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Mathematics Interest and Self-Efficacy: Exploring the Relationship between the History of Mathematics and Mathematics Performance

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ABSTRACT

This study investigates the mediating role of mathematics interest and self-efficacy in the relationship between the history of mathematics and mathematics performance. The study adopted a descriptive-correlational design utilizing a structured questionnaire. The sample size comprised 318 university students. The data obtained was analyzed using Structure Equation Modeling (SEM) run by Amos (ver. 23). The findings revealed that HST positively affected mathematics interest and self-efficacy. Self-efficacy and mathematics interest partially mediate the relationships between HIST and mathematics performance. Future studies may consider students in other mathematics-related disciplines in other universities within or outside Ghana to increase generalization.

Keywords: Mathematics, Mathematics Interest, Self-Efficacy, Mathematics Performance, University Students

INTRODUCTION

Across various disciplines such as computer science, physics, engineering, and economics, mathematics enhances critical thinking and problem-solving skills (Anggraini et al., 2020; Siregar et al., 2024). Many technological advancements depend on mathematical principles, from basic arithmetic in programming to complex algorithms in data science. Mathematics is essential for activities like budgeting, cooking, shopping, and travel planning. Mathematics enhances logical reasoning and analytical thinking, training the brain to think in a structured and methodological manner. Ramírez-Montoya et al. (2022), abstract mathematical concepts can improve creativity and understanding of complex systems. A firm grasp of mathematics is crucial for success in science, engineering, technology, and finance, as many careers in STEM fields, finance, and education rely heavily on math skills (Leyva *et al.*, 2022). The development of mathematical concepts has been vital to human civilization, influencing areas from architecture to astronomy.

In many African cultures, education is highly valued as a pathway to better opportunities, and mathematics is often seen as a crucial subject for academic and professional success (Mabena, Mokgosi, and Ramapela, 2021). Various governments and non-governmental organizations are working to improve the quality of math education through curriculum reforms, teacher training, and the provision of educational resources. Empirical studies have suggested that the history of mathematics, mathematics interest, and student self-efficacy may significantly influence mathematics performance (Ufer et al., 2017). This study looked at the factors that could predict students' mathematics performance.

Incorporating the history of mathematics into teaching mathematical concepts is not novel. This approach allows students to view mathematics as a dynamic and evolving field shaped by human creativity and problem-solving. This perspective can significantly enhance their engagement and interest in the subject, particularly for IT students, who often depend on mathematical principles in their studies and future careers. According to Jahnke et al. (2022), the history of mathematics is the sole component that can favorably affect students' interest and mathematics performance. He further emphasized that the history of mathematics enhanced students' motivation to study mathematics. Peeking into the scientific discoveries, the lives of mathematicians, and the historical evolution of mathematical concepts may stimulate students' interest in mathematics and improve their attitude towards it(Sriraman, 2021). As documented by Adolat (2019), one of the effective strategies to increase students' engagement and interest in mathematics is to incorporate historical topics into the teaching and learning process. This approach enhances students' deeper and more thorough understanding of mathematical concepts.

To further address the issue of poor mathematics performance, Arthur et al. (2022) highlighted that a student's enthusiasm for the subject plays a critical role in their academic success in mathematics. Hyland et al. (2022) defined mathematics interest as an individual's attraction to, curiosity about, or inclination towards exploring mathematical concepts, problems, and structures. An et al. (2021) stressed that students who genuinely enjoy mathematics are more likely to engage with challenging tasks, seek out solutions, and put in the effort needed to grasp abstract concepts. Interest fuels curiosity and a desire to delve deeper into mathematical topics (Tang et al., 2022). Students who are passionate about math often pursue additional resources, work independently, and explore complex subjects beyond the standard curriculum. Research has shown that interest enhances memory retention (Inslicht et al., 2021) and Brezavšček et al. (2020) argued that students with a strong interest in mathematics are more likely to retain what they learn, building a solid foundation for future academic success.

In addition to interest, a student's ability to complete a given task is essential for achieving strong performance in mathematics. Self-efficacy, a concept rooted in Bandura's social cognitive theory, has been extensively studied across various disciplines. Albert Bandura defines self-efficacy as "the belief in one's ability to organize and execute the course of action required to manage prospective situations" (Patton, 2021). Raharjo et al. (2023) similarly, self-efficacy is an individual's confidence in their ability to accomplish a specific task. According to Manzano-Sanchez et al. (2018), a person's capacity to comprehend and solve mathematical problems influences their engagement in learning activities and their persistence in overcoming challenges. Self-efficacy is crucial for enhancing personal effectiveness (Farley, 2020). Stajkovic and Luthans (1998) found a significant correlation between self-efficacy and mathematics performance. Therefore, this study also examines how mathematics interest and self-efficacy mediate the relationship between HIST and mathematics performance.

Despite the growing body of research in this area, the interaction between the history of mathematics, self-efficacy, mathematics interest, and performance among university students has not been thoroughly examined, leaving a gap that this study aims to address. Several empirical studies specifically examine how mathematics influenced mathematics performance among university students, and self-efficacy mediates the relationship between the history of mathematics and mathematics performance among university students. Most studies focused on the influence of the history of mathematics on mathematics performance (Arthur, 2022), the influence of mathematics interest on mathematics performance (Grigg et al., 2018), and the influence of self-efficacy on mathematics performance (Tus, 2020) without necessarily combining these factors in a single study. To add to the literature, we decided to examine the mediating effect of self-efficacy on the nexus between the history of mathematics and mathematics performance among university students. Understanding the factors that influence students' performance in mathematics is a crucial aspect of educational research. Based on this study design, the current study is among limited existing research that employs Structural Equation Modelling (SEM) to examine mathematics interest and self-efficacy as mediators of the relationship between history of mathematics (HIST) and mathematics performance among university students.

