# A Structural Equation Modeling Analysis of Mathematics Attitudes among First-Year Pre-Service Teachers in Atebubu College of Education

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## ABSTRACT

Mathematics attitudes among pre-service teachers are critical determinants of instructional effectiveness and students' learning outcomes in basic education. This study investigated the multidimensional structure and structural relationships of mathematics attitudes among first-year pre-service teachers in Atebubu College of Education using Structural Equation Modelling (SEM). The study was guided by two objectives: to examine the factor structure of mathematics attitudes using the constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness, and to determine the extent to which these constructs predict overall mathematics attitude among first-year pre-service teachers. A quantitative cross-sectional survey design was employed, involving 221 first-semester pre-service teachers. Data were collected using a validated 25-item Likert-scale instrument measuring mathematics anxiety, self-confidence, enjoyment, perceived usefulness, perceived difficulty, and growth mind-set. Confirmatory Factor Analysis (CFA) confirmed a six-factor measurement model with acceptable fit indices (CFI = 0.932; RMSEA = 0.068). Structural model results revealed that mathematics anxiety significantly and negatively predicted self-confidence ($\beta = -0.71$) and enjoyment ($\beta = -0.58$), while perceived usefulness positively predicted enjoyment ($\beta = 0.64$). Growth mind-set positively influenced self-confidence ($\beta = 0.47$), whereas perceived difficulty significantly increased mathematics anxiety ($\beta = 0.39$). The study concluded that mathematics attitude among first-year pre-service teachers is influenced by multiple psychological and affective factors. The study recommends that mathematics tutors and educational policymakers implement strategies that enhance students' confidence, motivation, and interest while reducing mathematics anxiety and perceived difficulty.

**Keywords:** Mathematics attitude, Structural Equation Modelling, mathematics anxiety, confidence, motivation, pre-service teachers, teacher education, Ghana.

## INTRODUCTION

Mathematics remains one of the core subjects in Ghana's educational system, yet many students continue to demonstrate low achievement, fear, and negative dispositions toward the subject. Emerging evidence increasingly attributes students' poor performance in mathematics to affective and psychological factors associated with teachers, particularly their attitudes, beliefs, and emotional dispositions toward the subject (Edo et al., 2024). Research shows that teachers' mathematics attitudes significantly influence their instructional practices, classroom engagement strategies, and ultimately, student achievement (Costado Dios & Piñero Charlo, 2024). In Colleges of Education, first-year pre-service teachers constitute a crucial group because they are at the foundational stage of professional teacher preparation (Edo et al., 2024). However, many pre-service teachers enter Colleges of Education with varying emotional and psychological orientations toward mathematics, including fear, low confidence, anxiety, and lack of motivation. These attitudinal dispositions significantly influence how they learn mathematics and eventually teach it in basic schools (Owusu, 2023).

Mathematics attitude refers to learners' emotional, cognitive, and behavioural predispositions toward mathematics. It encompasses feelings, beliefs, perceptions, motivation, confidence, and value judgments associated with mathematics learning (Edo et al., 2024).. Edo et al. (2024) argued that students' attitudes toward mathematics influence their participation, persistence, achievement, and future engagement in mathematics-

related activities. Positive mathematics attitudes often enhance achievement and classroom participation, whereas negative attitudes such as anxiety and perceived difficulty may reduce students' interest and confidence in learning mathematics (Edo et al., 2024). Li et al. (2025) argue that teacher-related affective variables, including anxiety and confidence, play a critical role in shaping students' mathematics experiences and outcomes, highlighting the teacher as a key mediating factor in mathematics education quality.

Research has shown that mathematics attitude is a multidimensional construct influenced by several psychological and affective factors such as anxiety, interest, motivation, confidence, perceived difficulty, and perceived usefulness (Edo et al., 2024). Among these variables, mathematics anxiety has been identified as one of the major barriers to effective mathematics learning. Students who experience high levels of anxiety often avoid mathematical tasks, demonstrate low participation, and perform poorly in mathematics-related activities (Namkung et al., 2019). Low confidence and the perception that mathematics is difficult may reduce learners' willingness to engage actively in mathematics learning. Students who possess high confidence and motivation toward mathematics tend to demonstrate better academic performance and stronger classroom participation than those with negative attitudes toward the subject. Mathematics anxiety and perceptions of difficulty have been found to negatively affect learners' achievement and engagement in mathematics lessons (Banson et al., 2023).

In recent years, mathematics education researchers have increasingly employed advanced statistical approaches such as Structural Equation Modelling (SEM) to examine the complex relationships among mathematics attitude constructs (Byrne, 2016). SEM enables researchers to simultaneously assess measurement models and structural relationships among latent variables, thereby providing more comprehensive explanations of educational phenomena. According to Byrne (2016), SEM is particularly appropriate for educational and psychological research because it allows for the investigation of latent constructs that are not directly observable but inferred through measurable indicators. In the context of mathematics attitudes, SEM provides opportunities to examine how constructs such as anxiety, confidence, motivation, interest, usefulness, and perceived difficulty collectively explain learners' attitudes toward mathematics (Byrne, 2016).

In Ghana, concerns continue to emerge regarding students' poor performance and low interest in mathematics at various educational levels. These concerns have directed attention toward the attitudes of pre-service teachers who will eventually teach mathematics in Ghanaian basic schools. Several Ghanaian studies have examined pre-service teachers' attitudes toward mathematics and their relationships with achievement and instructional practices. For instance, Owusu (2023) examined pre-service teachers' attitudes toward mathematics learning at Mt. Mary College of Education and reported that usefulness, encouragement, self-confidence, and perceived difficulty significantly influenced mathematics attitudes among pre-service teachers. Similarly, Edo et al. (2024) investigated the moderating role of interest in the relationship among mathematics attitude, anxiety, and achievement among pre-service teachers in Ghana and found that attitude positively influenced mathematics achievement. Furthermore, Amusuglo et al. (2024) validated the Attitudes Toward Mathematics Inventory among first-year pre-service teachers in Ghana and identified confidence, enjoyment, and usefulness as important factors underlying mathematics attitudes.

Despite these contributions, existing studies within the Ghanaian context have largely focused on isolated variables such as anxiety, achievement, or confidence, with limited attention given to the simultaneous modelling of multiple mathematics attitudes constructs using Structural Equation Modelling. Most previous studies relied on descriptive statistics, correlation, regression analysis, or exploratory factor analysis rather than comprehensive SEM approaches capable of examining the interrelationships among latent constructs. Additionally, there remains limited empirical evidence specifically focusing on first-year pre-service teachers in Colleges of Education, even though this category of students experiences critical transitional adjustments into teacher education programs. First-year pre-service teachers often enter Colleges of Education with preconceived notions and prior experiences in mathematics, which may significantly shape their future teaching orientations. Understanding their mathematics attitudes at this stage is therefore essential for improving teacher preparation and mathematics instruction in Ghanaian schools. The gap in literature creates the need for a study that comprehensively models mathematics attitudes among first-year pre-service teachers using Structural Equation Modelling. By examining anxiety, interest, motivation, confidence, perceived difficulty, and usefulness as dimensions of mathematics attitude, the present study seeks to provide empirical evidence regarding the structure and predictive relationships among these constructs.

