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*Research Article*

# Cognitive Awareness and Mathematics Achievement: The Mediating Role of Mathematics Perception

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**Abstract:** The study sought to examine the mediating role of mathematics perception on the relationship between cognitive awareness and mathematics achievement. The study used a purely quantitative method, which used a descriptive research design. The study adopted convenience sampling, stratified sampling, and simple random sampling techniques to select a sample of three hundred and fifty-three (353) students. The researchers used a structured questionnaire as a research instrument for data collection from the target respondents. The findings of the study revealed that cognitive awareness significantly influenced students' mathematics perception. In addition, mathematics perception had a direct and positive effect on mathematics achievement. Furthermore, mathematics perception partially mediates the relationship between cognitive awareness and mathematics achievement. The study recommends that teachers should encourage students to reflect on their problem-solving processes, which can be facilitated through activities that require students to explain their reasoning, discuss different problem-solving strategies, and reflect on the effectiveness of the strategies used.

**Keywords:** Cognitive awareness, Mathematics achievement, Mathematics perception

## 1. Introduction

Mathematics is the systematic study of quantity, structure, space, and change (Yi et al., 2019). It deals with patterns and relationships among numbers, shapes, and abstract entities. Mathematics encompasses a broad range of areas such, as arithmetic, algebra, geometry, calculus, probability, and statistics, each contributing to different aspects of understanding the world and solving real-world problems (Amalia et al., 2024; Tran et al., 2020). According to Zhao et al. (2024), mathematics is the bedrock of analytical and logical thinking, crucial for problem-solving across diverse domains, spanning from everyday situations to specialized fields like science, engineering, and finance. Mathematics equips individuals with the essential tools for quantitative literacy, empowering them to make well-informed decisions and navigate intricate information landscapes effectively (Dananjayan et al., 2023). Proficiency in mathematics opens doors to a myriad of career pathways, spanning finance, technology, research, education, and engineering, as these sectors actively seek individuals with robust mathematical skills. Moreover, mathematics fosters critical thinking and nurtures creativity by encouraging individuals to explore patterns, formulate conjectures, and construct coherent arguments, thereby enriching cognitive abilities (Kynigos & Diamantidis, 2022). In an increasingly interconnected world, nations with robust mathematical education systems gain a competitive edge. Hence, investing in mathematics education is pivotal for sustaining competitiveness on the global stage. Furthermore, studying mathematics instills valuable life skills such as perseverance, resilience, and effective problem-solving strategies, contributing to personal growth and overall cognitive development (Ansya et al., 2024). Thus, mathematics education catalyzes intellectual advancement and equips individuals with the tools necessary to thrive in an ever-evolving world.

As students advance in their education, mathematics tends to grow increasingly complex (Lambert et al., 2014). The fear of being unable to comprehend or solve problems can be overwhelming (Maloney et al., 2013). Many students view mathematics as inherently challenging, leading to feelings of fear and anxiety (Usher, 2009). This perception often arises from past negative experiences or difficulties with the subject. Moreover, there's often significant pressure to excel in mathematics, whether from family, educators, or societal expectations. This pressure can further intensify feelings of anxiety and a fear of failure. Additionally, some students lack confidence in their mathematical abilities, which contributes to their apprehension about studying the subject (Bursal & Paznokas, 2006). This lack of confidence may be rooted in past setbacks or a belief that they are not inherently "good at math". Furthermore, mathematics frequently deals with abstract concepts, which can pose difficulties, particularly for students who prefer more tangible or visual learning approaches (Abrahamson et al., 2020). The precision required in mathematics can also instill a fear of making mistakes, hindering full engagement with the material. This fear of being incorrect can be paralyzing and impede learning progress. Cultural attitudes and stereotypes about mathematics can also impact students' perceptions of the subject (Plante et al., 2009). If students internalize the idea that only certain individuals excel at math or that it lacks relevance to their lives, they may develop a fear of studying it.

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The study of mathematics holds immense significance in our daily lives. It equips us with problem-solving abilities that prove invaluable across various scenarios. Whether we are deciphering the best bargains at the grocery store or plotting the most efficient route for a road trip, mathematical thinking guides us. Moreover, a grasp of basic arithmetic, percentages, and interest rates is indispensable for managing personal finances effectively (Paladino, 2023). It aids in budgeting, saving, investing, and making informed choices regarding loans and mortgages, ensuring financial stability. Furthermore, mathematics serves as the universal language of science and technology, permeating fields like engineering, physics, computer science, and economics (Paladino, 2023). Mathematical concepts form the bedrock of these disciplines, from the design of structures to the coding of algorithms (Cao et al., 2023). In today's data-driven landscape, mathematical techniques such as statistics and probability are essential tools for analyzing vast datasets, making accurate predictions, and deriving meaningful insights. This is pivotal across diverse sectors, including healthcare, marketing, sports, and politics. Additionally, mathematics fosters logical reasoning and critical thinking skills, which are invaluable within mathematical domains and everyday decision-making and problem-solving contexts (Szabo et al., 2020). The principles of mathematics underpin numerous facets of art, architecture, and design, enriching creativity and aesthetics. Whether it's the symmetry in artwork or the algorithms powering digital design software, mathematics plays a central role. Lastly, mathematics aids us in comprehending and interpreting the world around us. From calculating distances and time to interpreting graphical representations in the media, mathematical literacy is crucial for making sense of information and phenomena, enabling a deeper understanding of our surroundings.