The current study aims to examine how mathematics interest and self-efficacy mediate the relationship between the history of mathematics (HIST) and mathematics performance among university students. Specifically, the objectives of this study were to: 1) determine the influence of the history of mathematics (HIST) on mathematics interest (MIN) among university students; 2) determine the influence of the history of mathematics (HIST) on self-efficacy (SE) among university students; 3) examine the mediating effect of self-efficacy (SE) on the history of mathematics (HIST) and mathematics performance (MP) among university students; and 4) examine the mediating effect of mathematics interest (MIN) on the history of mathematics (HIST) and mathematics performance (MP) among university students.

LITERATURE REVIEW

History of Mathematics (HIST) and Students' Mathematics Interest

Several scholars agree that teaching about the history of mathematics in mathematics classrooms is an excellent approach (Baki & Gürsoy, 2018). According to Bütüner and Baki (2020), incorporating HIST into the curriculum boosts students' mathematical ability and also increases their enthusiasm for the subjects. Using the history of mathematics in instruction offers students the opportunity to explore the past and understand the forces that have shaped the world (Samuel Baah-Duodu et al., 2021). Bertamino et al. (2018) claimed that interest is related to an individual's feelings, goals, and actions. Student's interest in the subject is a major element influencing success in a mathematics course and may have a favorable effect on the learning outcome process (Leyva et al., 2022). According to Furinghetti (2019), inculcating historical concepts of mathematics in mathematics instruction positively influences students' mathematics interest learning. For example, connecting the life story of Pythagoras to students can increase their interest in learning the Pythagorean Theorem. HIST is a valuable teaching tool that enhances student's communication skills and fosters their mathematics interest (Tzanakis et al., 2002). Studying the historical origin of mathematics influenced students' interest and mathematics performance (Romo Vázquez, 2015). Moreover, Shara (2020) found that HIST had a significant influence on students' mathematics interests. Rogers and Pope (2019) found that incorporating the history of mathematics into teaching significantly influenced 11th-grade students' mathematics interests. This hypothesized that;

H1: History of Mathematics (HIST) positively predicts students' mathematics interests.

History of Mathematics (HIST) and Students' Self-Efficacy

The research has found that students' beliefs about their mathematical self-efficacy are significantly affected by the history of mathematics. Mathematical self-efficacy is defined as a student's perception of their ability to succeed in mathematics. The study Stankov et al. (2012) defined mathematics self-efficacy as confidence in a person's ability to effectively handle mathematical situations, tasks, or problems. Moreover, the history of mathematics helps students to develop an approach to learning mathematics. Bhatti et al. (2021) in their study identified a potential causal connection between self-efficacy and the use of the history of mathematics in teaching and learning mathematics. Using the history of mathematics in teaching and learning improves students' efficacy and belief in learning mathematics. The potential advantages of students' mathematical self-efficacy while incorporating the history of mathematics were noted by Endris (2008). Jahnke et al. (2022) emphasized that inculcating the history of mathematics aids students in understanding how mathematical ideas have evolved, improves problem-solving skills, compares and contrasts mathematical topics between the past and present, and establishes the connections between mathematical topics and other disciplines. This hypothesized that;

H2: History of Mathematics (HIST) positively predicts students' self-efficacy.

Hypothesis 1 and 2 revealed that the history of mathematics (HIST) predicts mathematics interest and students' self-efficacy. Based on these findings, the current study proposes that;

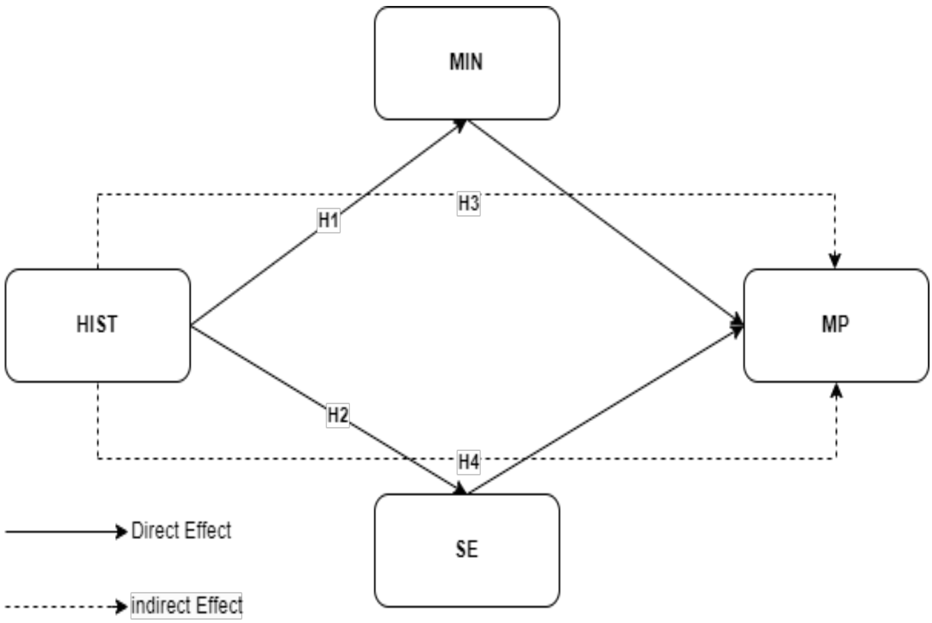
H3: *Mathematics interest mediates the relationship between the history of mathematics (HIST) and students' mathematics performance.*

H4: Self-efficacy mediates the relationship between the history of mathematics (HIST) and students' mathematics performance.

Figure 1 illustrates the conceptual framework of this study. *In Figure 1*, the history of mathematics (HIST) directly affects students' mathematics performance. In addition, the history of mathematics (HIST) directly influences students' mathematics interests (MIN). Moreover, HIST has a direct influence on students' self-efficacy. Furthermore, students' mathematics interest and self-efficacy (SE) mediate HIST and mathematics performance (MP). Finally, mathematics performance is the dependent variable.

Figure 1

Conceptual Framework



RESEARCH METHOD

Research Design

This study employed a descriptive-correlation research design. This design allows researchers to explore and describe the relationships between variables without manipulating them (Creswell, 2014). Furthermore, it provides insights into patterns and associations that may exist in the natural environment.

