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# Impact of Cognitive and Non-Cognitive Factors on Mathematics Achievement among Pre-service Teachers in Ghanaian Colleges of Education

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**Abstract**

This study investigated the extent to which cognitive and non-cognitive factors predict mathematics achievement among pre-service teachers in Colleges of Education (CoEs) in Ghana. Grounded in Bandura's Social Cognitive Theory, the study employed a correlational survey design to explore how personal, behavioural, and environmental factors interact to influence mathematics achievement. A sample of 498 pre-service teachers from various levels and specializations was selected using a convenience sampling approach. Data were collected through a structured Mathematics Achievement Questionnaire (MAQ), designed to measure cognitive factors (e.g., problem-solving, prior knowledge) and non-cognitive factors (e.g., self-efficacy, motivation, anxiety). The reliability of the instrument was confirmed through a pilot study ($\alpha = 0.76$), and data were analysed using multiple regression techniques. Findings revealed that both cognitive and non-cognitive factors significantly predicted mathematics achievement ($R^2 = 0.814$), with self-efficacy and problem-solving skills emerging as the strongest predictors. Notably, non-cognitive variables such as motivation and anxiety had a comparable or even greater influence on achievement than some cognitive dimensions. These results suggest that both domains play a critical and complementary role in shaping pre-service teachers' performance in mathematics. The study concludes that a holistic approach, targeting both cognitive and non-cognitive development, is essential for improving mathematics achievement among pre-service teachers. Further studies are recommended to explore these dynamics in different contexts using actual academic records rather than self-reported achievement. The implications of this study on learning and teaching practices in CoEs are discussed.

**Keywords**: Cognitive, Non-Cognitive, Mathematics Achievement, Pre-Service Teachers, Mathematics Education

## 1. Introduction

Mathematics, as a subject of study, is compulsory for every child at the pre-tertiary level of education in Ghana. At the basic school level, which is the foundational level, pre-service teachers at the various Colleges of Education (CoEs) across the country are supposed to receive the necessary training to effectively teach the subject at this level (Ministry of Education [MoE], 2019). Mathematics education fosters critical thinking and problem-solving skills essential for national development. In Ghana, pre-service teachers in CoEs, after graduation, will be responsible for establishing these foundational mathematical skills in the early years of learners. However, concerns have been raised about their performance in mathematics (Tetteh & Agyei, 2022), prompting investigations into the underlying factors influencing their achievement.

Many experts classified factors accounting for achievement according to constraints that they deem effectively represent the components under these factors. In the present study, these factors are looked at in two broad areas: cognitive and non-cognitive factors. Cognitive factors, such as prior knowledge, problem-solving skills, and retention, among others, have been found to play a significant role in mathematics achievement. For example, Agormor et al. (2022) found a strong positive relationship between prior mathematics achievement and performance among pre-service teachers in CoEs in geometry and trigonometry. Research has also shown that non-cognitive factors such as motivation, attitude, personal beliefs, and anxiety, among others, have a significant impact on mathematics achievement among students. For example, a study by Tetteh and Agyei (2022) found that motivation was the best determinant of mathematics achievement among pre-service teachers in CoEs in Ghana. Additionally, Edo et al. (2024) established that non-cognitive factors, such as attitude, have a direct positive effect on mathematics achievement. Senkpeil and Berger (2016) argue that different non-cognitive factors influence the performance of students depending on the learning environment.

Moreover, the mathematics curriculum for the CoEs underscores the importance of these constructs in preparing teachers to handle mathematics at the primary school level (Ministry of Education, 2018). This suggests that understanding the combined effect of these two major factors is crucial for a comprehensive approach to improving mathematics achievement. Sie and Agyei (2023) posit that while cognitive factors are primary predictors, non-cognitive factors can influence the extent of their impact.

It is therefore important to appreciate that tackling only individual factors affecting mathematics achievement at a time may not provide a holistic view of the situation. The current study sought to focus on the extent to which both cognitive and non-cognitive factors influence mathematics achievement. This study also sought to identify any significant interaction effects of both factors in predicting mathematics achievement. To this end, the following research questions guided the conduct of the study:

1. What is the impact of cognitive factors on the mathematics achievement of pre-service teachers in Ghana?
2. What is the impact of non-cognitive factors on the mathematics achievement of pre-service teachers in Ghana?
3. To what extent do cognitive and non-cognitive factors collectively predict mathematics achievement?

## 2. Review of Related Literature

### *2.1. Theoretical Framework*

The current study explores both cognitive and non-cognitive factors influencing the achievement of mathematics among pre-service teachers in Ghanaian CoEs. The theoretical framework underpinning this study is Albert Bandura's Social Cognitive Theory (SCT), which posits that learning occurs in a social context through the dynamic and reciprocal interaction of certain factors. The theory emphasizes the reciprocal dynamic interaction among personal factors, environmental factors, and behaviour, which continuously interact through influencing and being influenced by each other (Bandura, 1986).