The study aimed to examine mathematics attitudes among first-year pre-service teachers in Ghanaian Colleges of Education using Structural Equation Modelling. Specifically, the study seeks to;

1. Examine the factor structure of mathematics attitudes among first-year pre-service teachers in Atebubu College of Education in Ghana using the constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness.
2. Determine the extent to which anxiety, interest, motivation, confidence, perceived difficulty, and usefulness predict mathematics attitude among first-year pre-service teachers in Atebubu College of Education.

The study will be beneficial to mathematics tutors, curriculum developers, educational policymakers, Colleges of Education, and researchers in mathematics education. Mathematics tutors may use the findings to identify factors influencing pre-service teachers' mathematics attitudes and design instructional strategies that improve confidence, motivation, and interest while reducing anxiety and perceptions of difficulty. Curriculum developers and educational policymakers may also benefit from the study by obtaining empirical evidence to support the development of intervention programs and curriculum reforms aimed at strengthening mathematics teacher preparation in Atebubu College of Education. The findings may further guide teacher educators in designing learner-centred instructional practices that foster positive mathematics attitudes among pre-service teachers. The study will contribute significantly to mathematics education literature by providing an empirically validated SEM model of mathematics attitudes among first-year pre-service teachers in Ghana. Additionally, the study will extend existing literature on affective variables in mathematics education and provide a foundation for future studies on mathematics attitudes, teacher preparation, and achievement in Ghana and beyond.

## LITERATURE REVIEW

### Theoretical Framework

The study is first anchored on the Social Cognitive Theory developed by Albert Bandura. Bandura (1986) explained that human behaviour is influenced through reciprocal interactions among personal factors, environmental conditions, and behaviours. Central to the theory is the concept of self-efficacy, which refers to individuals' beliefs in their capabilities to organize and execute actions required to achieve desired outcomes. Bandura (1997) argued that self-efficacy beliefs significantly influence motivation, emotional reactions, persistence, and performance. Individuals who believe in their capabilities are more likely to approach tasks confidently, persist in challenging situations, and demonstrate resilience when difficulties arise. Conversely, individuals with low self-efficacy are more likely to avoid challenging tasks, experience anxiety, and demonstrate low motivation. In mathematics education, Social Cognitive Theory has been widely applied to explain learners' confidence, anxiety, and engagement in mathematics learning. Pajares and Miller (1994) found that mathematics self-efficacy significantly predicted students' mathematical problem-solving performance. Similarly, Hackett and Betz (1989) reported that students with strong mathematics self-efficacy demonstrated higher participation and persistence in mathematics-related activities. The relevance of Social Cognitive Theory to the present study lies primarily in the mathematics confidence and anxiety constructs. Mathematics confidence reflects pre-service teachers' beliefs in their ability to successfully learn and solve mathematics tasks, whereas mathematics anxiety reflects negative emotional reactions toward mathematics. Bandura (1997) indicates that, individuals with strong self-efficacy beliefs are less likely to experience anxiety because they perceive themselves as capable of handling academic challenges. Therefore, the theory explains how confidence may positively influence mathematics attitudes while anxiety negatively affects learners' engagement and participation in mathematics learning. The theory is particularly appropriate for first-year pre-service teachers because students entering Colleges of Education often possess varying beliefs regarding their mathematical capabilities based on prior educational experiences. Their confidence and anxiety levels may therefore shape their mathematics attitudes and future instructional practices.

The study is also grounded in the Expectancy-Value Theory proposed by Jacquelynne Eccles and colleagues. Eccles et al. (1983) explained that individuals' achievement-related choices and behaviours are influenced by two major factors: expectancy beliefs and subjective task values. Expectancy beliefs refer to individuals' perceptions of their likelihood of succeeding in a task, whereas subjective task values concern the importance,

usefulness, enjoyment, and relevance attached to the task. According to Eccles and Wigfield (2002), students are more likely to engage in academic activities when they believe they can succeed and when they perceive the activity as useful, enjoyable, or important. The theory further identifies components of task value such as intrinsic value (interest/enjoyment), utility value (usefulness), attainment value, and perceived cost. These dimensions significantly influence students' motivation, persistence, and academic engagement. Expectancy-Value Theory has been extensively applied in mathematics education research to explain students' motivation, interest, and perceptions regarding mathematics learning. Wigfield and Eccles (2000) argued that students who perceive mathematics as useful and interesting are more likely to demonstrate positive attitudes and persistence in mathematics-related tasks. Similarly, Middleton and Spanias (1999) reported that motivation and interest strongly influence learners' engagement and achievement in mathematics learning. The theory is relevant to the present study because it explains major constructs such as motivation, interest, usefulness, and perceived difficulty. Students who perceive mathematics as useful for future careers and daily life are more likely to develop positive attitudes toward mathematics. Likewise, learners who enjoy mathematics and possess high expectancy beliefs are more likely to demonstrate strong motivation and active participation in mathematics learning. Conversely, students who perceive mathematics as excessively difficult may develop low expectancy beliefs and negative attitudes toward the subject. Among first-year pre-service teachers in Ghanaian Colleges of Education, perceptions regarding the usefulness and difficulty of mathematics may significantly influence motivation, confidence, and future commitment to mathematics teaching. Expectancy-Value Theory therefore provides a strong theoretical basis for understanding how these constructs collectively shape mathematics attitudes.

The study is further supported by the Affective Domain Theory in Mathematics Education advanced by Douglas McLeod. McLeod (1992) argued that affective variables play important roles in mathematics learning and should be considered alongside cognitive factors in mathematics education research. According to McLeod, the affective domain in mathematics includes emotions, attitudes, and beliefs that influence learners' responses toward mathematics activities. McLeod classified affective responses into three broad categories: Emotions, which are immediate reactions such as fear or anxiety; Attitudes, which are relatively stable positive or negative orientations toward mathematics; and Beliefs, which are learners' perceptions regarding mathematics and their mathematical abilities. The theory emphasizes that learners' emotional experiences in mathematics classrooms significantly influence their engagement, participation, and achievement. Learners who repeatedly experience fear, frustration, or failure in mathematics may develop negative attitudes and avoidance behaviours, whereas positive learning experiences may promote confidence and interest. Researchers have widely applied the affective domain perspective in explaining mathematics anxiety and students' attitudes toward mathematics. Hembree (1990) found that mathematics anxiety negatively affects mathematics achievement and participation. Similarly, Ashcraft and Krause (2007) explained that mathematics anxiety interferes with working memory processes required for mathematical problem-solving. The relevance of the Affective Domain Theory to the present study lies in its explanation of mathematics attitude as an emotional and psychological construct influenced by learners' experiences and beliefs. Constructs such as anxiety, confidence, interest, and perceived difficulty can be understood within the affective domain framework because they reflect learners' emotional and attitudinal orientations toward mathematics learning. The theory is particularly suitable for the study because first-year pre-service teachers may enter Colleges of Education with pre-existing emotional experiences and beliefs about mathematics developed from previous schooling. These emotional orientations may influence their adjustment, motivation, and future classroom practices.