Population

This study population comprised all first-year students pursuing a Bachelor of Science (Mathematics education and Information Technology Education) at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Kumasi-Ghana, with 1540 students. These students were enrolled in the 2022/2023 academic year and undertook mathematics and statistics as part of their study. The study sample size was calculated using Yamane's (1967). Given as;

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

Where, N = population, n = sample size, and e represents 95% was chosen as the confidence level since it provides a good balance between a reasonably high level of confidence and a practical width of the confidence interval. Moreover, 5% was also chosen as the margin of error because it allows for a manageable sample size that balances resources (time, money, effort) and the need for precise estimates.

$$n = \frac{1540}{1 + 1540(0.05)^2} = 317.526 \approx 318$$

Hence, the required sample size for the study is 318.

This study used stratified sampling to classify university students based on their programs of study. In addition, simple random sampling was employed to select university students from each program of study, that is, 190 university students pursuing BSc. Information Technology Education and 128 university students pursuing BSc. Mathematics Education, who were present in their respective lecture halls during the data collection process.

Before the data gathering, the researchers saw that all research ethics were strictly followed. Following the respondents' assent to take part in this study, the data was managed with extreme confidentiality while preserving anonymity. A letter was sent to the faculty of applied science and mathematics education at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Kumasi, requesting permission to use the responders from the chosen university students for the survey participants. The researchers collected the data during lecture hours. The purpose of this study was conveyed to the respondents through research. The explanations provided persuaded the participants, who unhesitatingly provided their consent. The researcher from danger of any kind, including political, psychological, and bodily injury, shielded all those who responded. The study used a hard-copy questionnaire (*Appendix A*). The researchers' contact information was indicated on the questionnaire so the respondents could call for clarification when needed. The data the researchers gathered did not reveal the participants' identities, ensuring their confidentiality. After twelve (12) weeks, the respondents completed 318 questionnaires.

Data Collection and Research Instruments

The study data was collected from students pursuing a BSc. Mathematics Education and BSc. Information Technology Education at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Kumasi. A structural questionnaire was employed as the instrument for data collection in the study. History of mathematics, self-efficacy, mathematics interest, and mathematics performance were the main variables in the research (*Appendix A*). The four main variables were measured using a Likert scale (1 = Strongly agree to 5 = Strongly disagree). The items for the history of mathematics (HIST) were adapted from Arthur (2022). These items were; I enjoy the history component in the mathematics course outline, The history of mathematics in the course outline provides a variety of approaches for carrying out mathematics tasks, and Mathematics lecturers explain mathematical ideas to students using material from the history of mathematics. The items under mathematics interest were adapted from Asare et al. (2023). These items were; When it comes to mathematics, I am very self-assured, I would like to stay away from math in college, I believe I am capable of learning complex math, and I have enjoyed mathematics since elementary school. The items under self-efficacy were adapted from Arthur et al. (2024). These items were; I feel confident using mathematics outside of school, I feel confident asking questions in my mathematics class, and I get nervous before the mathematics test. The items under mathematics performance were developed by the researchers. These items were; "The ancient Greek mathematician Pythagoras is credited with the famous theorem that states: *"In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides."* I can find the length of the hypotenuse If a right triangle has legs of lengths 6 cm and 8 cm.", "Leonardo Fibonacci introduced the Fibonacci sequence, where each term is the sum of the two preceding ones. The first few terms are: 1, 1, 2, 3, 5, 8, ... I can find the 8th term in the Fibonacci sequence.", and "Archimedes approximated π (pi) and developed formulas for circle measurements. I can find the radius of a circle if the circumference of a circle is 44 cm (use $\pi \approx 3.14$)."

Common Method Bias

The data for this study was collected at a single point in time, raising the potential for common method bias (CMB). To address this concern, several steps were implemented to control CMN effectively. Firstly, the study underwent pilot testing before the main data collection phase. This process ensured that the items were refined and optimized for clarity and accuracy. Additionally, each point on the Likert scale was clearly labeled, following the recommendations of Podsakoff and Organ (1986), to reduce respondent confusion and improve measurement precision. Finally, Harman's one-factor test was conducted to determine whether a single factor could account for the majority of the variance in the dataset. The analysis revealed that the first extracted factor accounted for 20.76% of the total variance, well below the 50% threshold. This result indicated that no single factor dominated the dataset, thereby confirming the absence of significant CMB (Podsakoff & Organ, 1986).

Validity and Reliability Test

An exploratory factor analysis (EFA) was conducted using SPSS (v.23) software to ensure the accuracy of the items associated with the latent variables. EFA serves as a robust statistical technique for uncovering latent constructs that are not directly observable. By identifying these underlying dimensions, researchers can better understand the factors influencing their measured variable (Marsh et al., 2020). In this study, the primary variables under investigation were the history of mathematics (HIST), mathematics interest (MIN), self-efficacy (SE), and mathematics performance (MP). Each of these variables was assessed using ten distinct criteria to capture the respective dimensions comprehensively. During the EFA process, items that demonstrated poor alignment with their intended constructs, indicated by factor loading of less than 0.5, were removed from further analysis (Jr & Shuck, 2015). This elimination ensures that only the most relevant and reliable items were excluded, ultimately leading to a total variance extracted (TVE) of 89.74%. This value significantly exceeded the commonly accepted threshold of 50%, highlighting the robustness of the retained factors (Dong et al., 2020).

The adequacy of the sample for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure. The KMO score for this study was 0.888, which surpassed the recommended minimum value of 0.6 (Zakariya & Massimiliano, 2021). This high KMO value indicated that the sample size was sufficient to yield reliable results in the EFA. Additionally, Bartlett's test of sphericity, based on the original correlation matrix, was statistically significant. The rest results (X^2 = 8504.804; p = 0.00) demonstrated strong correlations among the variables, further validating the appropriateness of the EFA (de Winter et al., 2009). To ensure the data matrix used in the estimation process was positively definite, the determinant of the correlation matrix was examined. A determinant value greater than zero indicates a positively defined dataset, which is essential for the validity of the factor analysis (de Winter et al., 2009). In this study, the determinant of the correlation matrix was calculated as 1.767E-11, a value above zero. This finding confirmed that the dataset was positively defined and suitable for exploratory factor analysis (EFA). By adhering to these rigorous statistical procedures, the study ensured that the retained items were valid, reliable, and representative of the underlying latent variables. This thorough analysis strengthens the overall validity of the research findings and provides a solid foundation for further investigation.