Cognitive awareness is instrumental in fostering metacognitive skills, which entail comprehending one's cognitive processes (Ilma et al., 2022). In the realm of mathematics, being cognizant of one's problem-solving approaches can lead to the formulation of superior strategies and more streamlined techniques. According to Du (2020) by cultivating cognitive awareness, learners can more efficiently regulate their learning trajectory. They gain the capacity to monitor their comprehension of mathematical principles, pinpoint areas of challenge and deploy tailored learning tactics to surmount these obstacles. Moreover, cognitive awareness serves as a conduit for delving deeper into mathematical concepts (Biber, 2023). By conscientiously observing student’s cognitive processes during mathematical exploration, students can forge connections between disparate concepts and fortify their grasp of the subject matter. Cognitive awareness empowers learners to detect and rectify errors in their mathematical reasoning (Qomariyah & Darmayanti, 2023). Through introspection on their problem-solving methodologies and identification of misconceptions, students refine their understanding and enhance their precision in mathematical endeavors. This heightened cognitive awareness affords learners the flexibility to approach mathematical problems with adaptability. They can customize their strategies to suit the unique context of each problem, select suitable tools and methodologies, and explore alternative avenues to arrive at solutions. Cognitive awareness instills confidence in mathematical prowess (Ismirawati et al., 2020). By comprehending their cognitive processes and acknowledging their progress and accomplishments, learners cultivate a positive outlook toward mathematics, fostering motivation to further delve into new concepts and continue their learning journey. Cognitive awareness facilitates the transference of mathematical knowledge to novel scenarios (Schumacher & Stern, 2023). By reflecting on the application of mathematical concepts across diverse contexts, learners can extrapolate their understanding and effectively apply it to tackle unfamiliar challenges.

### 1.1. Problem Statement

Despite extensive research on the determinants of mathematics achievement, gaps persist in understanding the nuanced interplay between student cognitive awareness, perception of the subject, and their collective impact on academic outcomes. Cognitive awareness has been acknowledged as a fundamental aspect of mathematical proficiency, but the mediating role of math perception in shaping this relationship remains insufficiently explored. Previous studies have underscored the significance of student cognitive awareness in mathematics achievement. For instance, Wang et al. (2023) emphasized the importance of metacognitive processes, highlighting how students' ability to monitor and regulate their thinking influences problem-solving efficacy. Similarly, Dörrenbächer-Ulrich et al. (2023) seminal work on metacognition elucidated its role in facilitating self-regulated learning, a critical skill for mathematical success.

In parallel, studies have examined the impact of students' perceptions of mathematics on their academic performance. Kapasi and Pei's (2022) research on mindset theory revealed how students' beliefs about the malleability of intelligence influence their approach to learning mathematics, with a growth mindset associated with greater resilience and achievement. Additionally, Hidayatullah and Csíkos (2024) demonstrated the influence of perceived competence and value on students' attitudes toward mathematics, indicating their pivotal role in shaping motivation and effort allocation.

A gap that remains in this growing body of research is the relationship between cognitive awareness, mathematics perception, and student mathematics achievement, which has not been thoroughly examined. There is a shortage of empirical studies that specifically examine the mediating effect of student mathematics perception on the relationship between cognitive awareness and mathematics achievement. To close the gap, the current study examines the mediating effect of mathematics perception on the relationship between cognitive awareness and mathematics achievement. This study examines the mediating role of mathematics perception on the relationship between cognitive awareness and mathematics achievement.

### 1.2. Research Objectives

This paper aimed 1) to determine the effect of cognitive awareness on mathematics perception, 2) to determine the effect of mathematics perception on mathematics achievement, and 3) to examine the mediating role of mathematics perception on the relationship between cognitive awareness and mathematics achievement.

## 2. Literature Review

### 2.1. Cognitive Awareness and Mathematics Perception

Research by Sari and Sumilah (2020) suggests that cognitive awareness, particularly metacognitive knowledge correlates with students' self-efficacy beliefs in mathematics. Students who are aware of their thinking processes and strategies tend to have higher confidence in their ability to succeed in mathematical tasks. According to a study by Buzzai et al. (2020), students with strong metacognitive skills exhibit more positive attitudes toward mathematics. Understanding one's cognitive processes and problem-solving strategies can lead to a sense of mastery and enjoyment of mathematical tasks. Khasawneh et al. (2021) found that cognitive awareness is inversely related to mathematical anxiety. Students who are aware of their cognitive processes and confident in their problem-solving abilities are less likely to experience anxiety when faced with mathematical tasks, leading to a more positive perception of mathematics. Yorulmaz et al. (2021) argue that metacognitive awareness is essential for developing a deep understanding of mathematics. By reflecting on their thinking processes, students can identify misconceptions and gaps in understanding, leading to a more nuanced perception of mathematical concepts. According to Potgieter and van der Walt (2022), metacognitive skills enable individuals to adapt their problem-solving strategies based on the demands of the task. Students who are cognitively aware can approach mathematical problems with flexibility, viewing them as opportunities for creative problem-solving rather than rigid exercises. The National Research Council (2001) emphasizes the importance of metacognitive awareness for transferring mathematical skills to real-world contexts (Go et al., 2023). Students who understand the underlying principles and strategies in mathematics are better able to apply their knowledge in various situations, enhancing their perception of mathematics as a practical and relevant discipline. These hypothesized that;

H1: Cognitive awareness significantly predicts mathematics perception.

