, with a *p*-value of *** (*p* < 0.01) and a standard error (S.E.) of 0.074. The standardized path coefficient ($\beta = 0.236$) indicates a moderate positive effect, implying that a one standard deviation increase in self-efficacy is associated with a 0.236 standard deviation increase in students’ interest in mathematics. This confirms that higher levels of self-efficacy are directly associated with a stronger interest in mathematics.

H1: Self-efficacy has a direct positive effect on students’ interest in mathematics was confirmed.

4.8.2 Direct effect of mathematics anxiety on students’ interest in mathematics

The unstandardized estimate for the path from Mathematics Anxiety to Students’ Interest in Mathematics (MAA → SIM) is -0.057, with a C.R. value of -0.670. The effect is insignificant, with a *p*-value marked as 0.503 (*p* > 0.05). This suggests that mathematics anxiety has a negative and insignificant influence on students’ interest in mathematics. The standardized path coefficient ($\beta = -0.052$) further indicates a very weak negative effect, showing

TABLE 7 Path estimates.

Direct path	Unstd. estimate	Standardized path coefficients (β)	Critical ratio (C.R.)	Standard error (S.E.)	<i>P</i> -value
SEE→SIM	0.247	0.236	3.341	0.074	***
MAA→SIM	-0.057	-0.052	-0.670	0.085	0.503
CSP→SIM	0.189	0.214	2.898	0.065	0.004
REM→SIM	0.346	0.298	4.070	0.085	***

Model Fit Indices: CMIN = 209.000; DF = 139; CMIN/DF = 1.504; CFI = 0.963; TLI = 0.954; RMR = 0.009; RMSEA = 0.041; PClose = 0.905. *** ~ *P*-value significant at 1% (0.01), ~ *P*-value significant at 5% (0.05). Source: Researcher Fieldwork (2025).

