International Journal of Didactical Studies
Volume 6, Issue 2, 2025
https://doi.org/10.33902/ijods.202531438

Research Article

Examining the effect of student cognitive awareness and mathematics interest on mathematics achievement

Clement K. Asiedu Menlah[1] and Francis O. Boateng[2]

[1]*Wisconsin International University College, Ghana-Kumasi Campus, Ghana (ORCID: 0009-0008-2903-8850)*
[2]*Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Ghana (ORCID: 0000-0003-0197-7385)*

The research aimed to examine the effect of student cognitive awareness and mathematics interest on mathematics achievement. Using a descriptive-correlation design, the study targeted 6 second and third-year students studying Basic Statistics at Wisconsin International University College, with a total population of 1050 students. Utilizing a simple random sampling method, 290 questionnaires were distributed to these students. Data analysis employed a structural equation modeling (SEM). Results indicated that student cognitive awareness significantly positively influenced their mathematics achievement. Moreover, research revealed that students' passion for mathematics significantly impacted their mathematical success, demonstrating a notable and statistically significant effect. Additionally, a significant positive correlation emerged between mathematical achievement and curiosity. These findings underscore the importance of adopting a longitudinal approach in future studies to track changes in students' mathematical abilities, interest in mathematics, and cognitive awareness over time. Such an approach can provide valuable insights into the evolution of these factors and their influence on student outcomes.

Keywords: Cognitive awareness, Mathematics achievement, Mathematics interest

Article History: Submitted 8 October 2024; Revised 18 May 2025; Published online 2 July 2025

1. Introduction

Mathematics performance is a global concern due to its role in economic competitiveness, technological advancement, and individual career development. International assessments show significant disparities in students' mathematics proficiency, with 25% of 15-year-olds in participating countries not reaching the baseline level. This raises concerns about the adequacy of mathematics instruction, curriculum design, and student support systems globally. In Ghana and Sub-Saharan Africa, national performance trends mirror these global concerns, with low pass rates in core mathematics, particularly among students for the West African Senior School Certificate Examination [WASSCE]. Factors contributing to underperformance include limited teacher competency, insufficient instructional materials, poor student attitudes, and low cognitive engagement. The persistent struggle with mathematics achievement in Ghana raises questions about the effectiveness of existing teaching methods and the role of students' psychological and cognitive factors in academic success.

Mathematics is widely recognized as a foundational subject essential to academic development across disciplines and educational levels. Its application spans from basic problem-solving and logical reasoning to advanced areas such as statistics, algebra, and calculus, which are integral to success in science, technology, engineering, and mathematics [STEM] fields. According to Wang and Abdullah (2024), proficiency in

Address of Corresponding Author

Clement K. Asiedu Menlah, Wisconsin International University College, Ghana-Kumasi Campus, Ghana.

clement@wiuc-ghana.edu.gh

How to cite: Asiedu Menlah, C. K. & Boateng, F. O. (2025). Examining the effect of student cognitive awareness and mathematics interest on mathematics achievement. *International Journal of Didactical Studies, 6*(2), 31438. https://doi.org/10.33902/ijods.202531438

mathematics fosters critical thinking and analytical skills that are transferable to other subject areas and necessary for success in higher education. Moreover, mathematics serves as a gatekeeper subject; students who struggle with mathematics often face difficulties in accessing advanced educational opportunities (Amalia et al., 2024). In many national education systems, mathematics achievement is a key criterion for selection into competitive senior high schools, tertiary institutions, and specialized programs, highlighting its central role in shaping students' academic trajectories (Vicente et al., 2024). Beyond the classroom, mathematical competence has significant implications for career development and long-term economic outcomes. This emphasizes that mathematical literacy is critical for preparing learners for the 21st-century workforce—environments where data interpretation, quantitative reasoning, and financial decision-making are increasingly vital. Empirical studies show that integrating cultural context into lesson design enhances students' mathematical literacy (Kurniawan et al., 2024). Professions in fields such as engineering, economics, information technology, and health sciences rely heavily on mathematical knowledge, and employees with strong quantitative skills tend to enjoy better job prospects and higher salaries (Edwards et al., 2021). Furthermore, mathematical thinking enhances decision-making and problem-solving in everyday life, contributing to personal financial literacy and informed citizenship (Geiger et al., 2023). As such, improving students' interest and achievement in mathematics is not only an academic priority but also a socio-economic imperative.

Students around the world face a variety of challenges in learning mathematics, which often hinder their academic success and interest in the subject. One of the most frequently cited challenges is mathematics anxiety, which refers to feelings of tension, fear, or helplessness when engaging with mathematical tasks. This emotional response can significantly impair cognitive functioning and reduce students' ability to concentrate and perform well in mathematics assessments (Guo & Liao, 2022). Moreover, the abstract nature of mathematical concepts and the cumulative structure of the curriculum can make it difficult for students to grasp new topics without a solid understanding of prior content (Annala, 2022). This often leads to a cycle of confusion and disengagement. Research also indicates that instructional methods that emphasize rote memorization rather than conceptual understanding contribute to students' difficulties in applying mathematics in real-world contexts (Nilimaa, 2023). Another significant challenge lies in students' low self-efficacy and lack of cognitive engagement with mathematical content. Many students perceive mathematics as a difficult subject reserved only for "smart" individuals, which negatively affects their motivation and willingness to participate actively in learning (Chand et al., 2021). Additionally, factors such as poor teaching quality, large class sizes, and insufficient learning materials, especially in developing countries, compound the problem by creating environments where individualized support is limited (Major et al., 2021). Gender stereotypes and cultural beliefs also affect students' confidence, with girls in particular often being socialized to believe they are less capable in mathematics (Starr & Simpkins, 2021). These systemic and psychological barriers collectively contribute to persistent underperformance and widen the achievement gap among students, necessitating targeted interventions to promote inclusive, engaging, and confidence-building mathematics instruction.