### 2.2. Mathematics Achievement and Mathematics Perception

The effect of students' perception of mathematics on their mathematics achievement has been a focal point in educational research, given its implications for pedagogical strategies and student outcomes. The relationship between mathematics perception and achievement has been extensively studied. Ma and Kishor (1997) found that students' positive perceptions of mathematics were positively correlated with their mathematics achievement. Similarly, a meta-analysis by Wang et al. (1993) concluded that students with a positive perception of mathematics tend to achieve higher levels of mathematics proficiency. Eccles and Wigfield (2002) proposed the expectancy-value theory, which suggests that students' perceptions of the utility and relevance of mathematics influence their motivation and achievement. Research by Hidi and Harackiewicz (2000) supported this theory, demonstrating that students who perceive mathematics as relevant to their goals and interests are more motivated to engage with the subject and consequently achieve higher levels of mathematics proficiency. Research by Ma and Xu (2004) found a significant negative correlation between mathematics perception and mathematics achievement. Students who experience higher levels of negative perception tend to perform more poorly in mathematics. The perception of mathematics as difficult or challenging can influence students' self-concept in mathematics, which in turn affects their achievement outcomes (Devries et al., 2021). Niepel et al. (2022) demonstrated that students' perceptions of their mathematical ability (math self-concept) are significant predictors of their mathematics achievement. Students with higher math self-concepts tend to perform better in mathematics. Appiah et al. (2022) conducted a study examining the roles of teacher-student relationships, students' self-efficacy, and students' perceptions of mathematics on their performance in the subject. The study involves 400 students, including 112 males and 298 females, randomly selected from public senior high schools in the Ashanti region. Data was collected using a structural questionnaire and analyzed through structural equation modeling (SEM). The findings revealed that students' positive perception of mathematics has a significant positive impact on their performance in the subject.

H2: Mathematics perception significantly predicts mathematics achievement.

From hypotheses one and two, it was found that *Cognitive awareness significantly predicts mathematics perception and Mathematics perception significantly predicts mathematics achievement.* Based on these hypotheses, we hypothesized that;

H3: Mathematics perception mediates the relationship between cognitive awareness and mathematics achievement.

Figure 1 illustrates the conceptual framework for the study.

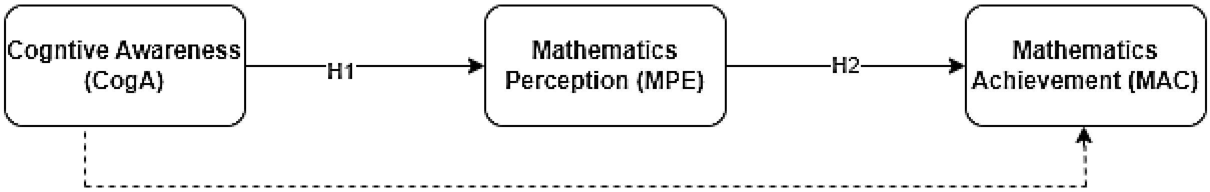


**Figure 1.** Conceptual Framework

## 3. Methodology

A quantitative research approach was adopted in this study. In quantitative research, researchers collect and analyze numerical data (Thwaites, 2020). This approach is often used to establish cause-and-effect relationships and to test hypotheses. Surveys, experiments, and statistical analysis are common methods in quantitative research.

### 3.1. Population of the Study

The population of the study was made up of students at Jachie Pramso Senior High School. All the students in General Arts, General Science, Home Economics, Visual Arts, and Business were included in the target population. Three thousand and seventeen (3017) students in SHS 1, SHS 2, and SHS 3 made up the total population.

The sample size for this study was determined using the formula proposed by Miller and Brewer (2003), which is outlined as follows:$n = \frac{N}{1+Ne^2}$ where $n$ = sample size, $N$ = the target population (n = 3017) =, and $e$ = level of significance = 0.05 (5%).

Given that the study involved human respondents, whose answers might be influenced by biases, the sample size was calculated using a 95% confidence interval and a 5% margin of error. From the formula, we have;

$$n = \frac{3017}{1 + 3017(0.05)^2} = 353.1753 \approx 353$$

The demographic information about the respondents includes their gender, age, educational level, and the program they are enrolled in. The demographic characteristics of respondents are presented in Table 1.