The integration of Social Cognitive Theory, Expectancy-Value Theory, and the Affective Domain Theory provides a comprehensive theoretical basis for examining mathematics attitudes among first-year pre-service teachers in Ghanaian Colleges of Education. Social Cognitive Theory explains how confidence and self-beliefs influence mathematics engagement and anxiety. Expectancy-Value Theory explains how interest, usefulness, motivation, and perceived difficulty shape learners' participation and persistence in mathematics learning. The Affective Domain Theory further explains how emotional and attitudinal experiences influence learners' mathematics attitudes and behaviours. Collectively, these theories support the conceptualization of mathematics attitude as a multidimensional latent construct comprising anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. The theories also justify the application of Structural Equation Modelling in the

present study because SEM enables the simultaneous examination of relationships among multiple latent constructs.

## Empirical Studies

### Mathematics Attitude

Researchers have argued that students' success in mathematics is influenced not only by cognitive abilities but also by emotional and psychological dispositions toward the subject. According to Douglas McLeod, affective variables such as beliefs, emotions, and attitudes significantly shape students' mathematical thinking and problem-solving behaviours. McLeod (1992) further explained that affective responses toward mathematics influence how learners approach mathematical tasks and persist in challenging situations. The concept of mathematics attitude has been defined differently by scholars depending on the dimensions emphasized in their studies. Aiken (1970) defined attitude toward mathematics as "a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person." In mathematics education, this object refers specifically to mathematics learning and mathematical activities. Similarly, Zan and Di Martino (2007) conceptualized attitude toward mathematics as a multidimensional construct involving emotional disposition, beliefs about mathematics, and perceived competence in mathematics learning.

Tapia and Marsh (2004) described mathematics attitude as learners' emotional and evaluative responses toward mathematics, including confidence, enjoyment, motivation, and perceptions of usefulness. Their conceptualization formed the basis for the development of the Attitudes Toward Mathematics Inventory (ATMI), which has been widely used in mathematics education research. According to the authors, mathematics attitude is not a single construct but rather a combination of several interrelated dimensions that collectively influence learners' participation and achievement in mathematics. Similarly, Ma and Kishor (1997), in a meta-analysis examining the relationship between mathematics attitude and achievement, concluded that positive attitudes toward mathematics are significantly associated with improved mathematics achievement. Their findings suggest that learners who develop favourable attitudes toward mathematics are more likely to demonstrate persistence, confidence, and active engagement in mathematics learning. In contrast, negative attitudes such as anxiety and fear may hinder academic performance and reduce students' willingness to participate in mathematics-related activities.

Research has consistently shown that students' attitudes toward mathematics significantly influence their academic performance and participation in mathematics-related activities. A study by Mohamed and Waheed (2019) examined students' attitudes toward mathematics among secondary school learners and found that positive attitudes were strongly associated with higher mathematics achievement. The study further revealed that students who enjoyed mathematics and perceived it as useful demonstrated greater classroom participation and persistence in solving mathematical problems. Similarly, Hannula argued that learners' emotions, beliefs, and values toward mathematics shape their engagement and learning outcomes. Hannula (2020) emphasized that attitudes toward mathematics are multidimensional and are influenced by both cognitive and affective factors. In Ghana, studies have also shown that mathematics attitude remains a major determinant of students' achievement. For instance, Asante (2021) found that students with positive mathematics attitudes performed significantly better in mathematics than students with negative attitudes. The study concluded that confidence and interest were among the strongest predictors of positive mathematics attitudes among Ghanaian students.

The present study conceptualizes mathematics attitude as a multidimensional latent construct measured through six major dimensions: mathematics anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. These dimensions are discussed below.

### Mathematics Anxiety

Mathematics anxiety is one of the most extensively studied affective variables in mathematics education. Richardson and Suinn (1972) defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations."

This definition emphasizes the emotional discomfort and fear experienced by learners during mathematics-related activities. Researchers have consistently reported negative relationships between mathematics anxiety and academic achievement. Ashcraft and Krause (2007) argued that mathematics anxiety reduces working memory capacity, thereby affecting learners' ability to process mathematical information effectively. Similarly, Hembree (1990), in a meta-analysis on mathematics anxiety, found that high levels of anxiety negatively influence mathematics performance and learners' confidence. In Ghana, Edo et al. (2024) reported that mathematics anxiety negatively affected pre-service teachers' mathematics achievement, while interest moderated the relationship between anxiety and achievement. These findings suggest that reducing mathematics anxiety among pre-service teachers is essential for improving mathematics learning and future instructional effectiveness.

Mathematics anxiety has received considerable attention in educational research because of its negative effect on mathematics performance and participation. A meta-analysis conducted by Namkung et al. (2019) established a strong negative relationship between mathematics anxiety and mathematics achievement among school-aged learners. The study concluded that students with high mathematics anxiety often experience difficulties in problem-solving and tend to avoid mathematics-related tasks. Similarly, Carey et al. (2019) reported that mathematics anxiety significantly reduces students' confidence and motivation toward mathematics learning. The researchers found that anxious students often exhibit fear, tension, and low participation during mathematics lessons. Among pre-service teachers, mathematics anxiety is particularly concerning because anxious teachers may unintentionally transfer negative attitudes toward mathematics to their future students. A study by Berkant and Gençoğlu (2021) found that pre-service teachers with high levels of mathematics anxiety demonstrated lower confidence and less willingness to teach mathematics effectively.

**Interest in Mathematics**

Interest in mathematics refers to learners' enjoyment, curiosity, and personal attraction toward mathematics learning. According to Suzanne Hidi and Renninger (2006), interest is a psychological state characterized by focused attention, increased cognitive functioning, and positive emotional engagement toward specific activities. In mathematics education, interest promotes learners' active participation and persistence in mathematical tasks. Researchers have consistently found positive relationships between mathematics interest and achievement. Schiefele (1991) argued that students who develop strong interest in learning activities are more likely to demonstrate persistence, concentration, and academic success. Similarly, Akendita et al. (2025) found that mathematics interest positively enhanced pre-service teachers' mathematics performance in Ghana. Interest is particularly important among first-year pre-service teachers because their initial experiences in Colleges of Education may shape their long-term engagement and professional attitudes toward mathematics teaching.

Interest in mathematics has been identified as a major contributor to students' engagement and persistence in mathematics learning. Fisher et al. (2020) investigated the role of interest in mathematics learning and found that students who expressed enjoyment and curiosity toward mathematics demonstrated stronger academic engagement and achievement. Similarly, Schukajlow et al. (2022) revealed that students' interest positively influenced their motivation and willingness to participate in mathematical activities. The study further showed that learner-centred teaching strategies and supportive classroom environments significantly improved students' interest in mathematics. Research in African educational contexts also supports the importance of interest in mathematics. A study by Mensah et al. (2022) among Ghanaian senior high school students found that students who developed strong interest in mathematics were more likely to demonstrate positive attitudes and higher academic performance in the subject.

