Journal of Studies in Science and Mathematics Education
ISSN: 2630-662x
Published: 03.08.2026
Volume (issue): 6(1)
Page: 40–54

Relationships between Mindsets and Attitudes toward Mathematics among Pre-Service Mathematics Teachers in Kaduna State, Nigeria

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Abstract

This study examined the relationships among fixed and growth mindsets with pre-service mathematics teachers' attitudes toward mathematics in Kaduna State, Nigeria. Specifically, it investigated how these mindsets relate to enjoyment and perceived value of mathematics and whether these relationships differ by sex. A cross-sectional survey design was employed involving 204 pre-service mathematics teachers (121 males and 83 females). Data were collected using the Revised Implicit Theories of Intelligence and the Attitudes Toward Mathematics Inventory – Short Form, both of which demonstrated acceptable validity and reliability (omega coefficient, ω = .641– .887). Pearson's correlation analyses revealed that growth mindset was moderately and positively related to enjoyment ($r = .368$, $p < .001$, $R^2 = .135$) and overall attitudes toward mathematics ($r = .484$, $p < .001$, $R^2 = .235$), whereas fixed mindset showed very weak and non-significant relationships with enjoyment ($r = –.129$, $p = .065$, $R^2 = .017$) and perceived value ($r = –.036$, $p = .611$, $R^2 = .001$). A one-way MANOVA indicated no significant differences between male and female participants on fixed mindset, growth mindset, enjoyment, or attitudes toward mathematics (Pillai's Trace = 0.023, $F(4, 199) = 1.183$, $p = .320$, partial $\eta^2 = 0.023$). These findings suggest that fostering a growth mindset is essential for enhancing pre-service teachers' engagement with mathematics. It is recommended that teacher education programs incorporate activities that promote a growth mindset and positive attitudes, providing meaningful, enjoyable, and relevant mathematics experiences.

Keywords: mindset, attitudes toward mathematics, growth mindset, fixed mindset, pre-service teachers, Kaduna State

1 Introduction

In recent years, educational research has shown that students' success is influenced not only by teaching methods or curriculum coverage but also by how learners think and feel about what they are learning. In mathematics education, learners' beliefs about their ability and their emotional responses to the subject play a central role in shaping engagement, effort, persistence, and achievement (Goldin et al., 2011; Hannula et al., 2016). Mathematics often requires sustained effort and abstract thinking; students who lack confidence or enjoy the subject less are more likely to disengage and avoid challenging tasks (Grehan et al., 2016; Ramos & Castañeda, 2025). According to DiNapoli (2023) students who view mathematics positively tend to demonstrate greater persistence, deeper engagement, and more strategic problem-solving. These patterns have been documented across diverse educational contexts, underscoring the importance of psychological factors as essential components of mathematics learning beyond instructional features alone (Newcombe et al., 2009). Understanding how these psychological constructs interact is therefore critical for improving teacher preparation and student outcomes in mathematics. A key psychological factor in education is mindset, which refers to a person's beliefs about their ability to learn. According to Dweck (2006), a growth mindset is the belief that intelligence and skills can improve with effort, practice, and effective strategies. Students with a growth mindset are more likely to accept challenges, learn from mistakes, and keep trying even when tasks are difficult. On the other hand, a fixed mindset is the belief that intelligence and talent are set and cannot change. Students with a fixed mindset often avoid challenges, fear failure, and give up easily. Research shows that students with a growth mindset are more persistent, motivated, and able to achieve

better results (Tang & Xu, 2025; Zhang & He, 2025). They also enjoy learning more and are more resilient, including in mathematics (Park et al., 2025). For pre-service teachers, their own mindset is important because it affects how they approach learning mathematics and how they will teach their future students.

Although mindset focuses on beliefs about ability, attitudes toward mathematics capture learners' emotional responses and value judgments about the subject. Attitudes reflect how much learners enjoy mathematics, how valuable they perceive it for their future careers, and their confidence when engaging with mathematical tasks. Wen and Dubé (2022) define attitude as a combination of liking or disliking the subject, willingness to engage in mathematical activities, perceived competence, and beliefs about the usefulness of mathematics. Attitudes are shaped by internal factors, such as enjoyment and self-confidence, as well as sociocultural influences, including teacher support and perceived relevance of mathematics (Belbase, 2010; Mata et al., 2012). Positive attitudes are consistently linked to higher engagement, motivation, and academic performance, whereas negative attitudes are associated with avoidance, anxiety, and lower achievement. Despite their interconnection, mindset and attitudes are conceptually distinct: mindset reflects beliefs about ability, while attitudes reflect emotional and evaluative orientations toward the subject (Bakhshandeh, 2022; Toding et al., 2023). Even though mindset and attitudes are deeply intertwined in influencing learners' engagement, much of the existing research has examined these constructs in isolation. Studies that consider mindset often ignore attitudes, and vice versa, which limits understanding of how these constructs operate jointly to affect learners' experiences. Some research suggests that the mindset may act as a precursor to more positive motivational outcomes, including enjoyment and value judgments about mathematics, while the fixed mindset may hinder adaptive engagement (Boaler, 2015; Degol et al., 2018; Yeasmin, 2021). However, research clarifying how fixed and growth mindsets relate differentially to multiple dimensions of attitudes, such as enjoyment and perceived value, remains limited, especially in teacher education contexts. This gap is particularly salient given evidence that teacher beliefs and attitudes influence not only their own learning but also their pedagogical practices and the climates they create in mathematics classrooms.