Cognitive factors play a vital role in shaping students' academic achievement, particularly in mathematics. These factors include students' metacognition, working memory, problem-solving skills, and cognitive awareness, the ability to understand and regulate one's thinking processes during learning. Students with strong cognitive awareness are more likely to plan, monitor, and evaluate their learning effectively, leading to improved academic performance (Shekh-Abed, 2024). Research has shown that students who actively engage in cognitive strategies such as self-questioning, goal-setting, and error analysis perform better in mathematics because they approach problem-solving in a structured and reflective manner (Lai et al., 2025). Additionally, cognitive flexibility and the capacity to transfer prior knowledge to new contexts enhance students' ability to understand abstract mathematical concepts (Scheibling-Sève et al., 2022). Thus, fostering cognitive awareness is essential in helping students become independent learners and overcome the complexities of mathematics learning. Alongside cognitive processes, affective factors such as interest, motivation, self-efficacy, and attitude toward mathematics significantly influence students' academic achievement. Among these, mathematical interest has been identified as a powerful predictor of sustained engagement and performance. When students find mathematics meaningful or enjoyable, they are more likely to invest effort, persevere through challenges, and develop deeper conceptual understanding (DiNapoli, 2023). Interest acts as a motivational driver that fuels curiosity and active participation, even in the face of academic difficulty. According to Zhu and Kaiser (2022), students who are emotionally connected to mathematics demonstrate higher learning gains and stronger achievement outcomes. Furthermore, affective factors can influence the development of cognitive skills; for example, students with high interest are more likely to engage in metacognitive reflection and problem-solving strategies (Thomas et al., 2022). This interplay highlights the importance of nurturing both cognitive and affective domains in mathematics instruction to promote holistic academic success.

Cognitive awareness refers to an individual's ability to recognize, regulate, and evaluate their own thinking and learning processes, commonly associated with metacognition and self-regulated learning. Metacognition includes two major components: knowledge about cognition (e.g., awareness of strategies, personal learning strengths and limitations) and regulation of cognition (e.g., planning, monitoring, and evaluating learning tasks) (Shekh-Abed, 2024). Cognitive awareness enables learners to make informed decisions about how to approach problem-solving, manage cognitive load, and transfer knowledge across different contexts. Research has shown that students with high cognitive awareness tend to be better at organizing their thoughts, selecting appropriate problem-solving strategies, and reflecting on mistakes, which in turn contributes to higher mathematics achievement (Zhang & Wang, 2020). In mathematics specifically, this awareness allows learners to navigate abstract concepts, monitor their understanding during multistep tasks, and self-correct errors, all of which are critical to academic success. Mathematics interest, on the other hand, is an affective-motivational construct that refers to a student's emotional engagement, curiosity, and enjoyment in learning mathematics. Interest can be situational, triggered by a specific context or task, or individual, reflecting a long-term disposition toward mathematics as a subject (Khormi, 2022). Students who find mathematics interesting are more likely to engage deeply with learning materials, persist through challenges, and develop intrinsic motivation (Amjad et al., 2023). Studies have consistently shown that mathematical interest significantly predicts achievement outcomes. For example, Luo et al. (2024) found that interest had a direct, positive effect on 8th-grade students' mathematics performance in China. Similarly, Arthur (2019) demonstrated that interest had a strong positive impact on undergraduates' math achievement, suggesting that emotional engagement enhances effort and achievement. Thus, both cognitive awareness and mathematics interest, although distinct, play complementary roles in fostering academic success in mathematics by shaping how students think and feel about learning.

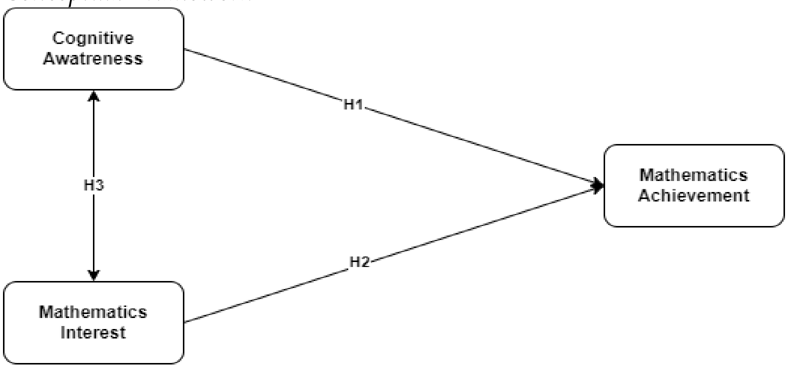
While substantial research has explored the individual influence of cognitive factors such as metacognition and affective factors like interest on academic achievement, relatively few studies have examined how these variables interact within a unified model to predict mathematics performance. Cognitive awareness contributes to how students process information and regulate their learning, whereas mathematics interest influences emotional engagement and motivation. However, much of the existing literature isolates these constructs, failing to capture their potential synergistic effect on mathematics achievement (Yu et al., 2024). In the Ghanaian context and broader sub-Saharan Africa, studies integrating both cognitive awareness and mathematics interest in a combined analytical model remain sparse. Most local research tends to focus on broader factors such as teaching quality, infrastructural challenges, or curriculum issues (Guàrdia et al., 2021). Moreover, there is a noticeable lack of data involving senior high school students, a critical population preparing for tertiary education, and national assessments like the WASSCE. Despite national concerns over poor performance in mathematics, evidenced by repeated low pass rates in core mathematics at the SHS level, limited studies have assessed the psychological drivers behind students' outcomes. Recent work by Asare et al. (2025a) acknowledged that both cognitive awareness and interest contribute to achievement, but called for more localized, quantitative research that integrates these dimensions into a single explanatory framework. This gap underscores the need for further empirical investigation within local educational settings to inform effective interventions and curriculum design.

1.1. Conceptual Framework

The conceptual framework underpinning this study draws upon Bandura's (1997 as cited in Leong, 2014) social cognitive theory, which posits that cognitive processes, environmental factors, and individual characteristics interact dynamically to shape behavior and achievement outcomes. Within this framework, students' cognitive awareness serves as a cognitive mediator, influencing their engagement with mathematical tasks and strategies. Concurrently, their interest in mathematics acts as a motivational catalyst, driving their investment of effort and persistence in learning activities.

The conceptual framework of the study is depicted in Figure 1. As depicted in the figure, the study's independent variables include mathematical achievement and cognitive awareness, while the dependent variable is math achievement. Moreover, Figure 1 visually represents the evident relationship between mathematical success and cognitive awareness, as well as interest in mathematics (H1 and H2). Additionally, the figure illustrates the connection (H3) between mathematical curiosity and cognitive awareness.

Figure 1
Conceptual Framework



The following hypotheses were tested in this study:

H_1: Cognitive awareness significantly predicts mathematics achievement (H1).
H_2: Mathematics interest significantly predicts mathematics achievement (H2).
H_3: There is a correlation between cognitive awareness and mathematics interest (H3).