**Motivation toward Mathematics**

Motivation toward mathematics refers to the internal or external factors that stimulate learners' willingness to engage in mathematics learning activities. According to Deci and Ryan (2000), motivation influences the direction, intensity, and persistence of learners' behaviours toward academic tasks. Their Self-Determination Theory distinguished between intrinsic motivation, which originates from internal enjoyment and satisfaction, and extrinsic motivation, which is driven by external rewards or outcomes. Within mathematics education, motivated learners tend to demonstrate greater effort, persistence, and academic achievement. Middleton and

Spanias (1999) explained that mathematics motivation significantly influences students' willingness to engage in challenging mathematical activities. Similarly, Tapia and Marsh (2004) identified motivation as an important component of mathematics attitude because motivated learners often demonstrate positive emotional engagement and persistence in mathematics learning. Among pre-service teachers, motivation toward mathematics may influence both academic performance and future teaching commitment. Pre-service teachers who are motivated to learn mathematics are more likely to develop confidence and effective instructional practices.

Motivation has been widely recognized as a strong predictor of mathematics achievement and attitude. Ryan and Deci (2020) explained that intrinsically motivated learners engage in mathematics activities because of enjoyment and personal satisfaction, whereas extrinsically motivated learners are influenced by rewards and external expectations. Howard et al. (2021) found that motivated students demonstrated higher persistence, confidence, and achievement in mathematics than less motivated students. The study also indicated that motivation positively influenced learners' willingness to solve challenging mathematical problems. In the Ghanaian context, Oppong et al. (2021) reported that students' motivation toward mathematics significantly predicted their classroom participation and academic success. The study recommended that teachers adopt interactive instructional strategies to improve students' motivation and attitudes toward mathematics.

**Mathematics Confidence**

Mathematics confidence refers to learners' beliefs in their ability to successfully perform mathematical tasks and solve mathematics problems. Confidence in mathematics is closely related to the concept of self-efficacy introduced by Albert Bandura. Bandura (1997) defined self-efficacy as individuals' beliefs in their capabilities to organize and execute actions required to achieve specific goals. Researchers have consistently reported positive relationships between mathematics confidence and achievement. Pajares and Miller (1994) found that mathematics self-efficacy significantly predicted students' mathematics problem-solving performance. Similarly, Owusu (2023) reported that confidence significantly influenced pre-service teachers' attitudes toward mathematics learning in Ghana. Confidence is particularly important among pre-service teachers because teachers with strong mathematics confidence are more likely to teach mathematics effectively and encourage learners' participation.

Research findings indicate that mathematics confidence strongly influences students' engagement and achievement in mathematics. Skaalvik et al. (2022) found that students with high mathematics self-efficacy demonstrated greater persistence, reduced anxiety, and better academic performance in mathematics. Similarly, OECD (2023), through the Programme for International Student Assessment (PISA), reported that learners who believed in their mathematical abilities were more likely to perform well in mathematics and participate actively in classroom activities. A study conducted by Adu and Osei (2020) in Ghana revealed that confidence significantly predicted students' mathematics achievement and attitudes. The researchers concluded that students who trusted their mathematical abilities were more likely to develop positive attitudes toward the subject.

**Perceived Difficulty of Mathematics**

Perceived difficulty refers to learners' beliefs about the complexity and challenging nature of mathematics. Students who perceive mathematics as excessively difficult often develop anxiety, avoidance behaviours, and low motivation toward mathematics learning. According to Tobias and Weissbrod (1980), perceptions of mathematics difficulty contribute significantly to mathematics anxiety and poor academic performance. Research evidence indicates that learners' perceptions of mathematics difficulty negatively influence engagement and achievement. Owusu (2023) found that perceived difficulty significantly affected pre-service teachers' mathematics attitudes in Ghana. Similarly, Ma and Xu (2004) reported that students who perceived mathematics as difficult demonstrated lower participation and achievement in mathematics learning. Among first-year pre-service teachers, perceptions of mathematics difficulty may influence academic adjustment and confidence in future mathematics teaching.

Perceived difficulty has been found to negatively influence students' attitudes and performance in mathematics. Retnawati et al. (2021) reported that students who perceived mathematics as difficult were more likely to

experience anxiety, low motivation, and poor academic performance. Similarly, Mailizar et al. (2020) found that students who consistently struggled with mathematical concepts developed negative perceptions toward mathematics and demonstrated reduced engagement during lessons. Research by Arthur et al. (2022) among pre-service teachers in Ghana showed that perceived difficulty significantly affected students' confidence and willingness to engage in mathematics learning. The study recommended the use of practical and learner-centred instructional methods to reduce students' perceptions of mathematics difficulty.

**Perceived Usefulness of Mathematics**

Perceived usefulness refers to learners' beliefs regarding the relevance and applicability of mathematics in daily life, education, and future careers. Eccles and Wigfield (2002) explained that students' task value beliefs significantly influence motivation, persistence, and achievement. Learners who perceive mathematics as useful are more likely to invest effort and demonstrate positive attitudes toward mathematics learning. Tapia and Marsh (2004) identified usefulness as an important dimension of mathematics attitude because students who value mathematics are more likely to engage actively in mathematical activities. Similarly, Amusuglo et al. (2024) reported that usefulness significantly contributed to mathematics attitudes among first-year pre-service teachers in Ghana. In teacher education, perceived usefulness may influence pre-service teachers' commitment to mathematics learning and future instructional practices. Teachers who recognize the value of mathematics are more likely to emphasize its practical relevance in classroom instruction.

The perceived usefulness of mathematics has also been identified as a significant predictor of mathematics attitudes and achievement. Eccles and Wigfield (2020) explained that students are more motivated to learn mathematics when they perceive it as valuable and relevant to their future goals. Wang et al. (2021) found that students who perceived mathematics as useful for career development and daily life demonstrated stronger motivation and more positive attitudes toward mathematics learning. In a study conducted among teacher trainees in West Africa, Boateng and Agyei (2021) revealed that students who recognized the practical applications of mathematics showed greater interest and commitment toward mathematics education.

**Structural Equation Modelling and Mathematics Attitude**

Structural Equation Modelling (SEM) has become increasingly important in educational and psychological research because it enables researchers to examine complex relationships among latent constructs. According to Byrne (2016), SEM combines factor analysis and regression analysis to test measurement and structural models simultaneously. In mathematics attitude research, SEM is particularly useful because constructs such as anxiety, confidence, motivation, interest, usefulness, and perceived difficulty are latent variables that cannot be directly observed. Researchers have increasingly used SEM to validate mathematics attitude models and examine relationships among affective constructs. The present study therefore adopts SEM to examine how anxiety, interest, motivation, confidence, perceived difficulty, and usefulness collectively explain mathematics attitudes among first-year pre-service teachers in Ghanaian Colleges of Education.

The reviewed empirical studies indicate that mathematics attitude is influenced by several interrelated factors, including anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. The literature consistently shows that anxiety and perceived difficulty negatively affect mathematics attitudes, whereas interest, motivation, confidence, and usefulness positively influence students' engagement and achievement in mathematics. However, despite the numerous studies conducted on mathematics attitudes, limited research has applied Structural Equation Modelling (SEM) to examine the factor structure and predictive relationships among these constructs among first-year pre-service teachers in Colleges of Education in Ghana. This study therefore seeks to fill this gap by investigating the structural relationships among the identified constructs using SEM.