Bandura's 1986 Social Cognitive Theory (SCT) is a widely used theoretical framework in education, particularly when it comes to factors affecting behavioural change (Example: Usher & Pajares, 2009; Komarraju & Nadler, 2013; Phan, 2013). The current study is grounded in the SCT because it aligns perfectly with the interplay of the variables (cognitive and non-cognitive factors) and a behavioural outcome (mathematics achievement). That is, this theory emphasizes the role of the interplay of factors, making it particularly relevant to understanding how both cognitive and non-cognitive factors shape mathematics achievement among pre-service teachers.

This suggests that the mathematics achievement of pre-service teachers in the CoEs is not only influenced by cognitive factors but also by non-cognitive factors. SCT helps explain why students with similar cognitive abilities may differ in performance due to non-cognitive factors. By using the SCT as a theoretical lens for this study, this study aims to explore how the interaction of cognitive and non-cognitive factors influences mathematics achievement among pre-service teachers in CoEs in Ghana.

### *2.2. Cognitive Factors and Mathematics Achievement*

Problem-solving skills are fundamental to mathematics learning, as they determine how students apply knowledge to new and complex situations. According to Polya (1945), problem-solving is a structured process involving understanding, planning, executing, and evaluating a solution. Research by Nahdi et al. (2020) found that problem-solving strategies significantly

impacted mathematics achievement among pre-service teachers in Indonesia, suggesting that similar findings might be relevant in Ghana. In the Philippines, Dangkulos et al. (2025) conducted a correlational descriptive survey to examine how problem-solving disposition predicts the performance of 134 pre-service teachers. The results revealed that problem-solving disposition significantly predicted the performance of the participants in problem-solving tasks.

Mathematical reasoning, which involves making deductions and recognizing patterns, is an essential determinant of mathematical performance and effective problem-solving. A study by Armah (2024) assessed the geometric thinking levels of 1,225 prospective mathematics teachers from three universities in Ghana using the van Hiele model. The findings revealed that a significant proportion of participants operated at lower levels of van Hiele's geometric reasoning scale. This suggests that enhancing mathematical reasoning skills could positively impact the overall mathematics achievement of pre-service teachers in Ghanaian teacher training institutions. This finding has implications for teacher education at the CoEs since students are admitted with similar entry characteristics to those admitted into the universities.

Similarly, Bukari and Govender (2024) employed a quasi-experimental design to investigate the development of modelling competencies in pre-service mathematics teachers through reflective thinking skills. Their findings demonstrated that participants who engaged in reflective practices exhibited improved mathematical reasoning and problem-solving abilities, leading to higher academic performance. This implies that students who possess high mathematical reasoning skills are more likely to achieve better in the subject.

Sam et al. (2023) investigated the content knowledge of 79 second-year pre-service teachers in teaching algebra within the Central Region of Ghana. Their findings revealed, among other things, that the participants' understanding of algebraic concepts was low. Among the contributing factors identified are pre-service teachers' previous algebraic knowledge, brought to the tertiary space (Sam et al, 2023). They emphasized the importance of strengthening algebraic foundations during pre-service training to enhance overall mathematics achievement. Similarly, Agyei and Voogt (2016) observed that many pre-service teachers lacked sufficient mathematical background knowledge, affecting their ability to teach effectively. These findings suggest that strengthening mathematical foundations at the pre-tertiary level is essential.

Furthermore, Sie and Agyei (2023), in examining the role of mathematical knowledge for teaching fractions and teaching practices, found that pre-service teachers' mathematical knowledge significantly predicts their success in their teaching practices, though anxiety insignificantly increased the magnitude of the regression coefficient. This finding suggests that even though anxiety may be a contributing factor to pre-service teachers' achievement in mathematics and teaching practices, their mathematical knowledge plays a more significant role.

*2.3. Non-Cognitive Factors and Mathematics Achievement*

The literature suggests that non-cognitive factors such as motivation, interest, attitude, self-efficacy, and anxiety play a crucial role in mathematics learning. Tetteh and Agyei (2022) explored the factors predicting 400 pre-service teachers' performance across three regions in Ghana. Their findings revealed that motivation was the strongest predictor of pre-service teachers' performance. Similarly, a quasi-experimental study by Mensah and Nabie (2021), using a sample of 80 high school students in the central region of Ghana, found that student motivation had a positive effect on their achievement in mathematics. These findings imply that motivation is a critical predictor of students' mathematics achievement at all levels of the educational ladder.