**Table 1.** Result of Demographic Characteristics of Respondents

| Demographic Characteristics of Respondents | Frequency (N) | Percentage (%) |
|---|---|---|
| **Gender** | ***353*** | ***100*** |
| Male | 258 | 73.1 |
| Female | 95 | 26.9 |
| **Age** | ***353*** | ***100*** |
| 14-16 years | 58 | 16.4 |
| 17-19 years | 193 | 54.7 |
| 20-22 years | 82 | 23.3 |
| 23 years and above | 20 | 5.6 |
| **Level of Education** | ***353*** | ***100*** |
| SHS1 | 139 | 39.4 |
| SHS2 | 112 | 31.7 |
| SHS3 | 102 | 28.9 |
| **Program of Study** | ***353*** | ***100*** |
| General Arts | 184 | 52.1 |
| General Science | 56 | 15.9 |
| Business | 16 | 4.5 |
| Home Economics | 57 | 16.1 |
| Visual Arts | 40 | 11.4 |

From Table 1, out of the three hundred and fifty-three (353) respondents, two hundred and fifty-eight (258) representing 73.1% were males while ninety-five (95) representing 26.9% were females. From the above description, there were more male respondents compared to female respondents. Moreover, fifty-eight (58) respondents representing 16.4% had ages ranging from fourteen (14) years to sixteen (16) years; one hundred and ninety-three (193) respondents representing 54.7% had ages ranging from seventeen (17) years to nineteen (19) years. Besides, eighty-two (82) respondents representing 23.3% had ages from twenty (20) to twenty-two (22) years, and twenty (20) respondents representing 5.6% had ages from twenty-three (23) years and above. This shows that most of the study respondents were from seventeen (17) years to nineteen (19) years. In terms of the level of education, one hundred and thirty-nine (139) representing 39.4% of the respondents were at senior high school (SHS), one hundred and twelve (112) representing 31.7% were in SHS 2, and one hundred and two (102) representing 28.9% were in SHS three. The data distribution shows that most of the study respondents were in SHS 2. Finally, according to the program of study, one hundred and eighty-four (184) representing 52.2% studied general arts, fifty-six (56) representing 15.9% studied general science, sixteen (16) representing 4.5% studied business, fifty-seven (57) representing 16.1% studied home economics, and forty (40) representing 11.4% studied visual arts. This shows that the number of students who responded to most of the questionnaires studied general arts.

### 3.2. Sampling Techniques

The researcher employed three sampling techniques: convenience sampling, stratified sampling, and simple random sampling. Convenience sampling was chosen for its cost-effectiveness, time efficiency, and ease of implementation (Kamrul-Hasan et al., 2023). Stratified sampling was used to categorize students into homogeneous sub-groups, including General Arts, General Science, Business, Home Economics, and Visual Arts. During the sample selection process, simple random sampling was utilized to select members from each stratum, ensuring that key characteristics of the population were represented in the sample. This method guarantees that each individual was chosen randomly, avoiding bias.

### 3.3. Data Collection Instruments

This study incorporated one independent variable (Cognitive Awareness – CogA), one mediator (Mathematics Perception – MPE), and one dependent variable (Mathematics Achievement-MACH. Responses for all five constructs were collected using a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The measurement items for cognitive awareness were adapted from Demetriou et al. (2020), while those for mathematics perception were based on Arthur (2022),. Items assessing mathematics achievement were developed by Asare et al. (2023). Although these items were sourced from previous studies, they were modified to align with the objectives of the current research.

A pilot test was conducted to refine the instrument, during which ambiguous statements were reworded. After analyzing the pilot test data, Cronbach’s alpha scores were calculated to assess the reliability of the constructs. The alpha score for cognitive awareness was 0.705, mathematics perception was 0.728, and mathematics achievement was 0.852. The relatively low factor loadings for certain constructs were attributed to ambiguities in some measurement items, which were identified and addressed during the pilot study before finalizing the questionnaire for the main data collection. One key advantage of using pre-existing measurement scales in a study is their extensive prior testing, which enhances reliability. As highlighted by Hyman et al. (2006), validated questionnaires are particularly effective when the conditions of the original validation closely resemble those of the new study environment. Employing validated measurement scales also alleviates the need for researchers to independently develop and validate new instruments.

### 3.4. Validity and Reliability

Determining the validity of a research questionnaire is a systematic process involving a variety of methods and analyses. First, content validity was examined by giving the questionnaire to an expert whose research interest is in line with the study title. The expert ensures that the questionnaire covers the entire domain of the concepts being measured. The expert also makes sure that the questions designed are clear, concise, and relevant to the research objects. The researchers revised the questions based on the expert's comments before administering the final questionnaire to the respondents.

Moreover, Cronbach's alpha was used to calculate reliability analysis using SPSS (ver. 23). This study was performed to examine the latent variables' internal consistency. Table 2 shows the reliability analysis for the various constructs.

**Table 2.** Reliability Analysis

| Variables | Number of Items | Cronbach’s Alpha Value |
|---|---|---|
| CogA | 4 | 0.926 |
| MP | 5 | 0.909 |
| MACH | 3 | 0.837 |

The reliability coefficient for cognitive awareness, mathematics perception, and mathematics achievement were given as 0.922, 0.891, and 0.886 respectively. The reliability coefficients for the four constructs used in this analysis were higher than the 0.7 minimal cut-off value as recommended by (Kosteniuk et al., 2017). In summary, Table 2 shows that all the variables being measured have high reliability, with Cronbach's Alpha values ranging from 0.837 to 0.926. This suggests that the items within each variable are consistent with each other in measuring the intended construct.

### 3.5. Data Analysis

To aid in research analysis, quantitative data were coded and input into the SPSS (version 23) where exploratory factor analysis (E.F.A) was performed and AMOS (version 23) software packages purposely for confirmatory factor analysis (C.F.A). The structural equation model (SEM) was then used to assess the data. The analysis of the gathered data was done to identify the key characteristics and relationships between the data to generalize and predict the results. Negative statements were reversed in the coding.