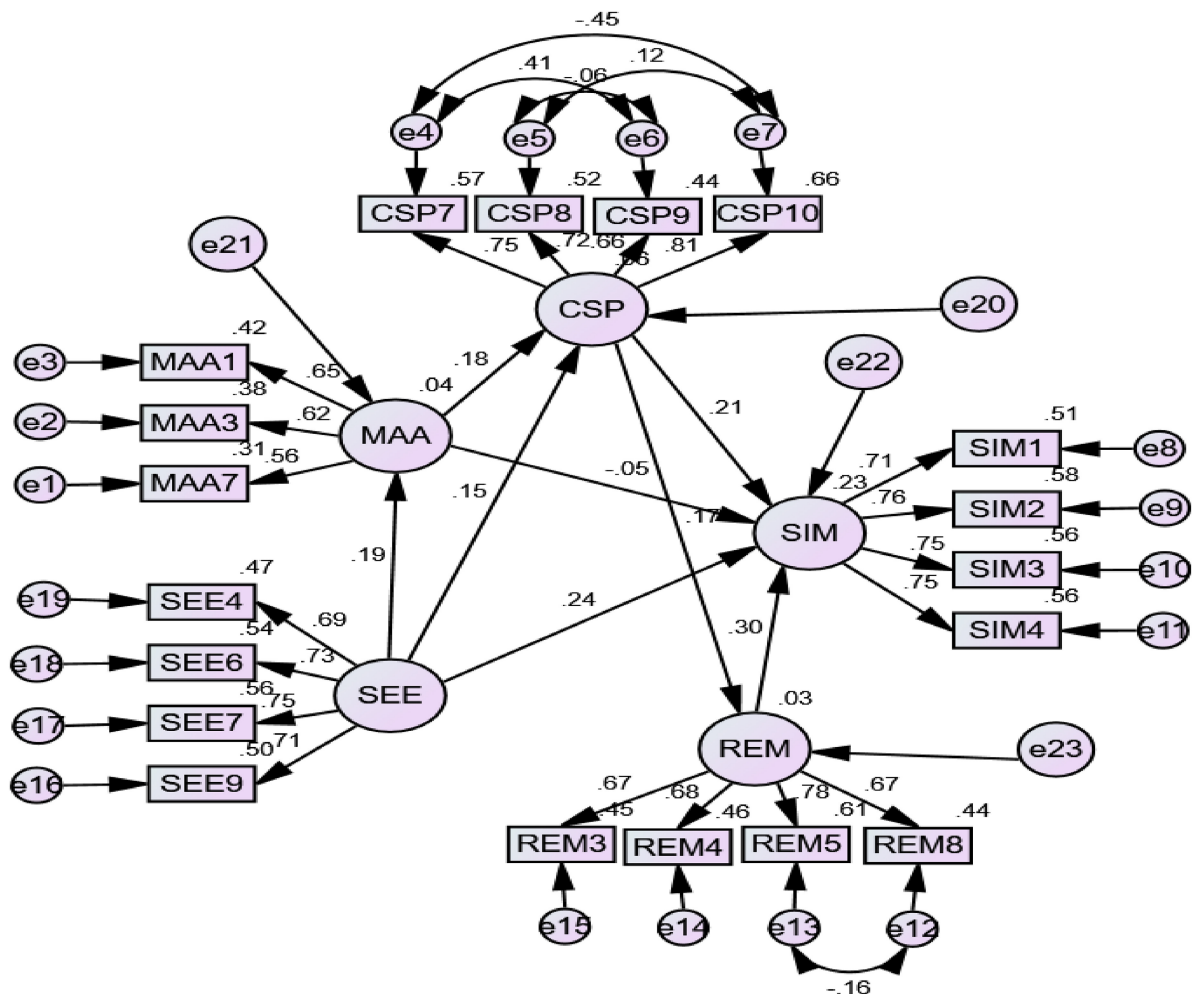


FIGURE 3 Structural path of mathematics interest model (SPMIM).

that variations in mathematics anxiety contribute minimally to changes in students' interest in mathematics. The lack of statistical significance implies that mathematics anxiety does not directly predict students' interest in mathematics within the proposed model.

H2: Mathematics anxiety has a direct negative effect on students' interest in mathematics was not supported.

4.8.3 Direct effect of cultural and societal perceptions on students' interest in mathematics

The relationship from Cultural and Societal Perceptions to Students' Interest in Mathematics (CSP → SIM) shows a strong unstandardized estimate of 0.189, with a C.R. of 2.898, S.E of 0.065, and a significant *p*-value marked of 0.004 (*p* < 0.005). This indicates that cultural and societal perceptions significantly impact students' interest in mathematics levels, emphasizing the role of cultural influences in educational settings. The standardized path coefficient ($\beta = 0.214$) reflects a moderate positive effect, suggesting that positive cultural and societal perceptions lead to

a meaningful increase in students' interest in mathematics. This finding underscores the importance of socio-cultural factors in shaping students' engagement with mathematics.

H3: Cultural and societal perceptions have a direct positive effect on students' interest in mathematics was confirmed.

4.8.4 Direct effect of relevance of mathematics on students' interest in mathematics

The relationship from Relevance of Mathematics to Students' Interest in Mathematics (REM → SIM) has an unstandardized estimate value of 0.346, a critical ratio (C.R) of 4.070, a standard error of 0.085, and a *p*-value marked as *** (*p* < 0.01), indicating statistical significance. This indicates that the relevance of mathematics positively influences students' interest in mathematics. The standardized path coefficient ($\beta = 0.298$) represents the largest effect among the predictors, indicating that relevance of mathematics is the strongest direct predictor of students' interest in mathematics. A one standard deviation increase in perceived relevance leads to a 0.298 standard deviation

increase in students' interest in mathematics, highlighting the central role of relevance in motivating learners.

H4: Relevance of mathematics has a direct positive effect on students' interest in mathematics was confirmed.

5 Discussion

This study provides meaningful insights into the various elements that influence students' interest in mathematics in colleges of education. The established a positive relationship between self-efficacy and students' interest in mathematics. Self-efficacy demonstrated a significant positive direct effect on students' interest in mathematics ($\beta = 0.236, p < 0.01$), indicating that students who believe in their capability to successfully engage with mathematical tasks are more likely to develop sustained interest in the subject.

This finding aligns with social cognitive theory, which posits that individuals' beliefs about their competence strongly influence motivation, persistence, and interest (Renner et al., 2008). In practical terms, students with higher self-efficacy are more willing to attempt challenging problems, persist through difficulties, and derive satisfaction from mathematical learning experiences (Grigg et al., 2018). This positive mindset creates a beneficial cycle where successful experiences reinforce confidence, thereby maintaining interest in the subject. On the other hand, students with low self-efficacy often enter a self-perpetuating pattern of underachievement, where reduced confidence leads to diminished effort and avoidance behaviors, ultimately weakening their mathematical interest (Gutiérrez-Doña et al., 2009). These mastery-oriented behaviors contribute directly to the development of interest, as students associate mathematics with personal success rather than failure. The significant effect of self-efficacy also suggests that confidence may serve as a protective factor, reducing the extent to which negative emotions such as anxiety undermine students' interest in mathematics. Supporting evidence from earlier studies indicates that students with strong self-efficacy beliefs are more likely to sustain interest in mathematics even when learning tasks become challenging (Zimmerman, 2000; Ampofo, 2019). However, contrasting findings suggest that the strength of this relationship may vary across classroom contexts, where differences in instructional support and learning environments can weaken or strengthen the role of self-efficacy in influencing interest (Skaalvik and Skaalvik, 2006).