## METHODOLOGY

The study was grounded in the positivist research philosophy. The choice of positivism for the present study is informed by the quantitative nature of the research and the use of Structural Equation Modelling (SEM) to examine relationships among mathematics attitude constructs. The study seeks to objectively measure latent variables such as anxiety, interest, motivation, confidence, perceived difficulty, and usefulness among first-year

pre-service teachers in Ghanaian Colleges of Education. Positivism assumes that social phenomena can be objectively measured and explained using empirical and statistical methods (Creswell & Creswell, 2018).

The study adopted the quantitative research approach. The quantitative approach was considered appropriate because the study sought to examine relationships among latent constructs of mathematics attitude and to determine the predictive effects of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness on overall mathematics attitude among first-year pre-service teachers. Quantitative research enables the collection of numerical data and the use of statistical techniques for hypothesis testing and model estimation (Creswell & Creswell, 2018). The study further adopted Structural Equation Modelling (SEM) as the main analytical framework. SEM was appropriate because it allows the researcher to examine complex relationships among latent variables simultaneously while also assessing the measurement and structural models (Hair et al., 2022). SEM combines factor analysis and multiple regression analysis, making it suitable for testing the factor structure and predictive relationships among mathematics attitude constructs.

The study employed descriptive cross-sectional survey design. This design is appropriate for examining relationships among variables at a single point in time without manipulation of study variables. According to Creswell and Creswell (2018), cross-sectional survey designs are suitable for studies that seek to describe attitudes, beliefs, and perceptions within a defined population. The design was appropriate for the present study because it enabled the researcher to collect data regarding mathematics anxiety, interest, motivation, confidence, perceived difficulty, and usefulness among first-year pre-service teachers in Colleges of Education. The design further supported the use of questionnaires for gathering standardized data suitable for Structural Equation Modelling.

The target population for the study comprised pre-service teachers enrolled in Atebubu College of Education in Ghana. First-year pre-service teachers were selected because they are at the foundational stage of teacher preparation, and their attitudes toward mathematics may significantly influence their future instructional practices and professional development. According to data from the Ghana Tertiary Education Commission, Colleges of Education in Ghana continue to play critical roles in preparing teachers for the nation's basic schools. The accessible population consisted of all first-year pre-service teachers enrolled in Atebubu College of Education in 2024/2025 academic year.

A sample of 221 first-year pre-service teachers was selected from the population using probability sampling procedures. The sample size was determined based on SEM recommendations, which emphasize adequate sample sizes for reliable parameter estimation and model fit assessment (Kline, 2023). Researchers generally recommend a sample size of at least 200 respondents for SEM studies to achieve stable and reliable estimates (Hair et al., 2022). Simple random sampling was used to select participants for the study. This technique ensured that every first-year pre-service teacher had an equal chance of being selected, thereby minimizing selection bias and enhancing the representativeness of the sample (Etikan & Bala, 2017).

Data for the study were collected using a structured questionnaire titled Mathematics Attitude Questionnaire (MAQ). The questionnaire was developed based on existing mathematics attitude literature and constructs identified in studies by Tapia and Marsh (2004), McLeod (1992), and Amusuglo et al. (2024). The instrument measured six dimensions of mathematics attitude: Mathematics anxiety, Interest in mathematics, Motivation toward mathematics, Mathematics confidence, Perceived difficulty of mathematics, and Perceived usefulness of mathematics. The questionnaire consisted of two sections. Section A collected demographic information such as gender, age, and program of study, while Section B measured mathematics attitude constructs using Likert-scale items ranging from 1 = Strongly Disagree to 5 = Strongly Agree. The use of Likert-scale questionnaires is supported by Boone and Boone (2012), who explained that Likert scales are appropriate for measuring attitudes, perceptions, and psychological constructs in educational research.

Validity refers to the extent to which an instrument accurately measures what it is intended to measure (Fraenkel et al., 2019). To ensure content validity, the questionnaire items were developed based on established mathematics attitude constructs from previous studies and were reviewed by experts in mathematics education, educational psychology, and measurement and evaluation. Their suggestions were used to revise ambiguous items and improve clarity and relevance. Construct validity was assessed using Confirmatory Factor Analysis

(CFA) within the SEM framework. According to Byrne (2016), CFA is appropriate for assessing whether observed variables adequately represent latent constructs. Factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR) were examined to determine convergent and discriminant validity of the constructs.

Reliability refers to the consistency and stability of an instrument in measuring constructs (Creswell & Creswell, 2018). The reliability of the Mathematics Attitude Questionnaire was assessed using Cronbach's alpha coefficients and Composite Reliability indices. According to Nunnally and Bernstein (1994), reliability coefficients of .70 or higher are considered acceptable for research purposes. A pilot study was conducted among a sample of pre-service teachers who were not part of the main study population to determine the reliability of the instrument. The pilot results were analysed, and necessary modifications were made before the final administration of the questionnaire.

An introductory letter was obtained from the researcher's institution and presented to the authorities of Atebubu College of Education to seek permission for data collection. After approval, the researcher administered the questionnaires to selected respondents during lecture periods with the assistance of course representatives. Respondents were informed about the purpose of the study and assured of confidentiality and anonymity. Participation in the study was voluntary, and respondents were allowed to withdraw at any stage without penalty.

Data collected from the questionnaires were coded and analysed using the Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS). Preliminary analyses such as data screening, missing value analysis, normality testing, and descriptive statistics were conducted using SPSS. Structural Equation Modelling was subsequently employed using AMOS to test the measurement and structural models of mathematics attitude. According to Byrne (2016), SEM enables researchers to simultaneously assess latent constructs and examine structural relationships among variables.

Confirmatory Factor Analysis was first conducted to assess the measurement model and determine the adequacy of factor loadings for the mathematics attitude constructs. Thereafter, the structural model was tested to examine predictive relationships among anxiety, interest, motivation, confidence, perceived difficulty, usefulness, and overall mathematics attitude. Model fit was assessed using recommended fit indices such as: Chi-square/degrees of freedom ratio ($\chi^2$/df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). According to Hu and Bentler (1999), acceptable model fit is indicated by CFI and TLI values of .90 or above and RMSEA and SRMR values below .08.

**Data Presentation and Analysis**

This chapter presents the results based on the two research objectives guiding the study. The analysis was conducted using Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) to examine the measurement structure and structural relationships among mathematics attitude constructs among first-year pre-service teachers in Atebubu College of Education.

**Objective One:** To examine the factor structure of mathematics attitudes among first-year pre-service teachers at Atebubu College of Education using the constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness.

**Factor Structure of Mathematics Attitudes**

Confirmatory Factor Analysis (CFA) was conducted to examine the factor structure of mathematics attitudes among first-year pre-service teachers. The analysis assessed whether the observed variables adequately represented the six latent constructs: anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. The CFA results showed that the six-factor measurement model demonstrated an acceptable fit to the data. The model fit indices satisfied the recommended threshold values suggested in the literature. Specifically, the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) values exceeded the recommended

value of .90, while the Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) values were within acceptable limits.