The next step in the analysis process involves performing a Confirmatory Factor Analysis (CFA) using Amos (v.23) to validate the factor loadings identified during the Exploratory Factor Analysis (EFA). CFA is a statistical method employed to confirm the factor structure of a set of observed variables. As described by

Sureshchandar (2023), this technique is instrumental in hypothesis testing, as it examines the relationships between observed variables and their corresponding latent constructs. Shek and Yu (2014) further highlight that CFA enables researchers to assess the degree to which the hypothesized factor model fits the data. The findings of the CFA are presented in Table 2 and visually represented in Figure 2. The results of the CFA suggest that all measurement variables have standardized factor loadings exceeding the threshold of 0.5. This indicates that the latent variables associated with each measurement item were significantly accounted for, confirming the validity of the measurement model. Additionally, a Cronbach Alpha (CA) test was conducted using the retained variables to evaluate the reliability of the scales. The analysis revealed that all latent variables achieved an alpha value exceeding the minimum acceptable criterion of 0.7, demonstrating strong internal reliability among the measurement variables.

Convergent validity, as outlined by Fornell and Larcker (1981), requires a composite reliability (CR) of at least 0.7 and an Average Variance Extracted (AVE) of at least 0.5. In this study, all constructs met these criteria, affirming that the latent variables effectively explain the variance in their associated observed variables. The high CR and AVE values further support the robustness of the measurement model and the consistency of the underlying constructs. To assess the model fit, various goodness-of-fit indices were considered. These included a CMIN/DF value lower than 3, a PClose value greater than 0.05, a Goodness-of-Fit Index (GFI) of at least 0.80, and Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) values exceeding 0.90.

Additionally, Root Mean Square Error of Approximation (RMSEA) and Root Mean Square Residual (RMR) values below 0.08 were required for an acceptable fit. As displayed in Table 2, the results indicate that all these indices were satisfied, confirming that the data aligns well with the hypothesized model. This robust model fit proves that the constructed model accurately represents the observed data. Table 1 represents confirmatory factor analysis and model fit indices results.

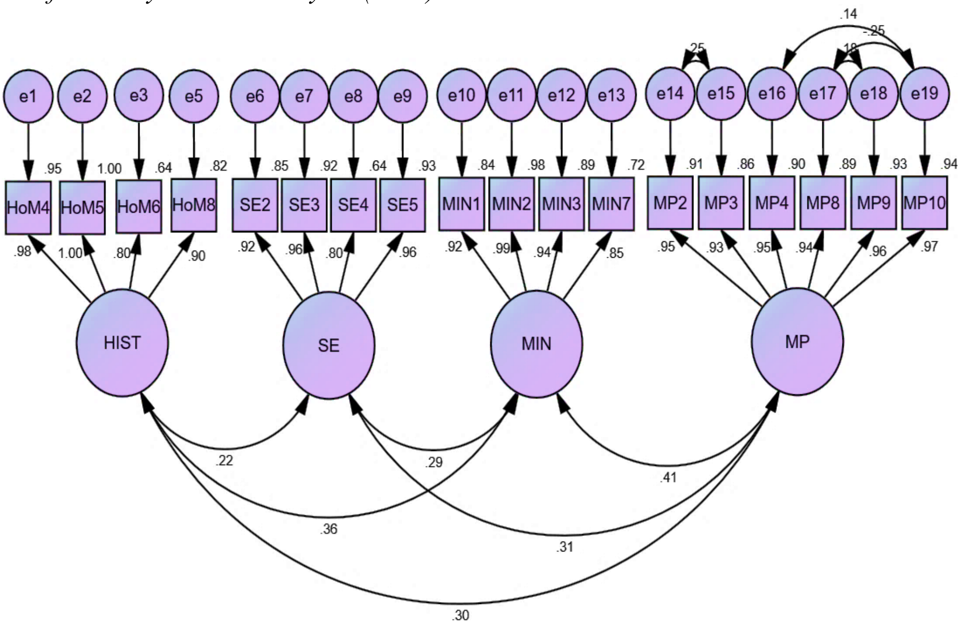
Table 1

Confirmatory Factor Analysis (CFA) and Model Fit Indices Result

Model Fit Indices: *CMIN = 223.166; DF = 119; CMIN/DF = 1.875; TLI = .989; CFI = .989; GFI = .941; AGFI = .915; RMR = .045; RMSEA = .050; PClose = .486*	**Factor loading(s)**
History of Mathematics (HIST): CA = 0.956	
HIST 4: History of mathematics makes mathematics class meaningful teaching.	.976
HIST5: My lecturer relates historical discoveries in mathematics to modern problem-solving techniques.	1.002