Contrary to initial expectations, mathematics anxiety does not have a statistically significant direct effect on students' interest in mathematics, though the negative relationship direction corresponds with existing literature. From a structural equation modeling approach, the standardized path coefficient for mathematics anxiety ($\beta = -0.052, p > 0.05$) confirms that anxiety does not exert a meaningful direct influence on students' interest in mathematics. This finding suggests that emotional discomfort alone is insufficient to suppress interest unless it translates into weakened motivational beliefs or diminished perceptions of value. The emotional and cognitive weight of mathematics anxiety can

weaken students' sense of competence and enjoyment, potentially affecting interest indirectly through reduced self-efficacy or perceived relevance. Ramirez et al. (2018) explore the emotional aspects of this relationship by emphasizing the counter-interest responses caused by mathematics anxiety. Such emotional fractures have been identified by them as the inability of anxious students to enjoy math challenges as well as their lack of curious engagement with, and appreciation of the relevance of, mathematics in their lives.

In the end, students' interest in mathematics is cultivated on a surface level, as disengagement happens more rapidly. There is ample evidence suggesting that, with no form of intervention, in the case of mathematics anxiety, the symptoms will only become more pronounced over time (Dowker et al., 2016). This anxiety is persistent and has the potential to affect a student's performance negatively across the board. Contradicting evidence from previous research suggests that mathematics anxiety can, in some contexts, exert a more direct influence on students' engagement and motivational responses to mathematics, particularly under conditions of high cognitive demand (Ashcraft and Krause, 2007; Wang et al., 2015). These contrasting results may be explained by differences in instructional settings, assessment practices, and students' ability to regulate emotional responses during mathematical tasks.

The significant positive effect of cultural and societal perceptions highlights mathematics learning as a socially embedded process. Cultural and societal perceptions were also found to have a significant positive influence on students' interest in mathematics ($\beta = 0.214, p < 0.01$). This result highlights the importance of broader social contexts in shaping students' motivational orientations toward mathematics. Societal beliefs about the value, difficulty, and prestige of mathematics can either encourage or discourage students' engagement with the subject. When students encounter cultural narratives that value mathematics and receive encouragement from community leaders, they are more likely to cultivate personal interest in the subject. Research indicates that math ability differences between men and women in society discourage female students from learning or thinking that they can perform well in mathematics. Gender stereotypes may lead girls to adopt the belief that mathematics is a man's domain, and that reduces their interest and confidence in learning the subject (Hyde and Linn, 2006). This mindset discourages fewer girls from enrolling in advanced math classes or math- and science-related professions. Students with a strong parental educational background generally perform better in mathematics, even though students from different backgrounds may also show some level of interest in the subject (Gonida and Cortina, 2014). Additionally, a student's cultural background positively influences their interest in mathematics, thereby affecting their achievement and performance (Arthur et al., 2017). Supporting studies emphasize that cultural and societal perceptions play an important role in shaping students' interest in mathematics by influencing expectations, identity formation, and perceived value of the subject (Nasir and Shah, 2011).

In contrast, other findings indicate that the impact of these perceptions is not uniform and may differ across social and educational contexts, particularly where systemic inequalities or

competitive academic cultures alter students' interpretations of societal messages about mathematics (Legewie and DiPrete, 2012).

Most notably, the relevance of mathematics emerged as the most powerful predictor of students' interest in mathematics. The strength of this relationship is reinforced by the standardized path coefficient ($\beta = 0.298$, $p < 0.01$), which indicates that relevance exerts the largest direct effect on students' interest among all predictors examined. This finding underscores the central role of value-based motivation in influencing interest, suggesting that when mathematics is perceived as meaningful and applicable, students are more likely to engage with the subject regardless of emotional challenges. When students perceive mathematical knowledge as connected to their personal lives, academic objectives, and future careers, they demonstrate substantially higher engagement levels. Research has shown that when students see mathematics as relevant and useful, their level of motivation and achievement in the subject improves significantly (Kaleva et al., 2019). This relevance can spark curiosity and encourage students to explore mathematical concepts more deeply. When students see the direct application of mathematics, their interest in the subject increases. Research indicates that students who understand how mathematics is used in their desired careers are likely to develop a favorable attitude toward the subject (Kaleva et al., 2019). Making mathematics relevant through practical examples and real-world problems can enhance student engagement. A strong connection between mathematics and its applications can lead to higher motivation levels among students.