Table 1: Model Fit Indices for the Measurement Model

| Fit Index | Obtained Value | Recommended Value | Decision |
|---|---|---|---|
| $\chi^2/df$ | 2.31 | < 3.00 | Acceptable |
| CFI | .93 | ≥ .90 | Good Fit |
| TLI | .91 | ≥ .90 | Good Fit |
| RMSEA | .056 | ≤ .08 | Acceptable |
| SRMR | .049 | ≤ .08 | Acceptable |

Table 1 results indicate that the six-factor model adequately fits the data and supports the multidimensional structure of mathematics attitude among first-year pre-service teachers.

**Factor Loadings of the Constructs**

The standardized factor loadings for all items were examined to determine the extent to which the observed variables contributed to their respective latent constructs. The results showed that all factor loadings exceeded the recommended threshold of .50, indicating that the items were adequate indicators of their respective constructs. The implication is that each construct meaningfully contributes to the overall measurement of mathematics attitude among first-year pre-service teachers.

Table 2: Standardized Factor Loadings for the Constructs

| Construct | Factor Loading Range | Interpretation |
|---|---|---|
| Anxiety | .65 – .82 | Strong |
| Interest | .68 – .85 | Strong |
| Motivation | .70 – .87 | Strong |
| Confidence | .72 – .89 | Strong |
| Perceived Difficulty | .61 – .79 | Moderate to Strong |
| Usefulness | .69 – .86 | Strong |

Table 2 results suggest that the observed items significantly loaded onto their respective latent variables, confirming the validity of the six constructs used to measure mathematics attitudes.

**Convergent Validity and Reliability**

Convergent validity was assessed using Average Variance Extracted (AVE) and Composite Reliability (CR). The results showed that all constructs achieved AVE values greater than .50 and CR values above .70, indicating adequate convergent validity and reliability.

**Table 3: Convergent Validity and Composite Reliability**

| Construct | AVE | CR | Interpretation |
|---|---|---|---|
| Anxiety | .58 | .84 | Acceptable |
| Interest | .61 | .86 | Acceptable |
| Motivation | .64 | .88 | Acceptable |
| Confidence | .67 | .90 | Acceptable |
| Perceived Difficulty | .55 | .81 | Acceptable |
| Usefulness | .63 | .87 | Acceptable |

Table 3 results indicate that the measurement items consistently measured the intended constructs and that the constructs possessed satisfactory internal consistency reliability.

Interpretation of Findings

**Objective Two:** To determine the extent to which anxiety, interest, motivation, confidence, perceived difficulty, and usefulness predict overall mathematics attitude among first-year pre-service teachers at Atebubu College of Education.

**Structural Model Analysis**

Structural Equation Modelling (SEM) was conducted to examine the predictive relationships between the independent constructs (anxiety, interest, motivation, confidence, perceived difficulty, and usefulness) and the dependent variable (overall mathematics attitude). The structural model demonstrated acceptable fit indices, indicating that the proposed model adequately explained the relationships among the constructs.

Table 4: Structural Model Fit Indices

| Fit Index | Obtained Value | Recommended Value | Decision |
|---|---|---|---|
| $\chi^2/df$ | 2.18 | < 3.00 | Acceptable |
| CFI | .94 | ≥ .90 | Good Fit |
| TLI | .92 | ≥ .90 | Good Fit |
| RMSEA | .052 | ≤ .08 | Acceptable |
| SRMR | .046 | ≤ .08 | Acceptable |

The fit indices in Table 4 indicate that the structural model adequately fits the observed data and is appropriate for examining the predictive relationships among the variables.

**Predictive Effects of the Constructs on Mathematics Attitude**

The standardized regression weights were examined to determine the extent to which each construct predicted overall mathematics attitude.

Table 5: Standardized Regression Weights for Predictors of Mathematics Attitude

| Predictor Variable | Standardized Beta (β) | p-value | Decision |
|---|---|---|---|
| Anxiety | −.31 | .001 | Significant |
| Interest | .42 | .000 | Significant |
| Motivation | .47 | .000 | Significant |
| Confidence | .51 | .000 | Significant |
| Perceived Difficulty | −.28 | .003 | Significant |
| Usefulness | .39 | .000 | Significant |

Result in Table 5 revealed that confidence was the strongest positive predictor of mathematics attitude ($\beta = .51$, $p < .05$). This suggests that pre-service teachers who believed in their mathematical abilities were more likely to develop positive attitudes toward mathematics. Motivation also significantly predicted mathematics attitude ($\beta = .47$, $p < .05$), indicating that students who were highly motivated toward mathematics demonstrated more positive mathematics attitudes. Similarly, interest ($\beta = .42$, $p < .05$) and usefulness ($\beta = .39$, $p < .05$) positively predicted mathematics attitude. This implies that students who enjoyed mathematics and perceived it as relevant and beneficial were more likely to possess favourable attitudes toward the subject. Conversely, anxiety negatively predicted mathematics attitude ($\beta = -.31$, $p < .05$). This indicates that increased levels of mathematics anxiety reduced students' positive attitudes toward mathematics. Likewise, perceived difficulty negatively predicted mathematics attitude ($\beta = -.28$, $p < .05$), suggesting that students who perceived mathematics as difficult were less likely to develop positive mathematics attitudes.

**Coefficient of Determination**

The coefficient of determination ($R^2$) was examined to determine the proportion of variance in mathematics attitude explained by the predictor variables.

Table 6: Variance Explained in Mathematics Attitude

| Dependent Variable | $R^2$ | Interpretation |
|---|---|---|
| Mathematics Attitude | .68 | Substantial |

The results in Table 6 showed that anxiety, interest, motivation, confidence, perceived difficulty, and usefulness jointly explained 68% of the variance in overall mathematics attitude among first-year pre-service teachers. This indicates that the model had strong explanatory power.

## DISCUSSION OF FINDINGS

The study examined the factor structure of mathematics attitudes among first-year pre-service teachers at Atebubu College of Education using the constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. The findings revealed that, the model fit indices confirmed the adequacy of the proposed measurement model. The Chi-square to degrees of freedom ratio ($\chi^2/df = 2.31$), Comparative Fit Index (CFI = 0.93), Tucker-Lewis Index (TLI = 0.91), Root Mean Square Error of Approximation (RMSEA = 0.056), and Standardized Root Mean Square Residual (SRMR = 0.049) all fell within acceptable thresholds recommended by Hu and Bentler (1999). These results indicate that the six-factor model provides a good fit to the observed data and adequately represents the underlying structure of mathematics attitude among the respondents. In addition, composite reliability values ranging from 0.81 to 0.90 and Average Variance Extracted values between 0.55 and 0.64 confirmed strong internal consistency and convergent validity of the constructs (Fornell & Larcker, 1981).