Also, Self-efficacy, the belief in one's ability to succeed in a specific task, affects students' willingness and motivation to engage in mathematics learning. This is supported by the renowned theorist, Bandura (1997), who states that students with high self-efficacy persist through challenges and develop resilience in problem-solving. Agormor et al. (2022) examined the effects of self-efficacy on Ghanaian pre-service teachers' achievement in geometry and trigonometry. Their findings revealed that pre-service teachers' self-efficacy is a strong predictor of their performance in geometry and trigonometry.

Similarly, Ampofo (2019) found a strong positive relationship between pre-service teachers' self-efficacy in teaching mathematics and their actual achievement in the subject. These findings from Ghana were confirmed by similar studies in other jurisdictions. Bamidele and Akanmu (2022) examined the relationship between pre-service mathematics teachers' self-efficacy and their academic performance in Colleges of Education in Nigeria. The results revealed a positive and independent relationship between pre-service teachers' self-efficacy components and their achievements, suggesting that enhancing self-efficacy could lead to improved academic achievement.

A positive attitude towards mathematics has been linked to higher achievement levels. Edo et al. (2024) investigated the moderating role of interest in the relationship between attitude, anxiety, and mathematics achievement among pre-service teachers. They reported that pre-service teachers' attitudes have a direct positive effect on their mathematics achievement, emphasizing the importance of fostering favourable perceptions of the subject. A study by Taley et al. (2021) investigated the impact of mathematics achievement and field experience on pre-service teachers' anxiety towards teaching mathematics. They found that pre-service teachers in Ghana experience significant anxiety when teaching mathematics, affecting not only their confidence but also their lesson deliveries. Likewise, a study by Brewster and Miller (2022**)** involving 27 Canadian pre-service teachers enrolled in a hybrid mathematics course found a significant negative relationship between mathematics anxiety and mathematical ability. This indicates that pre-service teachers with lower mathematical ability experienced higher levels of mathematics anxiety.

On the other hand, a study by Edo et al. (2024) found that though mathematics anxiety had a positive effect, its effect was statistically insignificant on achievement. This suggests that while anxiety exists, its direct impact on performance may be more

or less pronounced, possibly due to coping mechanisms or other mediating factors. This calls for further exploration of the situation to better understand the phenomenon.

Senkpeil and Berger (2016) investigated how non-cognitive factors contribute to the academic performance of 418 first-year engineering students in the United States of America, beyond the traditional cognitive factors. Using multiple regression analysis, the results revealed that adding non-cognitive factors to the model increased the explained variance to 13.1%, which hitherto was explained by 6.1% when only cognitive factors were used. This study reinforces the idea that non-cognitive factors, such as anxiety and self-discipline, among others, significantly impact academic outcomes, even when students have similar cognitive abilities.

*2.4. Summary of Literature Review*

The literature highlights that both cognitive and non-cognitive factors significantly impact mathematics achievement. Problem-solving ability, reasoning, and prior knowledge play a crucial role, while motivation, self-efficacy, and anxiety also influence performance. Pre-service teachers' perceptions and teaching strategies shape students' mathematical success. This is particularly relevant in the Ghanaian CoE context, where many pre-service teachers may enter with comparable academic qualifications but perform differently in mathematics. Consistent with the findings of Senkpeil and Berger (2016), it is our argument that non-cognitive factors may help explain performance disparities among pre-service teachers in CoEs with similar cognitive traits.

Previous studies, especially in Ghana, seem to focus on one aspect of factors affecting pre-service teachers' achievement in mathematics, at a time, thereby failing to provide a more holistic view of the phenomenon (See: Ampofo, 2019; Tetteh & Agyei, 2022; Mensah & Nabie, 2021) Investigating the combined effects of both cognitive and non-cognitive factors that influence the achievement of pre-service teachers in mathematics will provide insight to educators on a more holistic approach to this issue. This underscores the need to take a holistic approach to identifying and addressing both factors to enhance mathematics achievement among pre-service teachers. The current study fills this gap by exploring both cognitive and non-cognitive factors and their combined effects on mathematics achievement among pre-service teachers in the CoEs in Ghana.

## 3. Methodology

*3.1. Research Design*

This study employed a quantitative correlational survey design to examine the relationship between cognitive and non-cognitive factors and mathematics achievement. This approach enabled the researchers to obtain numerical data to test hypotheses and examine the relationships among variables (Akayuure & Atttuabea-Addo, 2025). The study utilizes multiple regression analysis to determine the predictive power of cognitive and non-cognitive factors on mathematics achievement among pre-service teachers.

*3.2. Population and Sampling*

The target population consists of pre-service teachers enrolled in Colleges of Education (CoEs) in the Eastern region of Ghana for the 2024/2025 academic year. A convenient sampling technique was adopted to select a sample of 498 pre-service teachers (240 males and 258 females) across the four different levels of study (first-year to fourth-year) and three different specializations (Early Grade Education, Primary Education, and Junior High School Education). This sampling technique enabled the researchers to use participants on CoEs campuses who were available and willing to participate in the study via an online questionnaire (Assuah, 2025).