Studies have shown that students who recognize the usefulness of mathematics tend to perform better (Leyva et al., 2022). The relevance of mathematics to daily life and other curriculum areas profoundly affects the interest of students in the subject. By connecting mathematical ideas with real-life situations and current issues by teachers, the students are trained to acquire a more positive attitude and increased interest in mathematics. This is based on evidence from research by Rakes et al. (2010), which supports that a teacher's inability to connect mathematics with daily life can negatively influence students' interest and exacerbate their struggle with solving math problems.

Similarly, Arthur (2018) believes that students' interest in mathematics can be more effectively predicted based on teachers' capability to relate mathematical concepts to practical problems, their immediate contexts, and other subjects. Supporting evidence suggests that perceiving mathematics as relevant and useful enhances students' interest by strengthening value-based motivation (Eccles and Wigfield, 2002; Gray, 2014). However, contradicting findings indicate that relevance alone may not sustain long-term interest unless it is accompanied by instructional practices that actively engage learners and promote meaningful application of mathematical ideas (Hulleman et al., 2010).

6 Conclusion

This study concludes that students' interest in mathematics develops through a complex interaction of psychological, social, and practical factors. Self-efficacy, cultural and societal perceptions, and the relevance of mathematics were found to contribute

significantly and positively to students' interest in mathematics, with the relevance of mathematics demonstrating particularly strong predictive power. However, mathematics anxiety showed a negative and statistically insignificant influence on students' interest in mathematics. This finding suggests that mathematics anxiety may not directly diminish students' interest unless it operates through other motivational pathways. In this context, anxiety alone appears insufficient to suppress interest when students maintain confidence in their abilities or perceive mathematics as relevant and meaningful. It is therefore likely that mathematics anxiety influences interest indirectly, particularly by weakening self-efficacy beliefs or reducing perceptions of value and relevance. Additionally, instructional support, adaptive coping strategies, and contextual learning environments within colleges of education may buffer the impact of anxiety, limiting its direct effect on interest. These explanations help clarify why mathematics anxiety, despite its negative direction, did not emerge as a significant predictor of students' interest in mathematics in the present study.

7 Implications for instructional practices

The findings propose several important implications for mathematics instruction in colleges of education. First, educators should implement teaching strategies that systematically develop students' self-efficacy through structured learning experiences, constructive feedback, and opportunities for mastery.

Second, instructional methods should explicitly connect mathematical concepts to real-world contexts, emphasizing applications in students' daily lives, future professions, and other academic disciplines. Third, instructors should actively work to establish positive classroom cultures that counter negative societal stereotypes about mathematics and promote inclusive participation. Finally, while addressing mathematics anxiety remains important, instructors should concentrate on building confidence and relevance as primary mechanisms for enhancing interest.

8 Theoretical implications

This study contributes to theoretical understanding by validating a multifaceted model of mathematical interest that incorporates self-efficacy, mathematics anxiety, cultural and societal perceptions, and relevance of mathematics within a unified framework. The findings reinforce social cognitive theory's emphasis on self-efficacy while highlighting the powerful role of relevance perceptions, suggesting potential integrations with expectancy-value frameworks. Furthermore, the demonstrated importance of cultural and societal factors underscores the necessity of situating interest development within broader socio-cultural contexts. Finally, the complex relationship between mathematics anxiety and students' interest in mathematics indicates the need for more detailed theoretical models that account for indirect effects and potential mediating variables.

9 Recommendations and future research directions

Based on the study findings, several recommendations emerge. Mathematics teachers should prioritize pedagogical approaches that enhance perceived relevance through authentic applications and real-world problem solving. Curriculum developers should design materials that systematically build self-efficacy while incorporating culturally responsive examples and applications. College administrators should facilitate professional development that equips instructors with strategies to address the multifaceted nature of mathematical interest.

Future research should explore several promising directions. Longitudinal studies could examine how these relationships evolve throughout teacher training and into professional practice. Investigation of potential mediating variables between mathematics anxiety and students' interest in mathematics would provide greater insight into the mechanisms underlying this relationship.

Future research, especially studies aiming for broader population inferences, should employ multi-level modeling (MLM) or multi-level SEM (MSEM) to account for the potential clustering of students within institutions and to partition the variance appropriately. Future studies are encouraged to employ gender-balanced sampling or statistical weighting techniques to improve representativeness. Finally, intervention studies testing specific strategies for enhancing relevance perceptions and self-efficacy would contribute valuable evidence for effective practice.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethics statement

The studies involving humans were approved by AAMUSTED Institutional Ethics and Research Committee with ID AAMUSTED/IERC/2025/023 of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi, Ghana. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

SB: Data curation, Formal analysis, Resources, Writing – original draft, Writing – review & editing. FB: Supervision, Validation, Writing – review & editing. BO: Investigation, Methodology, Software, Writing – original draft.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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