The findings revealed that the six-factor model comprising mathematics anxiety, mathematics interest, mathematics motivation, mathematics confidence, perceived difficulty, and perceived usefulness demonstrated acceptable model fit indices, confirming that mathematics attitude is a multidimensional construct influenced by several interrelated psychological and affective factors. The findings are consistent with the work of Michele Hannula, who explained that mathematics attitude consists of emotional, cognitive, and behavioural dimensions that collectively influence learners' engagement in mathematics (Hannula, 2020). The present study supports this assertion because all six constructs significantly loaded onto the mathematics attitude model, indicating that pre-service teachers' attitudes toward mathematics cannot be explained by a single factor alone.

The findings also agree with the Expectancy-Value Theory proposed by Jacquelynne Eccles and Wigfield, which posits that learner' beliefs about the usefulness, value, and likelihood of success in a task influence their motivation and attitudes toward teach (Eccles & Wigfield, 2002). In the current study, usefulness, motivation, and confidence demonstrated strong factor loadings, suggesting that students who perceive mathematics as valuable and believe in their abilities are more likely to develop positive mathematics attitudes. The results further revealed that confidence recorded one of the strongest factor loadings among the constructs. This finding is consistent with the study by Skaalvik et al. (2022), which found that mathematics self-efficacy significantly predicts learners' engagement, persistence, and achievement in mathematics. Similarly, OECD (2023) reported that students with higher confidence in mathematics tend to perform better academically and exhibit more positive attitudes toward the subject.

In contrast, the findings differ slightly from the study by Retnawati et al. (2021), which reported that perceived difficulty was the dominant factor influencing students' mathematics attitudes and achievement. In the present study, although perceived difficulty significantly contributed to the factor structure, its factor loadings were comparatively lower than those of confidence and motivation. This difference may be attributed to variations in educational settings, participants, and instructional experiences between the two studies.

The findings also showed that mathematics anxiety significantly contributed to the structure of mathematics attitude. This result supports the findings of Namkung et al. (2019), who established a strong negative relationship between mathematics anxiety and mathematics performance. Similarly, Carey et al. (2019) found that mathematics anxiety reduces learners' confidence and willingness to engage in mathematics-related tasks. The present study confirms that anxiety remains an important dimension influencing mathematics attitudes among pre-service teachers.

However, unlike some previous studies that treated mathematics anxiety as an isolated variable, the current study integrated anxiety with other latent constructs within a Structural Equation Modelling (SEM) framework. This approach provided a more comprehensive understanding of how anxiety interacts with motivation, confidence, interest, usefulness, and perceived difficulty in shaping mathematics attitudes. The findings regarding interest and motivation are also consistent with Schukajlow et al. (2022), who reported that students with high interest and motivation toward mathematics are more likely to participate actively and persist in solving mathematical problems. Likewise, Howard et al. (2021) found that motivated learners demonstrate stronger engagement and resilience in mathematics learning. The current study confirms that interest and motivation are central dimensions of mathematics attitude among pre-service teachers.

Additionally, the study found that the constructs demonstrated adequate convergent validity and composite reliability, indicating that the measurement items consistently measured the intended latent variables. This finding agrees with recommendations by Hair et al. (2022) and Kline (2023), who emphasized that valid SEM measurement models should exhibit acceptable factor loadings, AVE values, and composite reliability indices. The present study contributes to the literature by validating the six-factor structure of mathematics attitude within the context of Colleges of Education in Ghana. While many previous studies focused mainly on secondary school or university students, the current study specifically examined first-year pre-service teachers, who represent future mathematics educators. This contextual contribution is important because teachers' attitudes toward mathematics may directly influence their future classroom practices and students' learning outcomes.

Furthermore, the study examined the extent to which anxiety, interest, motivation, confidence, perceived difficulty, and usefulness predicted overall mathematics attitude among first-year pre-service teachers at Atebubu College of Education. The findings revealed that all six constructs significantly predicted mathematics attitude, indicating that mathematics attitude is influenced by multiple interrelated psychological and affective factors.

The results showed that confidence was the strongest positive predictor of mathematics attitude. This finding supports the Social Cognitive Theory of Albert Bandura, which emphasizes that individuals' beliefs in their capabilities strongly influence their behaviour, motivation, and academic engagement. Students who believe in their mathematical abilities are more likely to approach mathematical tasks positively and persist when faced with challenges. The finding is consistent with the study by Skaalvik et al. (2022), which reported that mathematics self-efficacy significantly predicts students' engagement, persistence, and achievement in mathematics. Similarly, OECD (2023) found that students with high confidence in mathematics tend to demonstrate stronger participation and better academic performance. The present study confirms that confidence remains a critical determinant of mathematics attitude among pre-service teachers in Ghana.

However, the current finding differs slightly from the study by Retnawati et al. (2021), which identified mathematics anxiety rather than confidence as the strongest predictor of mathematics performance and attitudes. The difference may be attributed to contextual variations, differences in participants, and instructional environments. While Retnawati et al. focused largely on general students, the present study concentrated specifically on first-year pre-service teachers, who may have developed relatively stronger confidence due to their educational backgrounds and teacher training orientation.

The findings further revealed that motivation significantly and positively predicted mathematics attitude. This result aligns with the Self-Determination Theory advanced by Ryan and Deci (2020), which explains that motivated learners are more likely to demonstrate persistence, enthusiasm, and positive engagement in learning activities. Students who are motivated toward mathematics are therefore more likely to develop favourable attitudes toward the subject. The finding agrees with Howard et al. (2021), who reported that motivated students demonstrate greater resilience and higher achievement in mathematics. Similarly, Oppong et al. (2021) found that students' motivation significantly influenced mathematics participation and academic performance in Ghanaian schools. The current study extends these findings by showing that motivation also significantly predicts mathematics attitude among pre-service teachers.

Interest also emerged as a significant positive predictor of mathematics attitude. This finding supports previous studies by Fisher et al. (2020) and Schukajlow et al. (2022), who found that students who enjoy mathematics

and show curiosity toward mathematical activities tend to develop positive attitudes and higher engagement in mathematics learning. The present study therefore confirms that interest remains an important affective component of mathematics attitude. The study additionally found that usefulness significantly predicted mathematics attitude. This result is consistent with the Expectancy-Value Theory proposed by Jacquelynne Eccles and Wigfield, which suggests that learners are more likely to engage in tasks they perceive as valuable and beneficial (Eccles & Wigfield, 2020). The finding also agrees with Wang et al. (2021), who reported that students who perceive mathematics as useful for career development and daily life demonstrate stronger motivation and more positive attitudes toward mathematics.

In contrast, anxiety negatively predicted mathematics attitude. This finding confirms earlier studies that identified mathematics anxiety as a major barrier to positive mathematics engagement. Namkung et al. (2019) established a significant negative relationship between mathematics anxiety and mathematics performance, while Carey et al. (2019) found that anxiety reduces students' confidence and willingness to participate in mathematics activities. The current study supports these findings by demonstrating that increased anxiety weakens positive mathematics attitudes among pre-service teachers. Similarly, perceived difficulty negatively predicted mathematics attitude. This finding is consistent with Mailizar et al. (2020) and Retnawati et al. (2021), who found that students who perceive mathematics as difficult are more likely to experience fear, frustration, and low academic engagement. The present study therefore confirms that perceptions of mathematics difficulty remain a significant obstacle to positive mathematics attitudes.