*3.3. Instrumentation, Validity, and Reliability*

A structured Mathematics Achievement Questionnaire (MAQ) was developed by the researchers based on constructs identified from the literature to explore the influence of cognitive factors, non-cognitive factors, and mathematics achievement using a 5-point Likert scale. The MAQ consisted of four (4) sections, measuring participants' demographics, cognitive factors (CF), non-cognitive factors (NF), and participants' self-perceived achievement in mathematics (MA), respectively. Section A of the MAQ collects demographic information (Program of study, level, age group, and gender) of participants. Section B of the MAQ has ten (10) items on cognitive factors with a focus on pre-service teachers' problem-solving ability, prior mathematical knowledge, retention, mathematical reasoning, and critical thinking. Section C contains five (5) items on non-cognitive Factors, including motivation, interest, attitudes and beliefs, self-efficacy, and anxiety. The last section has eight (8) items on self-reported perceptions about mathematics achievement.

The content validity of the questionnaire was validated by experts in mathematics education at the Mathematics Department of the University of Education, Winneba, Ghana**.** The items were checked by the experts for their appropriateness in measuring the constructs covered in the study. To check the reliability of the instruments, a pilot study with 50 pre-service teachers, selected randomly in one CoE, was conducted. The reliability of the instrument was measured using Cronbach's alpha. A reliability coefficient of 0.76 obtained was considered acceptable (Akayuure & Attuabea, 2025).

*3.4. Data Collection Procedure*

The primary data for the study were collected through an online survey. To ensure that only targeted participants respond to the instrument, a Google form was designed, and the link was forwarded to respondents' official college WhatsApp platforms for their responses. The Google Form was designed to collect email addresses of respondents, thereby limiting each respondent to one response to ensure unique participation. Before the instrument was administered, respondents were educated on the

purpose and significance of the study, on the same official WhatsApp platforms, and their emerging concerns were addressed. The respondents were given sufficient time of up to two weeks to complete the survey. After one week, the respondents were reminded of the deadline for the survey, and those who had not already completed the survey were asked to do so. The collection of responses was closed at the end of the two weeks for analysis.

The data collection was opened to respondents in all the colleges in the Eastern region who were willing to participate in the study. The instrument was sent to all the official WhatsApp platforms of all the participating colleges, and respondents were free to decide whether to participate or not. Other ethical considerations, such as anonymity and confidentiality of response, were ensured before data collection. The anonymity of respondents was further ensured as respondents were not required to provide their names or index numbers. After the data was collected, the assumptions underlying the regression test were tested for suitability for regression analysis.

*3.5. Data Analysis*

The data obtained from the MAQ were analysed using both descriptive and inferential statistics. Descriptive statistics were employed to summarize demographic characteristics of participants. Multiple Regression Analysis was employed to determine the relationship between CF and NF and the mathematics achievement of participants.

## 4. Results

Participants' demographic information and the results of the regression analysis are presented in this section, taking into account the research questions that guided the study.

*4.1. Demographic information*

The demographic data collected from respondents were analysed using frequencies and percentages as presented in Table 1. The demographic information collected includes level, age range, course of study, and gender of respondents.

**Table 1. Demographic Information of Respondents**

| DEMOGRAPHICS | | NUMBER | PERCENTAGE (%) |
|---|---|---|---|
| GENDER | Male | 240 | 48.2 |
| | Female | 258 | 51.8 |
| | **Total** | **498** | **100** |
| AGE RANGE | Below 20 Years | 14 | 2.8 |
| | 20-25 Years | 409 | 82.1 |
| | 26-30 Years | 57 | 11.5 |
| | Above 30 years | 18 | 3.6 |
| | **Total** | **498** | **100** |
| PROGRAM OF STUDY | Primary Education | 287 | 57.6 |
| | Early Grade Education | 133 | 26.7 |
| | JHS Education | 78 | 15.7 |
| | **Total** | **498** | **100** |
| LEVEL | Level 100 | 153 | 30.7 |
| | Level 200 | 243 | 48.8 |
| | Level 300 | 102 | 20.5 |
| **TOTAL** | | **498** | **100** |

Note. N = 498, Made Up of 240 Males and 258 Females.

From Table 1, the respondents were made up of 240 males, representing 48.2% and 258 females, representing 51.8%. Also, the majority of the respondents fall within the age category of 20-25 years, 409 representing 82.1%, depicting a very youthful sample size, while only a few were below 20 years (14 representing 2.8%) and above 30 years (18 representing 3.6%). More than half of the total number of respondents reported offering Primary Education (287 representing 57.6%), while 133 representing 26.7% and 78 representing 15.7% reported offering Early grade and JHS Education, respectively. The three levels of interest seem to be fairly represented, with the majority of the respondents being in level 200 (243 representing 48.8%).