HIST6: The history of mathematics in the course outline provides a variety of approaches for carrying out mathematics tasks.	.800
HIST8: Mathematics lecturer explains mathematical ideas to students using material from the history of mathematics.	.904
Self-Efficacy (SE): CA = 0.951	
SE2: I feel confident using mathematics outside of school.	.923
SE3: I feel confident asking questions in my mathematics class.	.958
SE4: I get nervous before the mathematics test.	.800
SE5: I get tense when I prepare for a mathematics test.	.965
Mathematics Interest (MIN): CA = 0.959	
MIN1: When it comes to mathematics, I am very self-assured.	.916
MIN2: I would like to stay away from math in college.	.988
MIN3: I believe I am capable of learning complex math.	.943
MIN7: I have enjoyed mathematics since elementary school	.851
Mathematics Performance (MP): CA = 0.983	
MP2: Leonardo Fibonacci introduced the Fibonacci sequence, where each term is the sum of the two preceding ones. The first few terms are: 1, 1, 2, 3, 5, 8, ... I can find the 8th term in the Fibonacci sequence.	.955
MP3: Archimedes approximated π (pi) and developed formulas for circle measurements. I can find the radius of a circle if the circumference of a circle is 44 cm (use $\pi \approx 3.14$).	.928
MP4: Al-Khwarizmi, known as the "Father of Algebra," introduced systematic methods for solving equations. I can find the value of *x* in the equation if $2x + 5 = 15$.	.947
MP8: Carl Friedrich Gauss discovered a shortcut for summing arithmetic sequences. I can find the sum of the first 50 natural numbers (1 + 2 + 3 + ... + 50).	.941
MP9: Leonhard Euler formulated the equation $V - E + F = 2$ for polyhedra, where V = vertices, E = edges, and F = faces. If a cube has 8 vertices and 6 faces, I can find the number of edges of polyhedra.	.963
MP10: Indian mathematician Brahmagupta played a key role in formalizing the concept of zero. If $3x = 0$, I can find the value of x.	.968

Figure 2
Confirmatory Factor Analysis (CFA)



The discriminant validity of the model was assessed through an analysis of the inter-correlation coefficients and the square root of the extracted average variance (AVE). This method follows the guidelines outlined by Bamfo et al. (2023), emphasizing AVE's significance in evaluating the constructs' validity. The square root of the AVE for each variable was compared against the inter-correlations among the variables, ensuring that each construct shared more variance with its items than with other constructs in the model. This step is critical in verifying that the constructs are conceptually distinct.

Table 2
Discriminant Validity

Variables	*CR*	*AVE*	*HIST*	*SE*	*MIN*	*MP*
HIST	0.959	0.853	**0.924**			
SE	0.953	0.836	0.224***	**0.914**		
MIN	0.960	0.858	0.356***	0.287***	**0.926**	
MP	0.982	0.903	0.301***	0.306***	0.412***	**0.950**

Note: $\sqrt{\text{AVE}}$ are bolded; ***~ p significant at 1%.

Particular attention was given to the AVE, as it represents the degree to which a construct explains the variance in its indicators relative to the variance caused by measurement error. This focus underscores the importance of AVE in determining the discriminant validity of the model. The analysis demonstrated that all variables satisfied the required criteria for discriminant validity. These findings are presented in detail in Table 2, which provides a comprehensive summary of the inter-correlation coefficients and the square root of the AVE for each construct.

RESULTS

Structural Equation Modeling (SEM) with Amos Graphics (ver. 23) was used to determine the path coefficient to investigate the influence of HIST, mathematics interest, and self-efficacy on mathematics performance among university students. Table 3 and Figure 3 illustrate the findings of this study.

Table 3

Paths Estimates

Hypothesis	Direct Effect	Std. Estimate	S.E.	C.R.	p-value	Decision
H1	HIST→MIN	0.356	0.039	9.128	< 0.01	Accepted
H2	HIST→SE	0.224	0.042	5.333	< 0.01	Accepted
Hypothesis	**Indirect Effect**	**Std. Estimate**	**LBc**	**UBc**	**p-value**	**Decision**
H3	HIST→MIN→MP	0.068	0.033	0.113	0.001	Accepted
H3	HIST→SE→MP	0.057	0.031	0.094	0.000	Accepted

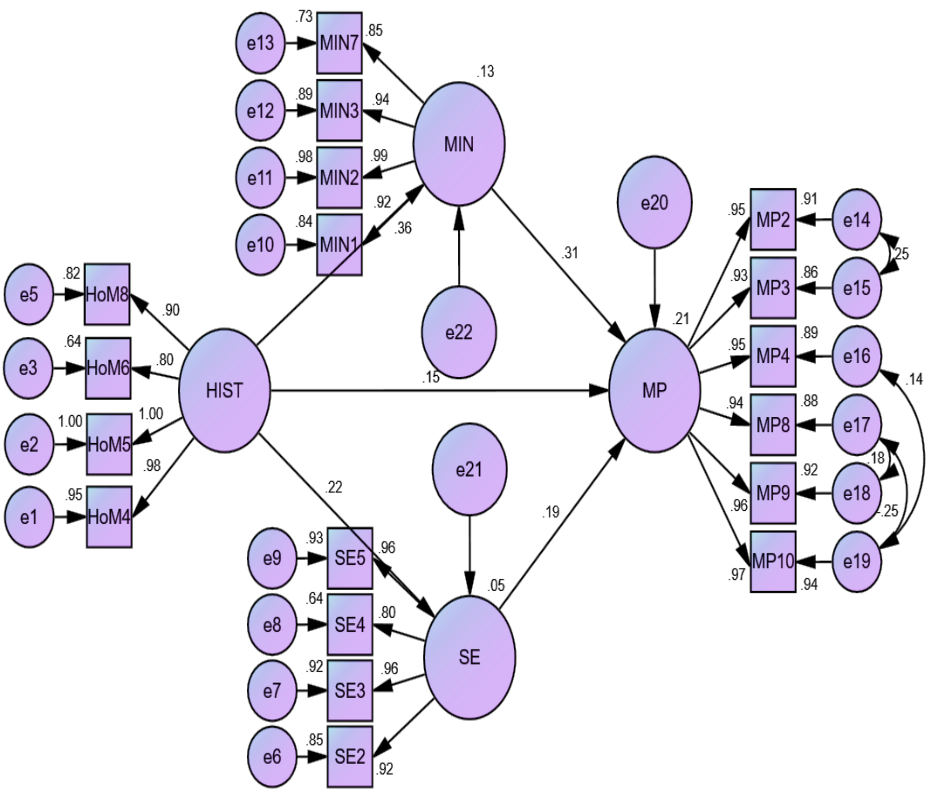
***Note:* β** *denotes the result for the standardized estimates result*

The first hypothesis (H1) proposed the history of mathematics to predict students' mathematics interests positively. From Table 3 we noticed that the history of mathematics has a positive effect and is statistically significant on students' mathematics interest ($\beta = .356$; C.R = 9.128). This implies a 35.6% positive effect on students' self-efficacy when mathematics teachers provide the history behind mathematics concepts. Hypothesis one (H1): "*History of Mathematics (HIST) positively predicts students'* mathematics interest" was accepted in this study.