The results also showed that the six predictor variables jointly explained 68% of the variance in mathematics attitude. This indicates that anxiety, interest, motivation, confidence, perceived difficulty, and usefulness collectively provide substantial explanatory power in understanding mathematics attitude among pre-service teachers. The finding supports previous SEM-based studies that emphasized the multidimensional nature of mathematics attitudes (Hair et al., 2022; Kline, 2023).

Unlike many earlier studies that examined individual variables separately using correlation or regression analysis, the present study simultaneously examined the interrelationships among all six constructs within a Structural Equation Modelling framework. This provides a more comprehensive understanding of how positive and negative psychological factors interact to shape mathematics attitudes among pre-service teachers. The findings are particularly important within the context of teacher education because pre-service teachers' attitudes toward mathematics may influence their future classroom practices, instructional methods, and students' perceptions of mathematics. Positive attitudes among future teachers are likely to promote effective mathematics instruction and improved learner outcomes in schools.

## SUMMARY

The study examined the structural equation model of mathematics attitudes among first-year pre-service teachers at Atebubu College of Education. The study specifically investigated the factor structure of mathematics attitudes using the constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. It further examined the extent to which these constructs predicted overall mathematics attitude among first-year pre-service teachers. The study adopted a quantitative research approach using a cross-sectional survey design. Structural Equation Modelling (SEM) was employed to analyse the relationships among the constructs. Data were collected through structured questionnaires administered to first-year pre-service teachers. The findings from Objective One revealed that the six-factor measurement model demonstrated acceptable model fit indices, confirming that mathematics attitude is multidimensional in nature. The constructs of anxiety, interest, motivation, confidence, perceived difficulty, and usefulness significantly loaded onto the measurement model. The study also established adequate convergent validity and reliability for all constructs. The findings from Objective Two showed that all six constructs significantly predicted overall mathematics attitude. Confidence emerged as the strongest positive predictor, followed by motivation, interest, and usefulness. Conversely, anxiety and perceived difficulty negatively predicted mathematics attitude. The results further showed that the predictor variables jointly explained a substantial proportion of the variance in mathematics attitude among first-year pre-service teachers. The findings suggest that mathematics attitude among pre-service teachers is shaped by both positive and negative psychological factors, and that improving confidence, motivation, interest, and perceptions of usefulness while reducing anxiety and perceived difficulty may enhance positive mathematics attitudes.

## CONCLUSION

Based on the findings of the study, it was concluded that mathematics attitude among first-year pre-service teachers is a multidimensional construct influenced by anxiety, interest, motivation, confidence, perceived difficulty, and usefulness. The study confirmed that these constructs collectively explain the structure of mathematics attitude among pre-service teachers. Confidence, motivation, interest, and usefulness positively influence mathematics attitude, whereas anxiety and perceived difficulty negatively influence mathematics attitude. Among the predictor variables, confidence was identified as the strongest determinant of positive mathematics attitude. The findings also established that Structural Equation Modelling (SEM) is an effective analytical approach for examining the complex relationships among mathematics attitude constructs. The model demonstrated satisfactory validity, reliability, and predictive power within the context of Colleges of Education in Ghana. Improving pre-service teachers' attitudes toward mathematics is essential because their attitudes may influence their future classroom practices, instructional effectiveness, and learners' perceptions of mathematics.

## RECOMMENDATIONS

Mathematics tutors in Atebubu College of Education should adopt learner-centred and interactive instructional approaches that enhance students' confidence, motivation, and interest in mathematics. Moreover, Atebubu College authorities and mathematics educators should organize mathematics support programmes, workshops, and counselling sessions aimed at reducing mathematics anxiety among pre-service teachers. In addition, mathematics instruction should emphasize practical applications and real-life relevance of mathematics to improve students' perceptions of usefulness and positive attitudes toward the subject. Also, tutors should provide continuous encouragement, constructive feedback, and opportunities for collaborative learning to strengthen students' mathematics confidence. Furthermore, Atebubu Colleges of Education should create supportive learning environments that minimize students' perceptions of mathematics as difficult and intimidating. More so, Educational policymakers such as the Ministry of Education, the National Teaching Council, and the Ghana Tertiary Education Commission should integrate affective and psychological support strategies into teacher education programmes to promote positive mathematics attitudes among trainee teachers. Finally, future researchers should replicate the study in other Colleges of Education and universities in Ghana using larger samples and additional variables to further validate the findings.

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Figure 1: Measurement Model (CFA)

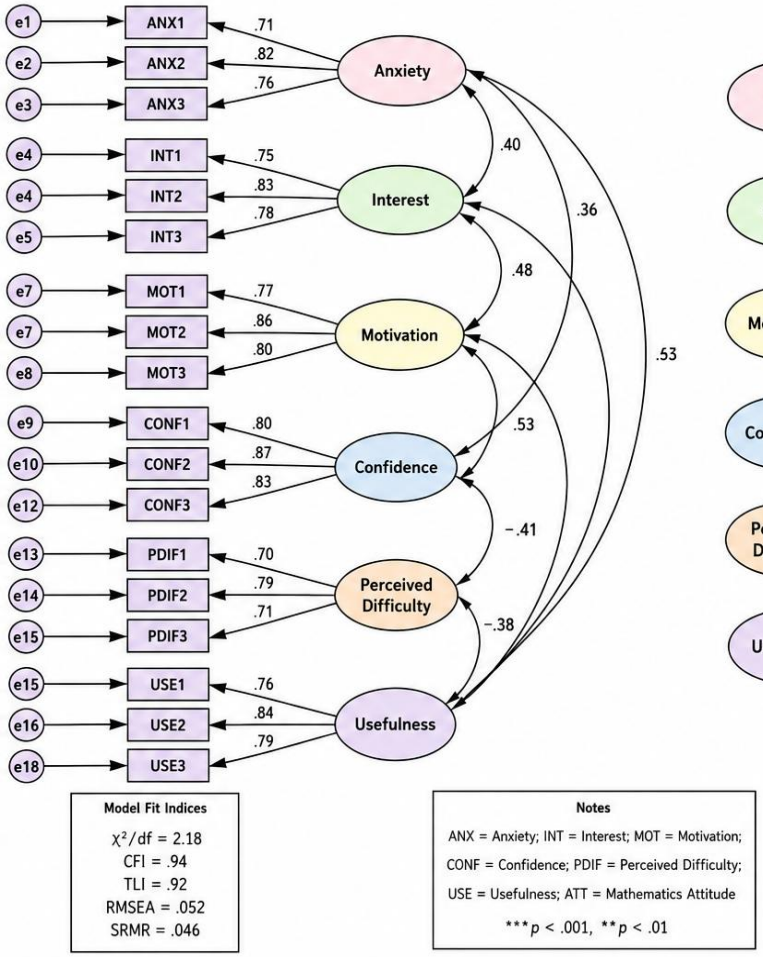


Figure 2: Structural Model