2. Method

2.1. Research Design

The present study employed a descriptive-correlational research design, which is commonly used to examine the relationships among variables without altering or controlling them. This design allows researchers to gather detailed information about the current status of variables as they naturally occur. In this context, the study explored how epistemological beliefs, reflective thinking, and mathematics interest are associated with students' mathematics performance, based on observed data rather than experimental manipulation. Descriptive-correlational design, also referred to as observational correlational design, is particularly useful when the goal is to identify patterns, trends, or associations among variables in a given population. It does not aim to establish cause-and-effect relationships but rather to highlight whether and how variables are linked. By focusing on naturally existing behaviors and perceptions, this design supports the development of theoretical frameworks and informs future experimental studies.

2.2. Participants

The target population for the current study includes a total of 1,050 undergraduate students enrolled in the Basic Statistics course at Wisconsin International University College, Kumasi Campus, Ghana. These students are drawn from both Level 200 and Level 300 cohorts, representing second and third-year students, respectively, across various academic disciplines within the university. These students were selected because Basic Statistics is a core course that incorporates mathematical concepts and applications, making them relevant for a study on mathematical performance. Since they are actively engaged in learning mathematics as part of their academic curriculum, their experiences, beliefs, and levels of interest in mathematics provide a suitable foundation for investigating how epistemological beliefs, reflective thinking, and mathematics interest predict overall performance in the subject.

This study adopted a dual approach to sampling by combining stratified sampling and simple random sampling to ensure a more representative and unbiased selection of participants. Stratified sampling was first employed to divide the student population into distinct subgroups, or strata, based on their educational level (e.g., first year, second year, third year). Once the students were grouped into these strata, simple random sampling was then applied within each group. Together, these sampling strategies helped the researchers achieve a balanced and representative sample for examining the predictive relationships among the variables under study. Sample group of the study included 290 undergraduate students.

2.3. Instruments

The questionnaire for this study was carefully constructed to reflect three key constructs: cognitive awareness, mathematics interest, and mathematics performance. To measure cognitive awareness, five items were adapted from the validated instrument developed by Bayat and Meamar (2016), with appropriate modifications made to suit the current study's context. Similarly, the construct of mathematics interest was assessed using five items drawn from the work of Asare et al. (2024) and Arthur et al. (2025), both of which were modified to align with the target population and research objectives. In assessing mathematics performance, five test-based questions were adapted and refined from the study conducted by Edo et al. (2024), ensuring relevance and clarity for the participants. All items in the questionnaire were rated using a five-point Likert scale to capture varying levels of agreement, ranging from 1 (strongly agree) to 5 (strongly disagree). This scaling approach allowed for the quantification of students' self-reported beliefs, interests, and achievement levels, providing robust data for statistical analysis and interpretation.

2.4. Data Analysis

The data gathered for this research study were analyzed using two statistical software packages: SPSS version 23 and AMOS version 23. SPSS was primarily utilized during the initial stages of data analysis to explore the structure and consistency of the measurement tools used. Specifically, the study employed Exploratory Factor Analysis [EFA] in SPSS to identify the underlying factor structure of the constructs measured and to ensure that the questionnaire items effectively represented the theoretical variables. This helped determine whether the data were suitable for further structural modeling. In addition to EFA, reliability analysis was conducted using SPSS to assess the internal consistency of each scale in the questionnaire. This involved calculating reliability coefficients, such as Cronbach's alpha, to confirm that the items within each construct consistently measured the same underlying concept. High reliability scores indicated that the data were dependable and suitable for advanced statistical modeling and hypothesis testing. Following these preliminary analyses, the study proceeded with more advanced statistical procedures using AMOS version 23. This software was employed to conduct Confirmatory Factor Analysis [CFA], which tested whether the data fit the hypothesized measurement model. Additionally, AMOS was used to examine discriminant validity, ensuring that the constructs measured were distinct from each other. Finally, the software was used to test the structural model and analyze the hypothesized pathways among epistemological beliefs, reflective thinking, mathematics interest, and mathematics performance, providing insights into the predictive relationships between these variables.

3. Findings

3.1. Findings regarding the Validity and Reliability of the Scales

3.1.1. Exploratory factor analysis

To assess the alignment of measurement items with their respective latent variables, we initiated an exploratory factor analysis using SPSS (v.23). Our investigation focused on three latent variables pertinent to Basic Statistics that level 200 and 300 students: cognitive awareness, mathematics interest, and mathematics achievement. Following the EFA, items exhibiting low loading (below 0.5) or displaying cross-loading across constructs were eliminated from further analysis (Akendita et al., 2025; Asare & Boateng, 2025). This criterion guided the removal of five measurement items from the latent variables. The total variance extracted [TVE] from the EFA outcomes amounted to 79.121%, surpassing the anticipated threshold of 50%. Table 1 presents the exploratory factor analysis results.

To determine whether the sample was suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was applied. The KMO result obtained was 0.877, which is well above the generally accepted minimum threshold of 0.60. This indicates that the data were sufficiently compact and appropriate for conducting Exploratory Factor Analysis (EFA). A high KMO value like this suggests that patterns of correlations are relatively distinct and reliable for identifying underlying factor structures. In addition to the KMO, Bartlett's Test of Sphericity was conducted to assess whether the correlation matrix among the items was significantly different from an identity matrix (which would imply no relationships among variables). The test yielded a highly significant result ($\chi^2 = 3079.922$; $p < .001$), confirming that the items are sufficiently interrelated and that factor analysis is appropriate. This finding supports the assumption that there is a strong enough correlation structure among the observed variables to proceed with EFA. Furthermore, the determinant of the correlation matrix was computed and found to be 3.21×10^{-6}, a value that suggests the matrix is positively definite. This means that multicollinearity (extremely high correlations between items) is not a concern, and the dataset maintains mathematical properties necessary for accurate factor extraction. For a more detailed breakdown and interpretation of the factor structure obtained through the EFA, readers are referred to Table 2 in the results section.

Table 1
Exploratory Factor Analysis (EFA)

Rotated Component Matrix			
Measurement Item	*Component*		
	1	*2*	*3*
cog2			.882
cog3			.908
cog4			.905
cog5			.893
int1	.726		
int2	.871		
int3	.883		
int4	.864		
int5	.827		
ma1		.794	
ma2		.784	
ma3		.865	
ma4		.851	
ma5		.864	
KMO and Bartlett's Test			
TVE			79.121
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.877
Bartlett's Test of Sphericity	Approx. Chi-Square		3079.922
	df		91
	Sig.		<.001
Determinant			3.21E-06

Note. Extraction Method: Principal Component Analysis; a. 3 components extracted.