The second hypothesis (H2) also proposed the history of mathematics to predict students' self-efficacy positively. From Table 3 we realize that the history of mathematics positively predicts students' self-efficacy in mathematics ($\beta = .224$; C.R = 5.333; *p-value* = 0.000). This further explains that the history of mathematics enhances the efficacy of university students by 22.9%. This means that, when the history of mathematics concepts is taught before introducing the main concept, it has a 22.4% positive effect on university students' efficacy in mathematics. Hypothesis two (H2): *"History of Mathematics (*HIST*) positively predicts students' self-efficacy",* was accepted in this study.

The third hypothesis (H3) also proposed mathematics interest to mediate the relationship between the history of mathematics (HIST) and performance. From Table 3 we realized that the history of mathematics (HIST) significantly predicted mathematics interest, while mathematics interest had a significant effect on performance. Despite the existence of mathematical interest, the mediating effect led to a partially positive outcome because performance is significantly predicted by the history of mathematics (HIST). The indirect effect of mathematics interest was conducted using a bootstrap of 5000 samples to determine whether the indirect effect is significant. From Table 5, we found that the mediating effect of mathematics interest in the relationship between the history of mathematics (HIST) and the performance had an effective size of .068 and was significant, where the lower and upper values are .033 and .113 respectively do not fall in between zero. Hypothesis three (H3*): "Mathematics interest mediates the relationship between the history of mathematics (HIST) and mathematics performance",* was accepted in this study.

Structural paths



The last hypothesis (H4) also predicted self-efficacy to mediate the relationship between the history of mathematics (HIST) and performance. From Table 3 we realized that the history of mathematics (HIST) significantly predicted self-efficacy, while self-efficacy significantly affected performance. Since the history of mathematics (HIST) significantly predicts performance, the mediating effect resulted partially despite the presence of mathematics interest. The indirect effect of mathematics interest was conducted using a bootstrap of 5000 samples was also used to determine whether the indirect effect (SE) is significant. From Table 5, we found that the mediating effect of SE in the relationship between the history of mathematics (HIST) and the performance had an effective size of .057 and was significant, where the lower and upper values are .031 and .094 respectively do not fall in between zero. Hypothesis four (H4): *"Self-efficacy mediates the relationship between the history of mathematics (HIST) and mathematics performance",* was accepted in this study. *Figure 3* illustrates the direct effect result as presented in *Table 3*

DISCUSSION AND CONCLUSIONS

The researchers examine how mathematics interest and self-efficacy as mediators influence the relationship between the history of mathematics (HIST) and performance. First, the study postulates that the history of mathematics (HIST) predicts university students' mathematics interests. The analysis supported this idea. This result suggests that the inculcating history of mathematical concepts fosters university students' mathematics interest. This supports several empirical theories. The current results aligned with the findings of Arthur (2022), who's findings revealed that the history of mathematics (HIST) had a significant positive effect on students' mathematics interest . Similarly, Rogers and Pope (2019) explored the influence of the history of mathematics (HIST) on 11^{th}-grade student's mathematics interests. Their study revealed that various aspects of the history of mathematics (HIST), including stories, tales, documentaries, and biographies, positively influenced students' mathematics interests, consistent with the current study's findings. Additionally, Shara (2020) found that the history of mathematics (HIST) had a direct and significant influence on students' mathematics interests.

Further, the empirical results of this study revealed that the history of mathematics (HIST) had a significant positive effect on students' self-efficacy. This result validates previous research by Arthur et al. (2024), which found that TVET students' interest in mathematics increased when the History of mathematics was taught during lectures. Shara (2020), also found that the history of mathematics (HIST) positively influenced students' self-efficacy. Similarly, the findings are consistent with Jahnke et al. (2022), who demonstrated that the history of mathematics (HIST) had a significant direct effect on students' mathematics abilities.

From the analysis result presented for Hypothesis 3, researchers noticed that mathematics interest was the mechanism through which the history of mathematics (HIST) affects performance among university students. The results indicated a partial mediation effect, as both the upper and lower bound of the indirect erect were positive and did not include zero. The results revealed a 6.8% effect of the history of mathematics (HIST) on performance through mathematics interest. This funding was consistent with Arthur (2022), who also found that mathematics interest partially mediates the relationship between HIST and mathematics performance. Additionally, other studies (Arhin and Gideon, 2020; Lai, Zhang, and Chang, 2020; Safo, 2021) have identified mathematics interest as a significant factor influencing mathematics performance. These results support the conclusion that the history of mathematics (HIST) positively influences mathematics interest, positively affecting mathematics performance among university students.

Finally, the study revealed self-efficacy as another mechanism through which the history of mathematics (HIST) affects mathematics performance among university students. The results found that self-efficacy partially mediates the nexus between the history of mathematics (HIST) and mathematics performance among university students, since both the upper and lower bound did not include zero. The study found that there was a 5.7% indirect effect of the history of mathematics on performance through self-efficacy. This finding was consistent with Arthur (2022), who found that the history of mathematics had a significant positive effect on students’ mathematics performance. Similarly, Arthur et al. (2024) noticed that the history of mathematics had a significant positive effect on Technical and Vocational Education and Training (TVET) students' efficacy. The study suggests that future studies may consider technical and vocational education and training (TVET) students in other disciplines in universities within or outside Ghana to increase generalization. Moreover, Arifin and Kuningan (2021) in their study found that students’ self-efficacy positively correlated and had a statistically significant effect on their mathematics performance. Zarch and Kadivar (2006) also noticed that students’ efficacy positively influenced their mathematics performance. No empirical studies have been found to support the mediating role of self-efficacy in the relationship between the history of mathematics and mathematics performance among university students. The novelty of this study lies in the mediating role of self-efficacy in the nexus between the history of mathematics and mathematics performance among university students in Ghana.