*4.2. Results of the Multiple Regression Analysis*

Before multiple regression was performed, the assumptions underlying the multiple regression model were tested using the SPSS software. The results of the test show that all the assumptions, namely, linearity, independence of errors, normality, homoscedasticity, and multicollinearity, were not violated. The relationship between the independent variables and the dependent variable is linear, as indicated by the scatter diagram in Figure 1.

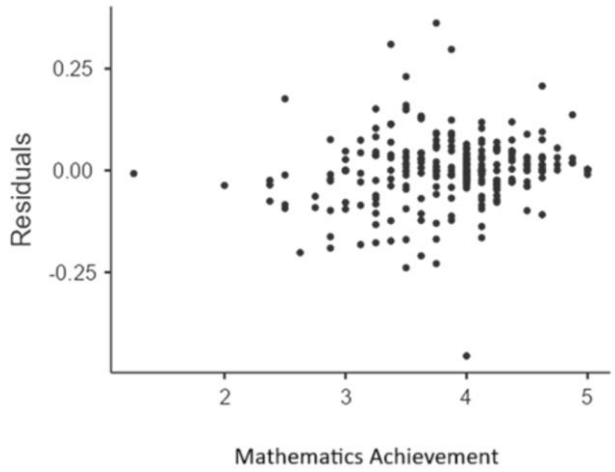


**Figure 1. Scatter Plot Showing the Relationship Between the Variables.**

Furthermore, the Durbin-Watson statistic for independence of errors was 2.289, indicating that the observations were independent of each other. Also, the independent variables were found not to be highly correlated with each other, with tolerance and VIF statistics of 0.643 and 1.556, respectively. A multiple regression analysis was then performed to test the underlisted hypothesis, bearing in mind the research questions. The results are presented in Tables 2, 3, and 4.

4.2.1. Hypotheses

Cognitive factors do not significantly predict mathematics achievement among pre-service teachers in Ghana. Cognitive factors significantly predict mathematics achievement among pre-service teachers in Ghana.

Non-cognitive factors do not significantly predict mathematics achievement among pre-service teachers in Ghana. Non-cognitive factors significantly predict mathematics achievement among pre-service teachers in Ghana.

Cognitive and non-cognitive factors together do not significantly predict mathematics achievement. Cognitive and non-cognitive factors together significantly predict mathematics achievement.

**Table 2. Model Summary of the Regression Analysis**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson Statistic |
|---|---|---|---|---|---|
| 1 | .902[a] | .814 | .814 | .26008 | 2.289 |

Predictors: (Constant). Cognitive Factors, Non-Cognitive Factors
Dependent Variable: Mathematics Achievement

**Table 3. ANOVA Summary of the Regression Analysis**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 146.967 | 2 | 73.484 | 1086.370 | .000[b] |
| | Residual | 33.483 | 495 | .068 | | |
| | **Total** | **180.450** | **497** | | | |

Dependent Variable: Mathematics Achievement
Predictors: (Constant). Cognitive Factors, Non-Cognitive Factors

**Table 4. Multiple Regression Showing Predictors of Mathematics Achievement**

| Predictor Variables | Unstandardized Coefficients (B) | Standard Error (SE) | standardized Coefficients (Beta) | t | Sig. |
|---|---|---|---|---|---|
| **(Constant)** | .344 | .080 | | 4.316 | .000 |
| **Cognitive Factors** | .564 | .025 | .539 | 22.340 | .000 |
| **Non-Cognitive Factors** | .356 | .018 | .470 | 19.449 | .000 |

Dependent Variable: Mathematics Achievement

The multiple regression analysis was conducted to evaluate the extent to which cognitive factors (CF) and non-cognitive factors (NF) predict mathematics achievement (MA) among pre-service teachers. The overall regression model was statistically significant, $F(2, 495) = 1086.37$, $p < .001$, indicating that both cognitive and non-cognitive factors reliably predicted pre-service mathematics teachers' achievement (see Table 3). The model explained a substantial proportion of variance in mathematics achievement, $R^2 = .814$, Adjusted $R^2 = .814$, suggesting that approximately 81.4% of the variance in mathematics achievement

is accounted for by cognitive and non-cognitive factors (see Table 2). The unstandardized and standardized coefficients, as presented in Table 4 (Cognitive factors: $\beta = .539$, $p < .001$; non-cognitive factors: $\beta = .470$, $p < .001$), indicate that both predictors significantly contributed to the model. This suggests that both cognitive and non-cognitive factors are strong, positive predictors of the mathematics achievement of pre-service teachers.

To further understand the individual influence of each of the dimensions of cognitive and non-cognitive factors on achievement, a multiple linear regression analysis was conducted to examine the influence of ten cognitive factors (CF1 to CF10) and five non-cognitive factors (NF1 to NF5) on mathematics achievement (MA) among the 498 pre-service teachers. The results are shown in Tables 5, 6, and 7.