3.1.2. Confirmatory factor analysis

Within Amos (v.23), a confirmatory factor analysis [CFA] was conducted utilizing the variables retained from the exploratory factor analysis (see Figure 2). It was anticipated that standardized factor loadings from the CFA would be at least 0.5, consistent with the EFA findings, which indeed aligned with the results of our inquiry (refer to Table 5). The noteworthy factor loadings for mathematical achievement (0.727), mathematical interest (0.753), and cognitive awareness (0.844) indicate that each test item effectively elucidated its respective latent variable. Ensuring a precise fit between the dataset and the calculated model entails assessing model fit indices during confirmatory factor analysis. As per Fornell and Larcker (2014) the satisfactory fit is indicated by the following criteria: RMSEA and SRMR below 0.08; TLI and CFI exceeding 0.9; PClose statistically insignificant (> 0.05); CMIN/DF less than 3, which is supported by earlier studies such as Asare et al. (2025a, 2025b) and Michael et al. (2025). All latent variables in our dataset met these criteria. Specific findings from the confirmatory factor analysis are detailed in Table 2.

From Table 2, the number of measurement items for cognitive awareness whose loading was above the minimum threshold of 0.5 are cog2, cog3, cog4, and cog5. Moreover, the measurement items for mathematics interest, whose loadings were above the minimum threshold, are int1, int2, int3, int4, and int5. In addition, the measurement items for mathematics achievement whose loading was above the minimum threshold of 0.5 were ma1, ma2, ma3, ma4, and ma5. Furthermore, Cronbach's Alpha [CA] was calculated for the retained variables utilizing SPSS (v.23), with a minimum expected alpha value set at 0.7. This analysis was conducted separately for each of the three latent variables (see Table 2), demonstrating strong internal consistency among the measurement items. Additionally, all latent variables exhibited composite reliability [CR], which was expected to meet or exceed 0.7, as suggested by Asare (2024). Specific reliability results are detailed in Table 2.

Figure 2
Confirmatory Factor Analysis

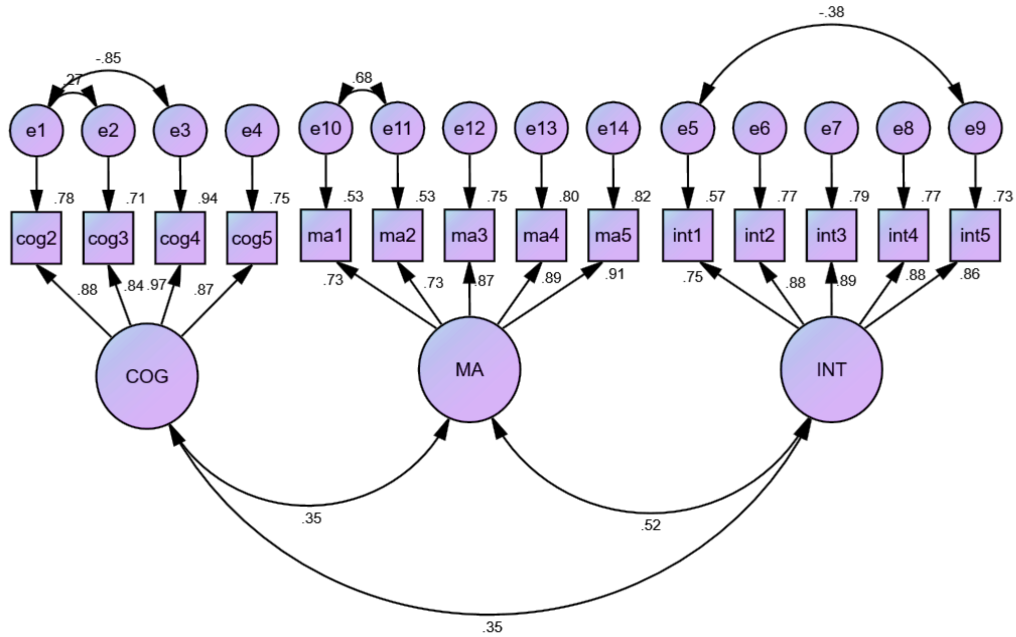


Table 2
Confirmatory Factor Analysis

Model Fitness*: CMIN = 113.567; DF = 70; CMIN/DF = 1.622; TLI = .981; CFI = .986; GFI = .940; RMR = .053; RMSEA = .050; PClose = 0.481;*	**Std. Loadings**
Cognitive Awareness (cog); CR = .939; CA= .937; AVE= .795;	
cog1: Before I reply, I carefully consider my options for the situation.	#
cog2: I attempt to utilize strategies that have yielded successful outcomes in the past.	.883
cog3: Following an exam, I am aware of my performance level.	.844
cog4: I intentionally focus my attention on the most vital facts.	.968
cog5: I possess strong skills in retaining knowledge.	.866
Mathematics Interest (int); CR = .930; CA= .889; AVE = .726;	
int1: My math teacher assigns homework, and I detest doing it.	.753
int2: When it comes to arithmetic, I usually give up easily.	.876
int3: I have a desire to delve deeper into the study of mathematics.	.889
int4: I find myself solving math problems more frequently than I find enjoyment in doing so.	.878
int5: I don't particularly fancy engaging in mathematics discussions.	.856
Mathematics Achievement (ma); CR = .915; CA = .923; AVE = .686;	
ma1: Among all subjects, mathematics is the one I am most passionate about.	.728
ma2: Typically, I excel in arithmetic.	.727
ma3: I struggle to achieve a passing grade in arithmetic.	.865
ma4: I do achieve high grades in math.	.893
ma5: I feel delighted when I can solve arithmetic questions	.907

Note: # indicates measurement item(s) whose loading is/are below the minimum threshold of 0.5.

3.1.3. Discriminant validity

Achieving discriminant validity is recognized when the square root of Average Variance Extracted exceeds the intercorrelation scores (dos Santos & Cirillo, 2023; Shrestha, 2021; Tian et al., 2021). Before comparison, intercorrelation coefficients were assessed to determine significant connections among variables, particularly independent ones. Correlation coefficients exceeding 0.7 are considered high. The highest statistically significant correlation coefficient observed in Table 3 was 0.523 (between mathematics interest and mathematics achievement). The correlation between mathematics interest and mathematics achievement, with mathematics interest as the independent variable and mathematics achievement as the dependent variable, was 0.523. Table 3 presents the result for the discriminant validity.