### 3.6. Confirmatory Factor Analysis (CFA)

After conducting the exploratory factor analysis (EFA), the next step involved performing a confirmatory factor analysis (CFA) using AMOS (version 23) to validate the EFA loadings for the latent variables. CFA is a statistical technique implemented in AMOS to confirm the measurement items associated with the latent variables. This method allows researchers to test hypotheses regarding the relationships between the examined variables and the underlying factors (Marsh et al., 2020). Researchers utilize theoretical knowledge, empirical research, or both to establish a prioritized relationship pattern, which is then tested using statistical methods (Byrne, 2010; Hair et al., 2010). The results of the CFA are presented in Table 4.

**Table 4.** Confirmatory Factor Analysis (CFA)

| ***Model Fit**: CMIN = 94.116; DF = 45; CMIN/DF = 2.091; CFI = 0.984; TLI = 0.976; NFI = 0.970; GFI = 0.956; SRMR = 0.047; RMSEA = 0.056; PClose = 0.261* | **Std. Estimate** |
|---|---|
| ***Cognitive Awareness (CogAW): CA = 0.926; CR = .928; AVE = .763*** | |
| CogA2: I am aware of my performance after completing a math exam. | .867 |
| CogA3: In my mathematics studies, I slow down when I come across crucial mathematics concepts. | .846 |
| CogA4: Interest in the subject matter increases my learning. | .910 |
| CogA5: I consider many approaches to a mathematical problem and select the most effective one. | .869 |
| ***Mathematics Perception (MEP): CA = 0.909; CR = 0.910; AVE = 0.669*** | |
| MP3: The knowledge I get from mathematics learning will not be useful in my career. | .780 |
| MP4: Mathematics is for creative people. | .857 |
| MP5: Mathematics is male-dominated. | .876 |
| MP6: Without learning mathematics, I will get a job to do in the future. | .830 |
| MP7: No matter how hard I try, I will not understand mathematics concepts. | .740 |
| ***Mathematics Achievement (MAC): CA = 0.837; CR = 0.838; AVE = 0.635*** | |
| MACH3: I get good grades in mathematics examinations. | .712 |
| MACH4: Mathematics enhances my ability to comprehend other subjects. | .875 |
| MACH5: Mathematics is one of the easy subjects to pass. | .795 |

The required factor loading value should exceed the minimum threshold of 0.6 as recommended by Dogbe et al. (2020). From Table 4, the least factor loading for the measurement items was 0.688 which exceeded the minimum factor loading of 0.6. This means that the measurement items under their respective constructs (i.e. cognitive awareness, mathematics perception, and mathematics achievement) loaded better and these measurement items will be used for further data analysis. Another important aspect to consider when conducting confirmatory factor analysis (CFA) is the model's fit. According to Dogbe et al. (2019), the CMIN/DF ratio should be less than 3, while the CFI and TLI should be at least 0.9. Additionally, RMR and RMSEA should be below 0.08, and P-close should be greater than 0.05. CMIN measures minimal inconsistency in the model, whereas RMR and RMSEA assess the deviation of the hypothesized model from a perfect model. CFI and TLI represent incremental fit indices by comparing how well the hypothesized model fits the baseline model which reflects minimal agreement (Zhou et al., 2020). The threshold values for CFI and TLI are derived from the maximum probabilities associated with normal continuous data theory, while P-close is expected to be statistically insignificant at the 5% level (above 0.05), representing the p-value for testing the null hypothesis in the population. All criteria were met, as shown in Table 4. The CFI value was 0.984, exceeding the 0.90 threshold, indicating that the model is valid and demonstrates a strong correlation between the model and the data. The CFI value was 0.984, suggesting a good fit for the resulting model. Furthermore, the RMSEA value was 0.056, which is below the acceptable threshold of 0.08, indicating that the basic factors of the four constructs are valid and acceptable. The TLI value of 0.976 also exceeded 0.9, signifying an excellent fit for the three-factor model. In terms of fitness assessments, the CMIN/DF value was 2.091, falling below 3, while the P-close value of 0.261 indicated statistical insignificance at the 5% level (Dogbe et al., 2019). Figure 2 illustrates a schematic representation of the confirmatory factor analysis.