**Table 5. Model Summary of the Regression Analysis of the Influence of Factors**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .989[a] | .979 | .978 | .08940 |

Predictors: (Constant), NF5, CF10, CF2, NF1, CF8, CF4, CF6, NF3, CF5, CF9, CF3, CF1, CF7, NF2, NF4

**Table 6. ANOVA Summary of the Regression Analysis of the Influence of Factors**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 176.597 | 15 | 11.773 | 1472.905 | .000[b] |
| | Residual | 33.483 | 495 | .008 | | |
| | **Total** | **180.450** | **497** | | | |

Dependent Variable: Mathematics Achievement

Predictors: (Constant), NF5, CF10, CF2, NF1, CF8, CF4, CF6, NF3, CF5, CF9, CF3, CF1, CF7, NF2, NF4

**Table 7. The Influence of Cognitive and Non-Cognitive Factors on Mathematics Achievement**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .028 | .033 | | .851 | .395 |
| | CF1 | .127 | .005 | .228 | 26.603 | .000 |
| | CF2 | .146 | .005 | .253 | 28.300 | .000 |
| | CF3 | .121 | .005 | .208 | 24.633 | .000 |
| | CF4 | .013 | .005 | .022 | 2.749 | .006 |
| | CF5 | -.004 | .005 | -.007 | -.810 | .418 |
| | CF6 | -.012 | .005 | -.020 | -2.457 | .014 |
| | CF7 | -.003 | .004 | -.007 | -.791 | .429 |
| | CF8 | .019 | .006 | .024 | 3.121 | .002 |
| | CF9 | .009 | .005 | .014 | 1.672 | .095 |
| | CF10 | .122 | .003 | .271 | 37.817 | .000 |
| | NF1 | .128 | .006 | .177 | 22.603 | .000 |
| | NF2 | .131 | .005 | .239 | 26.220 | .000 |
| | NF3 | .000 | .004 | .001 | .116 | .908 |
| | NF4 | .004 | .005 | .007 | .742 | .459 |
| | NF5 | .192 | .005 | .371 | 40.096 | .000 |

Dependent Variable: Mathematics Achievement

The overall regression model, as indicated in Table 6, was statistically significant, $F(15, 482) = 1472.91$, $p < .001$, indicating that the set of cognitive and non-cognitive variables significantly predicted mathematics achievement of pre-service teachers. The model explained approximately 97.9% of the variance in mathematics achievement, $R^2 = .979$, Adjusted $R^2 = .978$, with a standard error of the estimate of .089 (see Table 5). These results suggest an exceptionally strong model fit, indicating that both factors significantly predicted pre-service teachers' mathematics achievement.

The results from Table 7 show that among the cognitive variables, CF10 (problem-solving skills) with ($\beta = .271$, $p < .001$), CF2 (prior knowledge) with ($\beta = .253$, $p < .001$), and CF1 (retention) with ($\beta = .228$, $p < .001$) had large standardized coefficients indicating that they were influential predictors in the model. Other significant cognitive predictors included CF3 ($\beta = .208$, $p < .001$), CF8 ($\beta = .024$, $p = .002$), and lastly CF4 ($\beta = .022$, $p = .006$). However, the cognitive dimensions, CF5, ($\beta$

= –.007, p = .418), CF6, (β = –.020, p = .014), CF7 (β = –.007, p = .429), and CF9 (β = .014, p = .095), which basically measured mathematical reasoning and critical thinking skills, were found not to significantly influence pre-service teachers' mathematics achievement.

Similarly, Table 7 shows that the non-cognitive dimension, NF5 (self-efficacy), had the largest standardized coefficient (β = .371), indicating it was the most influential predictor in the model. This was followed by the dimensions, NF2 (motivation) with a standardized coefficient (β = .239) and NF1 (anxiety) with a standardized coefficient (β = .177). However, two non-cognitive dimensions, NF3 (beliefs) and NF4 (attitudes) had the lowest standardized coefficients (β = .001, p = .908) and (β = .007, p = .459) respectively, indicating that they were not significant predictors of mathematics achievement.

These findings suggest that cognitive factors such as problem-solving ability and prior mathematical knowledge, along with non-cognitive factors like self-efficacy and motivation, play central roles in influencing mathematics achievement. Conversely, factors such as beliefs, attitudes, and some forms of reasoning had little or no significant predictive power, indicating a need to re-evaluate their instructional emphasis.