Table 3
Discriminant Validity

Variables	*CR*	*AVR*	*COG*	*INT*	*MA*
COG	.939	.795	.891		
INT	.930	.726	.351**	.852	
MA	.915	.686	.354***	.523***	.828

Upon comparing AVE with intercorrelation coefficients, it became evident that AVE consistently exceeded the corresponding correlation coefficients, affirming the attainment of discriminant validity for each variable. Control variables lacked AVE for comparison. To confirm the convergence of CFA measures based on their factor loadings, Average Variance Extracted (AVE) was utilized. According to Roemer et al. (2021), an AVE value exceeding 0.5 indicates satisfactory convergent validity and unidimensionality. The fact that all AVEs in Table 3 surpassed 0.5 underscores the sufficient convergent validity of our constructs.

3.2. Findings regarding SEM Analysis

The study focused on examining the impact of cognitive awareness and mathematics interest on mathematics achievement. The hypothesized path results are presented in Table 4 and Figure 3.

Table 4
Hypothesized Paths

Hypothesized Paths	**Std. Estimate**	**S.E.**	**C.R.**	**p**
COG→MA	.189	.054	3.500	.002
INT→MA	.464	.069	6.723	***
COG↔INT	.354	.051	6.941	***

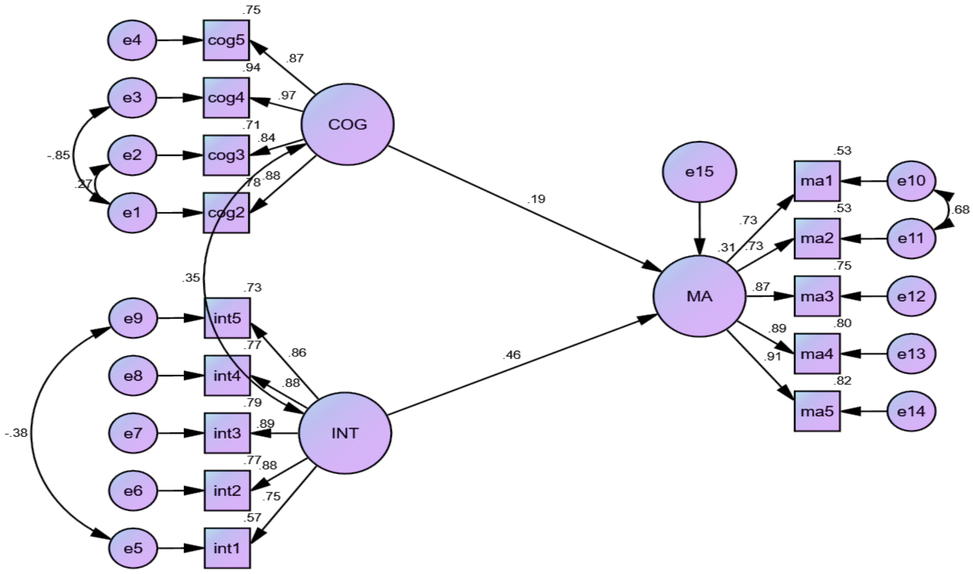
Note. ***: $p < .01$.

The research hypothesis one (1) aimed to determine whether cognitive awareness significantly predicts mathematics achievement (H_1). This was analyzed by the direct effect of (COG→MA). According to the findings analysis in Table 4, a standard estimate of .189, a standard error of .054, a critical ratio of 5.500, and a p-value denoted as (***) which is less than 1% suggests a very high level of statistical significance, indicating a strong positive effect students’ cognitive awareness in mathematics learning on their mathematics achievement. The findings also demonstrate a favorable effect of cognitive learning in Mathematics learning on mathematics achievement, which is estimated to be 18.9%. Therefore, Hypothesis One (H_1) is accepted for the study.

Furthermore, the second research hypothesis (H2) aims to ascertain whether mathematics interest significantly predicts mathematics achievement. The direct effect of mathematics interest on students' mathematics achievement was analyzed (INT→MA). Table 4 presents the direct effect of mathematics interest on mathematics achievement, with a standard estimate of 0.464, a standard error of .069, a critical ratio of 6.723, and a *p*-value denoted as *** indicating a significant level less than 1% which signifies a very high level of statistical significance, indicating a strong relationship between "INT" and "MA." The outcome indicates a 46.4% positive effect of mathematics interest on mathematics achievement. Therefore, hypothesis two (H2) is accepted in the current study.

Lastly, the final study hypothesis examines whether there is a significant correlation between students' enthusiasm for mathematics and their cognitive awareness. The direct effect of (COG↔INT) was utilized to explore the relationship between mathematical interest and cognitive awareness. The results revealed a standard estimate of .354, a standard error of .051, a critical ratio of 6.941, and a p-value of .000. The p-value indicates that this association is statistically significant. This indicates that students' interest in mathematics is positively and statistically significantly correlated with their cognitive awareness. The link between students' interest in mathematics and their cognitive awareness has not been investigated in previous research.

Figure 3
Path Analysis



4. Discussion

The findings of the present study demonstrated that cognitive awareness significantly and positively influences students' mathematics performance. This implies that students who possess a better understanding of their cognitive processes, such as planning, monitoring, and evaluating their learning, tend to perform better in mathematics. This result supports earlier research by Bayat and Meamar (2016), who found a strong connection between students' cognitive awareness and their achievement in algebra. Their study emphasized that students who are more aware of how they learn are better equipped to tackle mathematical challenges. Similarly, Bahrami's (2015) explored the combined effect of achievement goals and cognitive awareness on the academic performance of third-grade boys at the high school level in Kamyaran. Their results revealed that cognitive awareness had a significant and positive impact on students' mathematics achievement. This aligns closely with the current study's conclusion, reinforcing the idea that cognitive awareness plays a critical role in enhancing students' performance by enabling them to set learning goals and engage with mathematical tasks more effectively. In further support of this relationship, Semeraro et al. (2020) investigated the predictive role of both cognitive and non-cognitive factors on mathematics achievement. Their findings confirmed that cognitive awareness is a strong and consistent predictor of success in mathematics. This suggests that among various personal attributes, the ability to understand and regulate one's thinking processes is a crucial determinant of academic success in mathematics. The consistent evidence from multiple studies underscores the importance of fostering cognitive awareness in educational settings to support student achievement in mathematics.