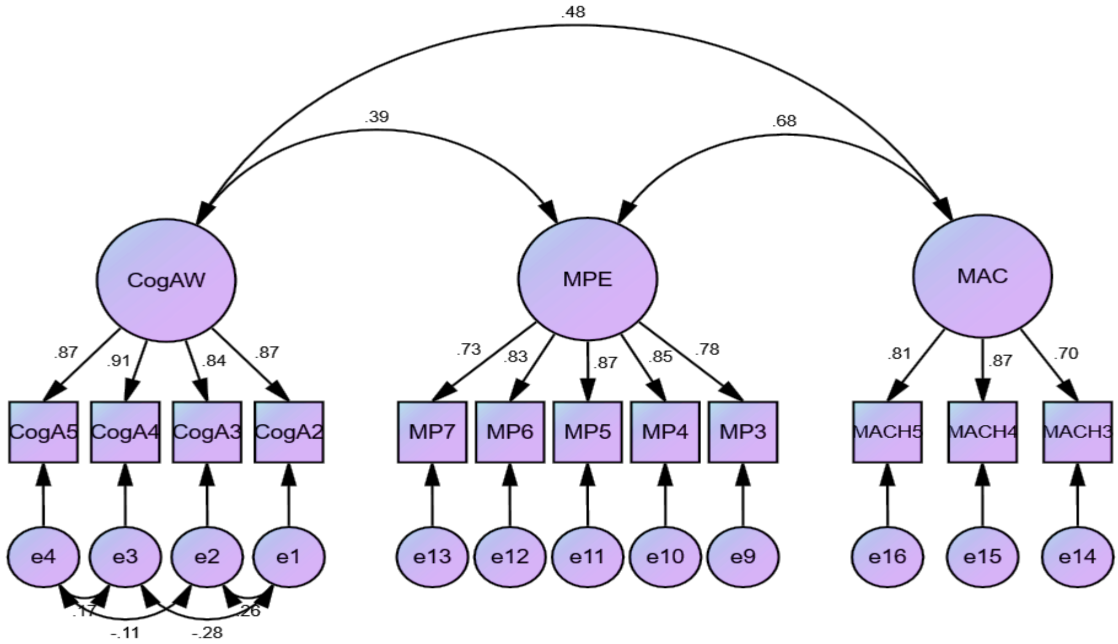


**Figure 2.** Confirmatory Factor Analysis (CFA)

### 3.7. Discriminant Validity Analysis

To objectively evaluate the convergent validity of the final observed variables used in the confirmatory factor analysis (CFA), Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated. According to Trochim and Donnelly (2006), convergent validity examines the degree to which two observable variables correlate when they pertain to the same concept. Both AVE and CR should meet the expected thresholds of at least 0.5 and 0.7, respectively. The results of the discriminant analysis for the study are presented in Table 5.

**Table 5.** Discriminant Analysis

| Variables | CR | AVE | CogAW | MPE | MAC |
|---|---|---|---|---|---|
| CogAW | 0.928 | 0.763 | ***0.873*** | | |
| MPE | 0.910 | 0.669 | 0.397$^{***}$ | ***0.818*** | |
| MAC | 0.838 | 0.635 | 0.485$^{**}$ | 0.671$^{***}$ | ***0.797*** |

*Note: $\sqrt{AVEs}$ Are bolded; $^{****}$ signified p-value less than 1% (0.001) meaning significant.*

The results presented in Table 5 meet the AVE and CR criteria established by Bright et al. (2024), with an AVE of 0.635 and a CR of 0.838, indicating that convergent validity has been achieved. Additionally, discriminant validity was assessed using a tool from AMOS (ver. 23). Discriminant validity is confirmed when the highest value of the interrelated constructs does not exceed the lowest value of the square root of the Average Variance Extracted (√AVE). In Table 8, the highest value for interrelated constructs was 0.397, while the lowest value for the square root of the Average Variance Extracted was 0.797. Since the highest value of the interrelated constructs does not surpass the lowest value of √AVE, this study successfully demonstrates discriminant validity.

## 4. Results

The research hypotheses of this study are evaluated in Table 6 using path analysis to determine the numerous direct effects. The paths analysis provides a method of breaking down the link between the independent factors and the dependent variables, supporting theories put forth by previous scholars. This was examined utilizing Structural Equation Modeling (SEM) run in AMOS (ver. 23).

**Table 6.** Path Estimation

| Hypothesis | Path Summary | Std. Estimates | S.E. | C.R. | p-value |
|---|---|---|---|---|---|
| *H1* | **CogAW→MPE** | 0.458 | 0.069 | 6.602 | < 0.01 |
| *H2* | **MPE→MAC** | 0.414 | 0.047 | 8.875 | < 0.01 |
| | Mediating Effects | **Std. Estimate** | **Lower BC** | **Upper BC** | **p-value** |
| *H3* | **CogAW→MPE→MAC** | .072 | .041 | .122 | .000 |

### 4.1. Research Hypothesis One (H1): Cognitive awareness significantly predicts mathematics perception

Research hypothesis one investigated the impact of cognitive awareness on predicting students' mathematics perception. This was analyzed using direct effect analysis (see Table 6). The analysis demonstrated that cognitive awareness had a direct and positive effect on mathematics perception, with a p-value < 0.01, indicating significance. Specifically, the relationship between cognitive awareness and mathematics perception had a p-value of 0.000, confirming its significance at the 0.01 level. The hypothesized paths (see Figure 3) showed that the path coefficients in the inner model are significant, with a critical ratio value greater than 1.64. The relationship between cognitive awareness and the mathematics perception of students was substantial. This was evidenced by a path coefficient (β) of 0.458 and a critical ratio of 6.602 (see Table 6). The β value of 0.458 indicated that cognitive awareness positively affects mathematics perception The interpretation is that for every unit increase in cognitive awareness, there was an associated increase in mathematics perception by 0.458 units. The critical ratio result of 6.602 showed that the effect of cognitive awareness is statistically significant on students' mathematics perception.