## 5. Discussion of Results

The results from the regression analysis conducted show that both cognitive and non-cognitive factors strongly predicted mathematics achievement among pre-service teachers. This finding agrees strongly with Senkpeil and Berger (2016), who argued that adding non-cognitive to cognitive factors significantly increased the regression model. This finding also agrees with the study by Sie and Agyei (2023), who found that though mathematical knowledge significantly predicted teaching practices, anxiety significantly increased the magnitude of the regression model. This suggests that pre-service mathematics teachers must give equal attention to both cognitive and non-cognitive factors, as they both strongly predict achievement in mathematics.

Another finding of this study is that cognitive factors strongly predicted the achievement of pre-service teachers. Among the cognitive determinants, problem-solving skills and prior knowledge emerged as very strong predictors of mathematics achievement among pre-service teachers. This finding agrees with the findings of Nahdi et al. (2020) and Dangkulos et al. (2025), who, in separate studies, found that problem-solving skills significantly impacted the performance of pre-service teachers in Indonesia and the Philippines, respectively. This finding also agrees strongly with other studies (Sam et al, 2023; Agyei & Voogt, 2016), who separately found that students' prior mathematical knowledge strongly affects their mathematical achievement.

It was also revealed in this study that pre-service teachers' mathematical reasoning and critical thinking skills did not influence their mathematical achievement. This finding contradicts the findings of Armah (2024) and Bukari and Govender (2024), who, in separate studies, found mathematical reasoning a significant predictor of mathematics achievement among pre-service teachers in geometry and competence-based mathematics, respectively. More research is required in this area to fully understand the extent to which these cognitive factors predict mathematics achievement, especially in college mathematics courses.

With non-cognitive factors predicting mathematics achievement, it was found in this study that self-efficacy was the strongest predictor of pre-service teachers' mathematics achievement, followed by motivation and anxiety. This finding is in line with separate studies conducted in Ghana by Agormor et al. (2022) and Ampofo (2019), who found a very strong positive relationship between students' self-efficacy and their mathematics achievement. This finding also confirms the claim by Bamidele and Akanmu (2022) that increasing students' self-efficacy could lead to improved mathematics achievement. Furthermore, the study also found that motivation correlates positively with students' achievement, in line with the findings of Mensah and Nabie (2021). Though these findings also agree with Tetteh and Agyei (2022) that motivation is a major predictor of pre-service teachers' achievement in mathematics, they disagree with their finding that motivation was the best predictor of mathematics achievement. These findings provide a timely call on mathematics educators to put in place measures that increase their students' self-efficacy and motivation in mathematics.

It was further found in this study that pre-service teachers' beliefs and attitudes had no significant influence on their mathematical achievements. This finding disagrees with the finding of Edo et al. (2024) that pre-service teachers' attitudes have a direct impact on their mathematical achievement. This is a call for deeper investigations into these non-cognitive factors to get more insight into the phenomenon.

These findings underscore the need for mathematics educators to address both cognitive and non-cognitive dimensions of learning, as each contributes significantly to pre-service teachers' achievement.

## 6. Recommendations and Directions for Future Research

This study revealed that both cognitive and non-cognitive factors have a strong positive predictive impact on the self-reported mathematics achievement of pre-service teachers in CoEs in Ghana. These are contextualized results and need to be extended to other contexts, educational levels, and samples to get more insights into this phenomenon. It is recommended that the combined influence of cognitive and non-cognitive factors on mathematics achievement is further explored in other contexts

and settings to better understand the situation. It is also recommended that future studies explore the use of participants' true achievement scores instead of self-reported achievements.

It was also found in this study that problem-solving skills and prior mathematical knowledge were the strongest cognitive predictors of pre-service teachers' mathematics achievement, while self-efficacy and motivation were the strongest non-cognitive predictors of their mathematics achievement. Based on these findings, it is recommended that teacher educators at the CoEs should take these variables very seriously in their instruction designs and teaching strategies in order to address them accordingly. It is also recommended, based on these findings, that future studies explore these variables further for more insight into the predictive factors of mathematics achievement. It is further recommended that intervention studies be conducted to test strategies to enhance or reduce these constructs among pre-service teachers.

**References**


Agormor, S., Apawu, J., Aboagye-Agbi, J. J. & Hokor, E. K. (2022). Prior mathematics achievement and mathematics self-efficacy as indicators for success in pre-service teachers' achievement in geometry and trigonometry. *Journal of Research in Instruction, 2*(2), 115-128. https://doi.org/10.30862/jri.v2i2.83

Agyei, D. D., & Voogt, J. M. (2016). Pre-service mathematics teachers' learning and teaching of activity-based lessons supported with spreadsheets. *Technology, Pedagogy and Education, 25*(1), 39–59. https://doi.org/10.1080/1475939X.2014.928648

Akayuure, P. & Addo, A. D. (2025). *Quantitative Research Essentials: A Guide for Graduate Scholars.* Weija-Accra: Big Mike's Publication Ltd.