The findings of the current analysis revealed that students' interest in mathematics plays a crucial role in enhancing their academic achievement in the subject. A statistically significant positive relationship was found, suggesting that the more students are interested in mathematics, the higher their performance tends to be. This result is consistent with earlier research by Zhang and Wang (2020), who examined eighth-grade students across four provinces in China. Their study demonstrated that mathematics interest directly and significantly influenced students' achievement in the subject. Similarly, Arthur (2022) conducted a study at the AAMUSTED-Kumasi Campus, focusing on first-year undergraduate students. Their research explored how student interest mediates the relationship between performance and factors such as motivation, peer-assisted learning, and teaching quality. Their findings revealed a strong and significant direct effect of mathematics interest on performance, indicating that student interest contributed to a 61.8% increase in mathematics performance. This supports the current study's result, which found a 43.5% positive effect of mathematics interest on students' mathematics achievement. Further supporting evidence comes from the work of Asare et al. (2023) and Bright et al. (2024), both of whom reported a significant positive association between mathematics interest and mathematics performance among students. These studies collectively reinforce the idea that cultivating students' interest in mathematics can lead to better learning outcomes. The consistency across these findings highlights the essential role of mathematics interest as a key determinant of academic success in the subject.

The findings of the study demonstrated that cognitive awareness significant and positive relationship with students' interest in mathematics. This indicates that when students are more aware of their cognitive processes, such as how they think, learn, and solve problems, they are more likely to develop a strong interest in mathematics. This positive relationship suggests that enhancing students' metacognitive skills can lead to increased engagement and curiosity in mathematical learning. Cognitive awareness empowers students to take ownership of their learning by reflecting on their strategies and understanding, which can make the subject more meaningful and enjoyable to them. This result makes a valuable contribution to the existing body of literature by highlighting the role of cognitive awareness as a critical factor in fostering mathematics interest. While previous studies have often focused on external motivators or teaching strategies, this study emphasizes the importance of internal cognitive processes in shaping students' attitudes toward mathematics. Studies in recent years underscore the interplay between motivation, interest, and cognitive functioning in mathematical contexts. For example, Varveris et al. (2023) emphasized that students who exhibit higher interest in mathematics are more likely to engage in metacognitive regulation, which enhances their strategic thinking and awareness during problem-solving. Similarly, Schöpfer and Hernandez (2024) found that intrinsic motivation, of which interest is a critical component, strongly predicts students' use of deep cognitive strategies and higher-order thinking skills. Further supporting evidence is presented by Vattøy and Gamlem (2024), who demonstrated that students' emotional and cognitive engagement in mathematics tasks, driven by personal interest, leads to heightened self-monitoring, reflection, and a better understanding of their own learning processes. These components align with the construct of cognitive awareness. Recent longitudinal studies have also confirmed the directionality of this relationship. Hashim et al. (2021) noted that students with consistent interest in mathematics over time exhibited significant gains in cognitive engagement and awareness, which contributed to more effective learning habits and improved academic outcomes. A more recent study by Drakatos and Drigas (2024) explored interest and executive functions in STEM education. The findings indicated that interest not only influences attention and effort but also correlates positively with students' ability to plan, monitor, and evaluate their cognitive processes, again reinforcing the cognitive awareness component.

5. Conclusion, Suggestions for Further Studies, and Recommendations

The study population consisted of students enrolled in Basic Statistics at Wisconsin International University College, Ghana-Kumasi Campus, totaling 1050 students. Stratified and random sampling techniques were employed to select a sample of two hundred and ninety students from the total population. The study adopted a descriptive-correlational design, utilizing exploratory factor analysis, confirmatory factor analysis, discriminant validity, and hypothesized path analysis for analysis. The findings revealed that both cognitive awareness and mathematics interest had a direct, positive, and significant effect on mathematics achievement. Additionally, a strong positive relationship was observed between students' cognitive awareness and their mathematics interests. The study suggests that future research should include level 100 students to provide valuable insights into the study results. Furthermore, extending the study to include additional universities would yield diverse results. Similarly, conducting a similar study at the secondary level of education in Ghana could be beneficial. Finally, the study recommends that future research consider implementing a longitudinal research design to track changes in student cognitive awareness, mathematics interest, and mathematics achievement over time. Such an approach could offer valuable insights into the developmental trajectories of these factors and their impact on student outcomes.

Acknowledgements: The authors would like to thank the Heads of Department at the Wisconsin International University College and students who contributed in diverse ways towards the successful completion of this research article.

Author contribution: All the authors were involved in concept, design, collection of data, interpretation, writing, and critically revising the article. Authors approve final version of the article.

Data Availability: The corresponding author has access to the data supporting the findings of this study upon request.

Declaration of interest: The authors have no conflict of interest to declare regarding the content of this article.

Ethics declaration: The authors stated that the study was approved by the Mathematics Education Research

Ethics Committee of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) on 24th March 2024. Written informed consent was obtained from the Heads of the Departments and lecturers, as well as from the students.

Funding: No funding source is reported for this study.

References

Akendita, P. A., Arthur, Y. D., & Asare, B. (2025). Moderating effect of teacher efficacy on the relationship between students perception of mathematics and students mathematics achievement. *International Journal of Didactical Studies, 6*(1), Article 28932. https://doi.org/10.33902/ijods.202528932

Amalia, L., Makmuri, M., & Hakim, L. El. (2024). Learning design: to improve mathematical problem-solving skills using a contextual approach.*Jurnal Ilmiah Ilmu Pendidikan*, *7*(3), 2353–2366. https://doi.org/10.54371/jiip.v7i3.3455

Amjad, A. I., Habib, M., Tabassum, U., Alvi, G. F., Taseer, N. A., & Noreen, I. (2023). The impact of brain-based learning on students' intrinsic motivation to learn and perform in mathematics: a neuroscientific study in school psychology. *International Electronic Journal of Elementary Education*, *16*(1), 111–122. https://doi.org/10.26822/iejee.2023.318

Annala, J. (2022). Disciplinary knowledge practices and powerful knowledge: a study on knowledge and curriculum structures in regions. *Teaching in Higher Education*, *27*(8), 1084–1102. https://doi.org/10.1080/13562517.2022.2114340

Arthur, Y. D. (2019). Students mathematics interest in senior high schools: empirical evidence from ashanti region of Ghana. *Asian Research Journal of Mathematics*, *15*(3), 1–14. https://doi.org/10.9734/arjom/2019/v15i330147

Arthur, Y. D. (2022). Modeling student ' s interest in mathematics : Role of history of mathematics , peer-assisted learning , and student ' s perception. *Eurasia Journal of Mathematics, Science and Technology Education, 18*(10), Article em2168.