The study examined the relationship between the history of mathematics and students' mathematics performance, emphasizing the mediating effects of students' interest in mathematics and their self-efficacy. The analysis was based on 351 students from the public in Ghana. The study analysis showed that the history of Mathematics (HIST) significantly predicts students' mathematics interests. Additionally, students' self-efficacy was significantly predicted by studying the history of Mathematics (HIST). Furthermore, the study found that students' mathematics interest partially mediates the relationship between the history of mathematics and students' mathematics performance. Finally, the study also found that the relationship between the history of mathematics (HIST) and students' mathematics performance was partially mediated by their self-efficacy. These findings indicate that fostering students' interest in mathematics and strengthening their self-efficacy through integrating the history of mathematics may significantly enhance their mathematics performance.

IMPLICATIONS

Theoretical Implications

This study contributes to the literature in four main ways. Firstly, the history of mathematics (HIST) had a significant positive effect on mathematics interest. Studies have largely focused on the history of mathematics (HIST) on students' mathematics interests (Arthur, 2022). Realizing that history of mathematics (HIST) can enhance students' mathematics interests. Secondly, the current study contributes to the literature by identifying that, the history of mathematics (HIST) has a significant positive effect on self-efficacy. The history of mathematics (HIST) has been studied in self-efficacy (Jahnke, Jankvist, and Kjeldsen, 2022). Thirdly, this study contributes to the literature by identifying mathematics interest partially mediating the relationship between the history of mathematics (HIST) and mathematics performance. Finally, this study also contributes to the literature by identifying the history of mathematics (HIST) to have a significant effect on self-efficacy which is in context with a study by Reed et al. (2019), and some studies also studied the effect of self-efficacy on mathematics performance (Özcan & Kültür, 2021). This study deviated from previous studies by identifying that self-efficacy partially mediates the relationship between the history of mathematics (HIST) and performance among university students.

Practical Implication

The positive effect of the history of mathematics on students' interest and self-efficacy suggests that incorporating the history of mathematics into the curriculum and instructional practices can effectively improve students' attitudes and beliefs toward mathematics. Teachers should be encouraged to learn about the history of mathematics concepts they teach and find ways to share relevant historical anecdotes to help students develop a growth mindset. By increasing students' interest in mathematics and their efficacy in their abilities, using the history of mathematics can lead to improved mathematics performance. The finding that students' mathematics interest and self-efficacy mediate the relationship between the history of mathematics and performance indicates that these factors play an important role in translating the benefits of the history of mathematics into improved achievement. Instructors should focus on cultivating interest and self-efficacy and incorporating the history of mathematics to maximize the positive impact on performance. Furthermore, professional development programs should be developed to help instructors learn about the history of mathematics which will help them to identify relevant historical connections for their courses, and develop strategies for integrating the history of mathematics into their teaching in an engaging way.

Limitations

This study contributed to the literature, but some limitations call for further studies. The study was confined to students pursuing Mathematics Education and Information Technology Education in a single public university in Ghana. Future studies may consider students in other disciplines related to mathematics in other universities within or outside Ghana to increase generalization. Moreover, the data were collected from two departments in a single university, thus Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). This study made use of two sample techniques: stratified and simple random sampling. The sample size for this study was 351 first-year students enrolled in BSc. Mathematics Education and BSc. Information Technology Education. Moreover, the study adopted a survey method for collecting data.

Suggestions for Further Studies

To be able to generalize the findings, further research should expand to include more programs at various universities to assess the broader impact of the history of mathematics (HIST). Additionally, incorporating both interviews and questionnaires could provide a more comprehensive view of university students' perspectives on integrating the history of mathematics (HIST) into teaching. Further studies could also employ a longitudinal design to examine the moderating effect of self-efficacy and mathematics interest in the relationship between the history of mathematics (HIST) and performance. Moreover, further studies could also look at various historical contexts in mathematics with their impact on students' mathematics interests, self-efficacy, and performance. Finally, further studies could examine the moderating effect of anxiety and the mediating effect of motivation on the relationship between the history of mathematics and mathematics performance among university students from diverse groups.

Recommendations

This study recommends that mathematics teachers and educational authorities invite historians of mathematics or mathematicians with a strong interest to give guest lectures. Moreover, mathematics teachers must use historical problems to engage students in problem-solving, showing they can tackle the same challenges as historical mathematicians. In addition, mathematics teachers should organize group projects where students collaboratively explore historical mathematical topics, fostering both interest and a deeper understanding. Finally, it is recommended that mathematics teachers facilitate discussions where students can share their thoughts on the historical aspects of the mathematics they are learning.

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Appendix A

QUESTIONNAIRE

Please take a few moments to complete this questionnaire, solely for academic purposes. A high level of anonymity and secrecy is guaranteed. The study assessed. There are no correct or incorrect replies. Please mark (√) where applicable. It will take roughly 20 minutes to complete the entire questionnaire.

Section A: History of Mathematics (HoM)

Q1. Please indicate your level of agreement or disagreement with the statement below. They have been rated as *1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, and 5-Strongly Disagree.*

Please Tick (√) in the box where appropriate.

CODE	HISTORY OF MATHEMATICS	1=SA	2=A	3=N	4=D	5=DS
HoM1	My lecturer integrates historical mathematical concepts into lessons to enhance my understanding.	[1]	[2]	[3]	[4]	[5]
HoM2	Learning about the historical development of mathematical concepts improves my interest in mathematics.	[1]	[2]	[3]	[4]	[5]
HoM3	My lecturer uses the history of mathematics to connect abstract concepts to real-world applications.	[1]	[2]	[3]	[4]	[5]
HoM4	History of mathematics makes mathematics class meaningful teaching.	[1]	[2]	[3]	[4]	[5]
HoM5	My lecturer relates historical discoveries in mathematics to modern problem-solving techniques.	[1]	[2]	[3]	[4]	[5]
HoM6	The history of mathematics in the course outline provides a variety of approaches for carrying out mathematics tasks.	[1]	[2]	[3]	[4]	[5]
HoM7	The inclusion of historical perspectives in mathematics lessons makes the subject more engaging.	[1]	[2]	[3]	[4]	[5]

HoM8	Mathematics lecturers explain mathematical ideas to students using material from the history of mathematics.	[1]	[2]	[3]	[4]	[5]
HoM9	Understanding the historical background of mathematical concepts improves my confidence in solving mathematical problems.	[1]	[2]	[3]	[4]	[5]

Section B: Self-Efficacy (SE)

Q2. Please indicate your level of agreement or disagreement with the statement below. They have been rated as *1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, and 5-Strongly Disagree.*

Please Tick (√) in the box where appropriate.