Ampofo, C. B. (2019). Relationship between pre-service teachers' mathematics self-efficacy and their mathematics achievement. *African Journal of Educational Studies in Mathematics and Sciences, 15*(1). https://www.ajol.info/index.php/ajesms/article/view/187476

Armah, R. B. (2024). Geometric thinking of prospective mathematics teachers: Assessing the foundation built by university undergraduate education in Ghana. *Teacher Education and Curriculum Studies, 9*(2), 40–51. https://doi.org/10.11648/j.tecs.20240902.12

Assuah, C. K. (2025). *A comprehensive guide to navigating the maze of qualitative research.* Accra New Town: Emmpong Press.

Bamidele, A. T., & Akanmu, M. A. (2022). Pre-service mathematics teachers' self-efficacy and performance: A case study of education colleges in Kwara State, Nigeria. *ATTARBAWIY: Malaysian Online Journal of Education, 7*(2). https://doi.org/10.53840/attarbawiy.v7i2.158

Bandura, A. (1986). *Social foundations of thought and action.* Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* W. H. Freeman.

Brewster, B. J., & Miller, T. (2022). Expressive writing interventions for pre-service teachers' mathematics anxiety. *International Electronic Journal of Mathematics Education, 17*(4), em0704. https://doi.org/10.29333/iejme/12298

Bukari, H. I., & Govender, R. (2024). Developing modelling competencies in pre-service mathematics teachers through reflective thinking skills. *African Journal of Teacher Education and Development, 3*(1), a54. https://doi.org/10.4102/ajoted.v3i1.54

Dangkulos, T. G., Ibanez, E. D. & Pentang, J. T. (2025). Problem-solving disposition as a predictor of pre-service elementary teachers' problem-solving performance. *Journal of Education and Learning (EduLearn), 19*(1), 54-62. https://doi.org/10.11591/edulearn.v19i1.21387

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). https://www.pedagogicalresearch.com/article/pre-service-teachers-mathematics-achievement-attitude-and-anxiety-the-moderative-role-of-pre-service-14192

Komarraju, M., & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter? *Learning and Individual Differences, 25*, 67–72. https://doi.org/10.1016/j.lindif.2013.01.005

Mensah, J. Y., & Nabie, M. J. (2021). The effect of PowerPoint instruction on high school students' achievement and motivation to learn geometry. *International Journal of Technology in Education, 4*(3), 331–350. https://doi.org/10.46328/ijte.55

Ministry of Education. (2018). *Four-year Bachelor of Education degree supported teaching in school: School placement handbook.* Ministry of Education.

Ministry of Education. (2019). *Mathematics curriculum for primary schools (Basic 4–6).* National Council for Curriculum and Assessment (NaCCA).

Nahdi, D. S., Jatisunda, M. G., Cahyaningsih, U. & Suciawati, V. (2020). Pre-service teachers' ability in solving mathematics problems viewed from numeracy literacy skills. *Ilkogretim Online - Elementary Education Online, 19*(4), 1902-1910. https://doi.org/10.17051/ilkonline.2020.762541

Phan, H. P. (2013). Self-efficacy, reflection, and achievement: A short-term longitudinal examination. *The Journal of Educational Research, 107*(2), 90–102. https://doi.org/10.1080/00220671.2012.753860

Polya, G. (1945). *How to solve it.* Princeton University Press.

Sam, L. N., Asiedu-Addo, S. K., & Enu, J. (2023). An assessment of preservice teachers' content knowledge for teaching algebra: Evidence from Ghana Central Region. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education*, *4*(1), 6–11. https://fnasjournals.com/index.php/FNAS-JMSE/article/view/140

Senkpeil, R. R., & Berger, E. J. (2016). Impact of non-cognitive factors on first-year performance (Paper ID #15565). *American Society for Engineering Education.* https://peer.asee.org/impact-of-non-cognitive-factors-on-first-year-performance

Sie, C. K., & Agyei, D. D. (2023). Relationship between pre-service teachers' mathematical knowledge for teaching fractions and their teaching practices: What is the role of teacher anxiety? *Contemporary Mathematics and Science Education, 4*(2), ep23017. https://doi.org/10.30935/conmaths/13252

Taley, I. B., Adusei, O., & Koranteng, D. N. (2021). Mathematics teaching anxiety among college of education pre-service teachers in Ghana: The influence of mathematics achievement and field experiences. *International Journal of Innovative Research and Development, 10*(4). https://doi.org/10.24940/ijird/2021/v10/i4/159356-391055-1-SM

Tetteh, H. N. K., & Agyei, D. D. (2022). Factors influencing pre-service teachers' performance in mathematics in colleges of education: Re-counting experiences in Ghana. *African Journal of Educational Studies in Mathematics and Sciences, 18*(1). https://doi.org/10.4314/ajesms.v18i1.6

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*(1), 89–101. https://doi.org/10.1016/j.cedpsych.2008.09.002