Arthur, Y. D., Vittori, T. De, Welcome, N. B., Dogbe, C. S. K., & Asare, B. (2025). Enhancing TVET students ' interest in mathematics through the history of mathematics and self-efficacy. *Journal of Applied Research in Higher Education*. Advance online publication. https://doi.org/10.1108/JARHE-05-2024-0238

Asare, B. (2024). Moderating effect of teacher–student relationship and mediating role of self-efficacy on the relationship between peer-assisted learning and mathematics performance. *Frontiers in Education*, *9*, 1450499. https://doi.org/10.3389/feduc.2024.1450499

Asare, B., Arthur, Y. D., & Adu, O. B. (2024). Mathematics interest and self-efficacy : exploring the relationship between the history of mathematics and mathematics performance. *American Journal of STEM Education: Issues and Perspectives, 7*, 51–80. https://doi.org/10.56855/ajste/v7n2024-51-80

Asare, B., Arthur, Y. D., & Al-hassan, A.-M. (2025a). Mediating role of student self- efficacy on the nexus between cognitive awareness and student math performance. *Journal of Applied Research in Higher Education*. Advance online publication. https://doi.org/10.1108/JARHE-07-2024-0365

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

Asare, B., Arthur, Y. D., & Obeng, B. A. (2025b). Modeling motivation : The effect of peer teaching on mathematics achievement. *International Journal of Didactical Studies*, *6*(2), 30243. https://doi.org/10.33902/ijods.202530243

Asare, B., & Boateng, F. O. (2025). Self-awareness and self-regulatory learning as mediators between ChatGPT usage and pre-service mathematics teacher ' s self-efficacy. *Journal of Pedagogical Research, 9*(2), 38–54. https://doi.org/10.33902/JPR.202530637

Bahrami, D., & Bahrami, M. A. (2015). The relationship of self-esteem and achievement goals with academic performance. *African Journal of Basic & Applied Sciences*, *7*(1), 65–72.

Bayat, S., & Meamar, A. (2016). Predicting algebra achievement: cognitive and meta-cognitive aspects. *Procedia - Social and Behavioral Sciences*, *217*, 169–176. https://doi.org/10.1016/j.sbspro.2016.02.054

Bright, A., Welcome, N. B., & Arthur, Y. D. (2024). The effect of using technology in teaching and learning mathematics on student's mathematics performance: The mediation effect of students' mathematics interest. *Journal of Mathematics and Science Teacher*, 4(2), em059. https://doi.org/10.29333/mathsciteacher/14309

Chand, S., Chaudhary, K., Prasad, A., & Chand, V. (2021). Perceived causes of students' poor performance in mathematics: a case study at Ba and Tavua secondary schools. *Frontiers in Applied Mathematics and Statistics*, *7*, 1–13. https://doi.org/10.3389/fams.2021.614408

DiNapoli, J. (2023). Distinguishing between grit, persistence, and perseverance for learning mathematics with understanding. *Education Sciences*, *13*(4), 402. https://doi.org/10.3390/educsci13040402

dos Santos, P. M., & Cirillo, M. Â. (2023). Construction of the average variance extracted index for construct validation in structural equation models with adaptive regressions. *Communications in Statistics: Simulation and Computation*, *52*(4), 1639–1650. https://doi.org/10.1080/03610918.2021.1888122

Drakatos, N., & Drigas, A. (2024). The impact of STEAM education using robotics on the executive function of typical and ADHD students along with developmental exploration. *Brazilian Journal of Science*, *3*(2), 113–122. https://doi.org/10.14295/bjs.v3i2.467

Edo, H., Vivian, M., Asare, B., & Arthur, Y. D. (2024). *Pre-service teachers' mathematics achievement, attitude, and anxiety: The moderative role of pre-service teachers' interest in the learning process. Pedagogical Research, 9*(2), Article em0192. https://doi.org/10.29333/pr/14192

Edwards, K. A., McCollester, M., Phillips, B., Acheson-Field, H., Leamon, I., Johnson, N., & Lytell, M. C. (2021). *Compensation and benefits for science, technology, engeneering and mathematics (STEM) workers.* RAND Corporation. https://doi.org/10.7249/RR4267

Fornell, C., & Larcker, D. F. (2014). SEM with unobservable variables and measurement error. *Algebra and Statistics*, *47*(3), 138-145.

Geiger, V., Gal, I., & Graven, M. (2023). The connections between citizenship education and mathematics education. *ZDM - Mathematics Education*, *55*(5), 923–940. https://doi.org/10.1007/s11858-023-01521-3

Guàrdia, L., Clougher, D., Anderson, T., & Maina, M. (2021). IDEAS for transforming higher education: an overview of ongoing trends and challenges. *International Review of Research in Open and Distributed Learning*, *22*(2), 167–184. https://doi.org/10.19173/irrodl.v22i2.5206

Guo, S., & Liao, S. (2022). The role of opportunity to learn on student mathematics anxiety, problem-solving performance, and mathematics performance. *Frontiers in Psychology*, *13*, 829032. https://doi.org/10.3389/fpsyg.2022.829032

Hashim, S., Masek, A., Mahthir, B. N. S. M., Rashid, A. H. A., & Nincarean, D. (2021). Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement. *Indonesian Journal of Science and Technology*, *6*(1), 113–122. https://doi.org/10.17509/ijost.v6i1.31526

Khormi, S. A. (2022). *Integrating GeoGebra into a primary mathematics teaching intervention: impact on students' learning processes and outcomes* [Unpublished doctoral dissertation]. Newcastle University, England.