### 4.2. Research Hypothesis Two (H2): Mathematics perception significantly predicts mathematics achievement

The second research hypothesis sought to examine the effect of mathematics perception on mathematics achievement. The effect of mathematics perception on mathematics achievement was analyzed using direct effect analysis (see Table 6). The analysis demonstrated that mathematics perception had a direct and positive effect on mathematics achievement, with a $p$-value < 0.01. Specifically, the relationship between mathematics perception and mathematics achievement had a $p$-value of 0.000, confirming its significance at the 0.01 level. The hypothesized paths (see Figure 3) showed that the path coefficients in the inner model were statistically significant, with a critical ratio value greater than 1.64. The relationship between mathematics perception and mathematics achievement of students was substantial. This was evidenced by a path coefficient (β) of 0.414 and a critical ratio of 8.875 (Table 9). The β value of 0.414 indicated that mathematics perception positively affected mathematics achievement; for every unit increase in student positive mathematical perception, there was an associated increase in mathematics achievement by 0.414 units. The critical ratio of 8.875 signified that this relationship was statistically significant and reliable, providing strong support for the positive impact of mathematics perception on the mathematics achievement of students.

### 4.3. Research Hypothesis Three (H3): Mathematics perception mediates the relationship between cognitive awareness and mathematics achievement

The research hypothesis (H3) sought to examine the mediating effect of mathematics perception on the relationship between cognitive awareness and mathematics achievement. From Table 6, the mediating effect of mathematics perception was positive and statistically significant on the relationship between cognitive awareness and mathematics perception ($\beta = .072^{***}$). This implied that the effect of cognitive awareness on students' mathematics perception, is direct, but also explained through the mediating role of mathematics perception.

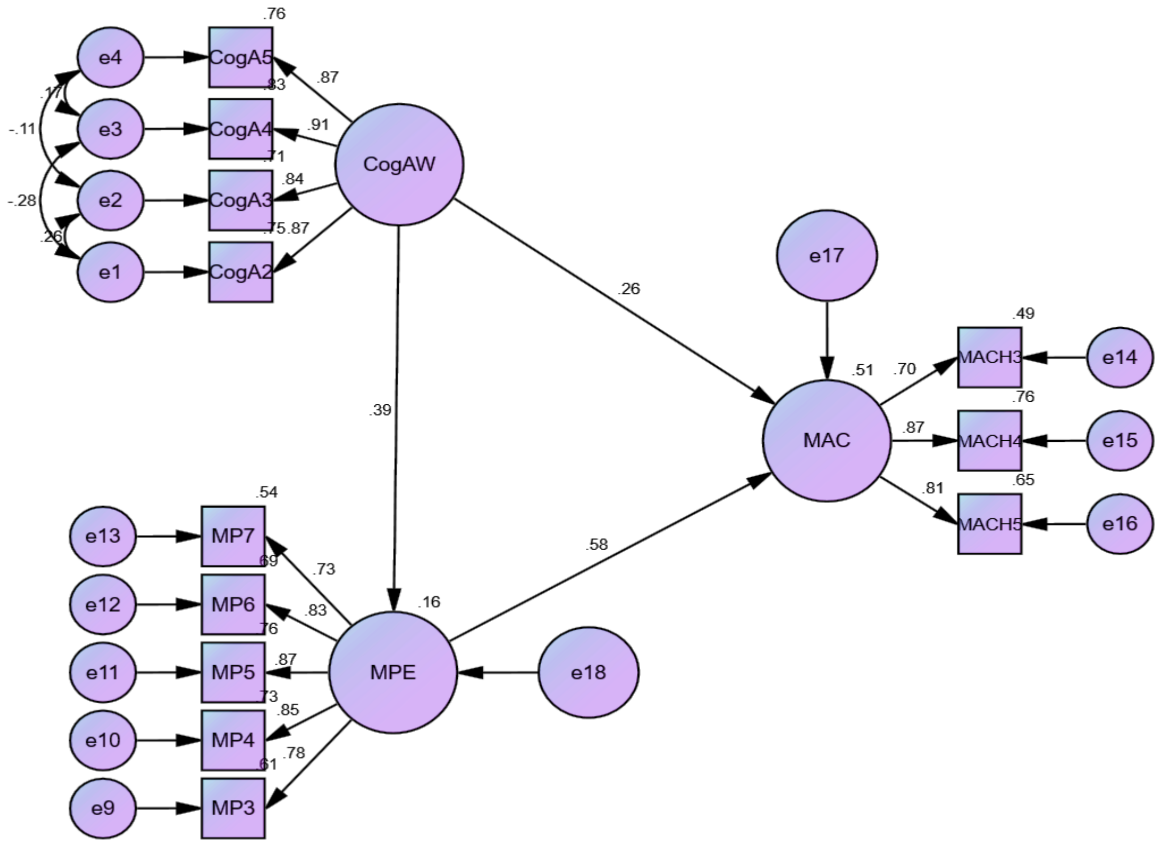


**Figure 1.** Path Summary

## 5. Discussion

The study result revealed that cognitive awareness positively influence students' mathematics perception. This result is supported by several empirical studies. According to Rivas et al. (2022), metacognitive plays a crucial role in learning and problem-solving, as it enables students to regulate their learning strategies effectively. Akpur (2021) also emphasized the importance of meta-cognitive strategies in academic success. His research demonstrated that students who employ meta-cognitive strategies tend to have better mathematics achievement, as they are more capable of monitoring their understanding and adjusting their learning approaches accordingly. Moreover, Eriyani (2020) developed the Metacognitive Awareness inventory, which further established the link between metacognitive awareness and academic performance. Their studies showed that higher levels of meta-cognitive awareness are associated with improved academic performance, particularly in complex subjects like mathematics. The positive relationship between cognitive awareness and mathematics perception is further supported by recent research by Öztürk et al. (2020), who found that students' self-regulation and cognitive strategies significantly predict their academic perception. Their work highlights that cognitive awareness, as a component of self-regulation, is crucial for understanding and succeeding in mathematics.