CODES	SELF-EFFICACY BELIEFS	1=SA	2=A	3=N	4=D	5=DS
SE1	I feel confident when using mathematics outside of school.	[1]	[2]	[3]	[4]	[5]
SE2	I feel confident enough to ask questions in my mathematics class.	[1]	[2]	[3]	[4]	[5]
SE3	I believe I can think like a mathematician.	[1]	[2]	[3]	[4]	[5]
SE4	I feel confident enough to ask questions in my mathematics class.	[1]	[2]	[3]	[4]	[5]
SE5	I get tense when I prepare for a mathematics test.	[1]	[2]	[3]	[4]	[5]
SE6	I get nervous when I have to use mathematics outside of school.	[1]	[2]	[3]	[4]	[5]
SE7	I worry that I will not be able to use mathematics in my future career when needed.	[1]	[2]	[3]	[4]	[5]
SE8	I am afraid to give an incorrect answer during my mathematics class.	[1]	[2]	[3]	[4]	[5]

SE9	I can do almost all the work in class if I don't give up.	[1]	[2]	[3]	[4]	[5]
SE10	I'm certain I can master the skills taught in class this year.	[1]	[2]	[3]	[4]	[5]

Section C: Mathematics Interest

Q3. Please indicate your level of agreement or disagreement with the statement below. They have been rated as *1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, and 5-Strongly Disagree.*

Please Tick (√) in the box where appropriate.

CODE	**Mathematics Interest**	**1=SA**	**2=A**	**3=N**	**4=D**	**5=DS**
MIN1	When it comes to mathematics, I am very self-assured.	[1]	[2]	[3]	[4]	[5]
MIN2	I'd like to stay away from math in college.	[1]	[2]	[3]	[4]	[5]
MIN3	I believe I am capable of learning complex math.	[1]	[2]	[3]	[4]	[5]
MIN4	I find mathematics to be unsettling.	[1]	[2]	[3]	[4]	[5]
MIN5	In a math lesson, I'm always under a lot of pressure.	[1]	[2]	[3]	[4]	[5]
MIN6	Even the prospect of having to solve a math issue makes me uneasy.	[1]	[2]	[3]	[4]	[5]
MIN7	Ever since elementary school, I have enjoyed math.	[1]	[2]	[3]	[4]	[5]
MIN8	I still enjoy mathematics despite my average grades in the subject.	[1]	[2]	[3]	[4]	[5]
MIN9	Attending math lessons is exciting for me.	[1]	[2]	[3]	[4]	[5]
MIN10	I enjoy providing accurate responses to math questions.	[1]	[2]	[3]	[4]	[5]

Section D: Mathematics Performance (MP)

Q4. Please indicate your level of agreement or disagreement with the statement below. They have been rated as *1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree, and 5-Strongly Disagree.*
Please Tick (√) in the box where appropriate.

CODE	Mathematics Performance	1=SA	2=A	3=N	4=D	5=DS
MP1	The ancient Greek mathematician Pythagoras is credited with the famous theorem that states: *"In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides."* I can find the length of the hypotenuse If a right triangle has legs of lengths 6 cm and 8 cm.	[1]	[2]	[3]	[4]	[5]
MP2	Leonardo Fibonacci introduced the Fibonacci sequence, where each term is the sum of the two preceding ones. The first few terms are: 1, 1, 2, 3, 5, 8, ... I can find the 8th term in the Fibonacci sequence.	[1]	[2]	[3]	[4]	[5]
MP3	Archimedes approximated π (pi) and developed formulas for circle measurements. I can find the radius of a circle if the circumference of a circle is 44 cm (use $\pi \approx 3.14$).	[1]	[2]	[3]	[4]	[5]
MP4	Al-Khwarizmi, known as the "Father of Algebra," introduced systematic methods for solving equations. I can find the value of x in the equation if $2x + 5 = 15$	[1]	[2]	[3]	[4]	[5]
MP5	Euclid's "Elements" laid the foundations of geometry. One of his postulates states: *"Through any two points, there is exactly one straight line."* I	[1]	[2]	[3]	[4]	[5]

	can find the sum of the interior angles of a pentagon.					
MP6	Isaac Newton co-developed calculus. If $f(x) = x^2 + 4x$, what is $f'(x)$, I can find the derivative of the function.	[1]	[2]	[3]	[4]	[5]
MP7	Blaise Pascal's triangle helps in binomial expansion. I can find the coefficient of x^2y^2 in the expansion of $(x + y)^4$ using Pascal's Triangle.	[1]	[2]	[3]	[4]	[5]
MP8	Carl Friedrich Gauss discovered a shortcut for summing arithmetic sequences. I can find the sum of the first 50 natural numbers $(1 + 2 + 3 + ... + 50)$.	[1]	[2]	[3]	[4]	[5]
MP9	Leonhard Euler formulated the equation $V - E + F = 2$ for polyhedra, where V = vertices, E = edges, and F = faces. If a cube has 8 vertices and 6 faces, I can find the number of edges of polyhedra.	[1]	[2]	[3]	[4]	[5]
MP10	Indian mathematician Brahmagupta played a key role in formalizing the concept of zero. If $3x = 0$, I can find the value of x.	[1]	[2]	[3]	[4]	[5]

This is the end of the questionnaires. Thank you for your time and your effort.