Kurniawan, H., Purwoko, R. Y., & Setiana, D. S. (2024). Integrating cultural artifacts and tradition from remote regions in developing mathematics lesson plans to enhance mathematical literacy. *Journal of Pedagogical Research, 8*(1), 61–74. https://doi.org/10.33902/JPR.202423016

Lai, J. W., Qiu, W., Thway, M., Zhang, L., Jamil, N. B., Su, C. L., Ng, S. S. H., & Lim, F. S. (2025). Leveraging process-action epistemic network analysis to illuminate student self-regulated learning with a socratic chatbot. *Journal of Learning Analytics*, *12*(1), 32–49. https://doi.org/10.18608/jla.2025.8549

Leong, F. (2014). Social cognitive career theory. In W. B. Walsh & P. J. Hartung (Eds.), *Encyclopedia of counseling* (Vol. 3, pp. 1627–1630). Sage. https://doi.org/10.4135/9781412963978.n585

Luo, Z., Yang, Y., Sun, J., Yuan, W., Liu, S., & Wang, L. (2024). Motivational profiles in mathematics among Chinese secondary school students and their relations with perceived parent/teacher goals and academic achievement. *Educational Psychology*, *44*(4), 395–414. https://doi.org/10.1080/01443410.2024.2369232

Major, L., Francis, G. A., & Tsapali, M. (2021). The effectiveness of technology- supported personalised learning in low- and income countries : A meta- analysis. *British Journal of Educational Technology, 52*(5), 1935–1964. https://doi.org/10.1111/bjet.13116

Michael, B., Arthur, Y. D., & Asare, B. (2025). Influence of peer learning , self-regulatory learning, and mathematics interest on mathematics performance. *International Journal of Didactic Mathematics in Distance Education*, *2*(1), 105–116.

Nilimaa, J. (2023). New examination approach for real-world creativity and problem-solving skills in mathematics. *Trends in Higher Education*, *2*(3), 477–495. https://doi.org/10.3390/higheredu2030028

Roemer, E., Schuberth, F., & Henseler, J. (2021). HTMT2–an improved criterion for assessing discriminant validity in structural equation modeling. *Industrial Management and Data Systems*, *121*(12), 2637–2650. https://doi.org/10.1108/IMDS-02-2021-0082

Scheibling-Sève, C., Gvozdic, K., Pasquinelli, E., & Sander, E. (2022). Enhancing cognitive flexibility through a training based on multiple categorization: developing proportional reasoning in primary school. *Journal* *of Numerical Cognition*, *8*(3), 443–472. https://doi.org/10.5964/jnc.7661

Schöpfer, C., & Hernandez, J. (2024). The critical time for critical thinking: intellectual virtues as intrinsic motivations for critical thinking. *Philosophical Psychology*. Advance online publication. https://doi.org/10.1080/09515089.2024.2430509

Semeraro, C., Giofrè, D., Coppola, G., Lucangeli, D., & Cassibba, R. (2020). The role of cognitive and non-cognitive factors in mathematics achievement: The importance of the quality of the student-teacher relationship in middle school. *PLoS ONE*, *15*(4), 1–22. https://doi.org/10.1371/journal.pone.0231381

Shekh-Abed, A. (2024). Metacognitive self-knowledge and cognitive skills in project-based learning of high school electronics students. *European Journal of Engineering Education*, *50*(1), 214–229. https://doi.org/10.1080/03043797.2024.2374479

Shrestha, N. (2021). Factor Analysis as a Tool for Survey Analysis. *American Journal of Applied Mathematics and Statistics*, *9*(1), 4–11. https://doi.org/10.12691/ajams-9-1-2

Starr, C. R., & Simpkins, S. D. (2021). High school students' math and science gender stereotypes: relations with their STEM outcomes and and socializers' stereotypes. *Social Psychology of Education*, *24*(1), 273–298. https://doi.org/https://doi.org/10.1007/s11218-021-09611-4

Thomas, A. K., Wulff, A. N., Landinez, D., & Bulevich, J. B. (2022). Thinking about thinking about thinking … & feeling: A model for metacognitive and meta-affective processes in task engagement. *Wiley Interdisciplinary Reviews: Cognitive Science*, *13*(6), 1–14. https://doi.org/10.1002/wcs.1618

Tian, H. yun, Dogbe, C. S. K., Bamfo, B. A., Pomegbe, W. W. K., & Borah, P. S. (2021). Assessing the intermediary role of relationship ending capability and dark side between network embeddedness and SMEs' innovation performance. *Journal of Competitiveness*, *13*(1), 146–163. https://doi.org/10.7441/joc.2021.01.09

Varveris, D., Saltas, V., & Tsiantos, V. (2023). Exploring the role of metacognition in measuring students' critical thinking and knowledge in mathematics: a comparative study of regression and neural networks. *Knowledge*, *3*(3), 333–348. https://doi.org/10.3390/knowledge3030023

Vattøy, K. D., & Gamlem, S. M. (2024). Students' experiences of peer feedback practices as related to awareness raising of learning goals, self-monitoring, self-efficacy, anxiety, and enjoyment in teaching EFL and mathematics. *Scandinavian Journal of Educational Research*, *68*(5), 904–918. https://doi.org/10.1080/00313831.2023.2192772

Vicente, R. S., Reomero, J. I., Flores, L. C., Amora, M. S., & Almagro, R. E. (2024). Comparative analysis of two educational systems in both basic and higher education between japan and Singapore. *Asian Journal of Education and Social Studies*, *50*(1), 114–135. https://doi.org/10.9734/ajess/2024/v50i11243

Wang, Q., & Abdullah, A. H. (2024). Enhancing students' critical thinking through mathematics in higher education: a systemic review. *SAGE Open*, *14*(3), 1–15. https://doi.org/10.1177/21582440241275651

Yu, X., Li, J., Luan, X., Wang, H., & Zhou, X. (2024). The correlation between problematic Internet use and mathematical performance becomes weaker as students grow older. *Current Psychology*, *43*(26), 22626–22636. https://doi.org/10.1007/s12144-024-05983-w

Zhang, D., & Wang, C. (2020). The relationship between mathematics interest and mathematics achievement: mediating roles of self-efficacy and mathematics anxiety. *International Journal of Educational Research*, *104*, 101648. https://doi.org/10.1016/j.ijer.2020.101648

Zhu, Y., & Kaiser, G. (2022). Impacts of classroom teaching practices on students' mathematics learning interest, mathematics self-efficacy and mathematics test achievements: a secondary analysis of Shanghai data from the international video study Global Teaching InSights. *ZDM - Mathematics Education*, *54*(3), 581–593. https://doi.org/10.1007/s11858-022-01343-9