The findings of this study indicated that students' mathematics perception has a direct positive and statistically significant effect on their mathematics achievement. This suggests that students' attitudes and feelings toward mathematics can directly influence their performance in the subject. Furthermore, the positive correlation between students' perceptions of mathematics and their achievement is supported by existing literature. When students hold a positive view of mathematics, they are more likely to engage with the subject, persist through challenging problems, and employ effective learning strategies, all of which contribute to improved achievement. This finding is in line with the study of Lazarides et al. (2019). Their study discussed the expectancy-value theory, which posits that students' expectations of success and the value they place on the task at hand are critical predictors of their performance. Their result found that a positive perception of mathematics enhances both their expectancy of success and the intrinsic value they place on learning mathematics, thereby improving their achievement. The study by Kiwanuka et al. (2022) investigated the relationship between mathematics perception and achievement using a LISREL model. The findings indicated that students with a positive perception of mathematics tend to perform well in the subject. Additionally, Öztürk et al. (2020) found that interest in a subject, closely linked to positive perception, significantly predicts academic achievement. Their research demonstrated that when students find mathematics interesting, they are more likely to invest time and effort, leading to improved performance. Furthermore, Mao et al. (2021) conducted a meta-analysis that revealed a strong relationship between students' attitudes toward mathematics and their achievement, supporting the notion that a positive student attitude results in better outcomes in mathematics. Finally, Appiah et al. (2023) examined the roles of teacher-student relationships, student efficacy, and students' perceptions of mathematics on their performance in the subject. Their study involved 400 randomly selected students from public senior high schools in the Ashanti region, comprising 112 males and 298 females. Data were collected using structured questionnaires and analyzed through structural equation modeling (SEM). The findings revealed that students' positive perceptions of mathematics have a significant positive effect on their performance in the subject.

Finally, the study supports the notion that students' perception of mathematics mediates the relationship between cognitive awareness and mathematics performance. Arthur (2022) asserted that mathematics perception acts as a mediating mechanism between the history of mathematics, peer-assisted learning, and students' interest in mathematics. Additionally, Hagan et al. (2020) found that students with a positive perception of mathematics tend to perform well in the subject.

## 6. Conclusion

The current study aimed to examine the effect of cognitive awareness on mathematics achievement, mediated by mathematics perception. The study used a convenient, stratified, and simple random sampling approach for selecting the samples for the research. Hence, the data analysis emphasized three hundred and fifty-three (353) respondents. Questionnaire items that were used in the data collection were all adopted from other research work and these questions were scaled based on the variables under the study, comprising cognitive awareness, mathematics perception, and mathematics achievement. Data analysis was conducted using the Structural Equation Model (SEM) run using AMOS (version 23). The analyses performed in the study included Exploratory Factor Analysis, Confirmatory Factor Analysis, Direct Path Effect analysis, Discriminant Validity assessment, and Indirect Effect analysis. The study findings revealed that cognitive awareness had a significant positive effect on students' mathematics perception. Moreover, mathematics perception significantly predicts mathematics achievement. Finally, mathematics perception partially mediates the relationship between cognitive awareness and mathematics achievement.

## 7. Limitations for the Study

The study concentrated on the use of cognitive awareness and mathematics perception to measure students' mathematics achievement. The study was limited to one Senior High School in the Bosomtwe District in the Ashanti region of Ghana, that is, Jachie Pramso Senior High School, which was not enough to make a true inference about the population. Additionally, questionnaire was used to collect data from the sampled students. Finally, a structural equation modeling (SEM) run in Amos was used to test the hypothesis paths for this study.

## 8. Recommendations

Mathematics curricula should include training in meta-cognitive strategies to enhance students' self-awareness and regulation of their cognitive processes. This can be achieved through explicit teaching of meta-cognitive skills such as self-monitoring, self-evaluation, and strategic planning. Furthermore, teachers should prompt students to reflect on their problem-solving processes, which can be facilitated through activities that require students to explain their reasoning, discuss different problem-solving strategies, and reflect on the effectiveness of the strategies used. Further, professional development programs should therefore include components that help pre-service and in-service teachers develop their meta-cognitive skills and positive beliefs about mathematics. In addition, educational stakeholders should integrate meta-cognitive strategy training and formative assessments into mathematics curricula, develop students' problem-solving skills to enhance cognitive awareness, foster positive attitudes towards mathematics through supportive and engaging teaching practices, and consider individual and social factors in educational interventions to create a conducive learning environment.

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**Ethics Declaration:** All participants into the current study were given a consent form and asked to opt in whether they wanted to participate. No additional ethical approval was ¬required to conduct the study.

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

**Conflict of Interest:** The author affirms that there were no conflicts of interest associated with the study.

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