This issue is especially important for pre-service mathematics teachers, who develop professional beliefs and emotional orientations during their training. Pre-service teachers' mindsets and attitudes not only affect their own engagement with mathematics content but also influence how they will teach and support future learners. Teachers who hold growth-oriented beliefs and positive attitudes toward mathematics are more likely to model persistence, reinforce productive struggle, and promote confidence in their students. Conversely, pre-service teachers with a fixed mindset or negative attitudes may perpetuate cycles of avoidance, anxiety, and low achievement in their own classrooms. Studies of pre-service teachers highlight that their beliefs and attitudes early in preparation can have enduring effects on instructional practices and student outcomes. Yet, in Nigeria, particularly in Kaduna State, research has focused largely on methods, assessment, and performance, with minimal attention to the psychological constructs that underlie engagement. Guided by these concerns, the present study examines the relationships between fixed mindset, growth mindset, and attitudes toward mathematics among pre-service mathematics teachers in Kaduna State, Nigeria. Attitudes are operationalised in terms of enjoyment of mathematics and perceived value of mathematics. Additionally, the study examines whether these relationships differ by sex. Specifically, the objectives of this are to:

1. Examine the relationship between fixed mindset and pre-service teachers' enjoyment of mathematics.
2. Examine the relationship between fixed mindset and pre-service teachers' perceived value of mathematics.
3. Examine the relationship between growth mindset and pre-service teachers' enjoyment of mathematics.
4. Examine the relationship between growth mindset and pre-service teachers' perceived value of mathematics.
5. Eetermine whether male and female pre-service teachers differ in their mindsets and attitudes toward mathematics.

In order to achieve these objectives, the following research questions were raised:

1. What is the relationship between fixed mindset and pre-service teachers' enjoyment of mathematics?
2. What is the relationship between fixed mindset and pre-service teachers' perceived value of mathematics?
3. What is the relationship between growth mindset and pre-service teachers' enjoyment of mathematics?
4. What is the relationship between the growth mindset and pre-service teachers' perceived value of mathematics?
5. Do male and female pre-service teachers differ in their mindsets and attitudes toward mathematics?

By integrating these research questions, the study aims to provide evidence on how mindset and attitudes jointly influence pre-service teachers' engagement with mathematics, thereby informing teacher education programmes and supporting the development of positive beliefs and attitudes toward the subject.

2 Theoretical Framework

This study is theoretically grounded in Dweck's Mindset Theory, which provides a coherent framework for understanding how individuals' beliefs about the nature of ability influence motivation, emotional engagement, and learning outcomes. Mindset theory originates from Dweck's seminal work (2006), which demonstrated that variations in academic behaviour and achievement are not solely attributable to innate ability or instructional exposure, but to learners' beliefs about whether ability is fixed or malleable. This reconceptualisation marked a departure from traditional ability-centered explanations by highlighting learning as an intentional and belief-driven process. Subsequent research has positioned mindset theory within a relational framework, where students' beliefs interact with contextual factors such as teaching practices, assessment systems, and socio-cultural expectations to shape learning behaviour (Hannula et al., 2016; Laurell et al., 2021; Mansour, 2009). At the core of mindset theory is the distinction between fixed and growth mindsets. A fixed mindset is characterised by the belief that mathematical ability is innate and cannot be changed, whereas a growth mindset reflects the belief that ability can be developed through effort, practice, and effective strategies. Crucially, mindset theory conceptualises academic engagement as a function of both beliefs and behavioural responses: learners' mindsets influence how they approach challenges, cope with mistakes, and persist in the face of difficulty (Kapasi & Pei, 2022; Yeager & Dweck, 2012). Within this framework, attitudes toward mathematics, including enjoyment of the subject and perceived value, are theoretically central, as they mediate the relationship between mindset and learning behaviours. Students' emotional and evaluative responses to mathematics are shaped by their beliefs about ability, which in turn affect engagement, persistence, and performance outcomes (Schukajlow et al., 2023).

Mindset theory further posits that beliefs about ability are context-sensitive rather than fixed traits. Learners' orientations toward mathematics are shaped by prior experiences, classroom practices, and cultural narratives about intelligence and success (Retanal & Maloney, 2026). Positive attitudes toward mathematics, such as enjoyment and perceived relevance, are expected to be reinforced by growth-oriented beliefs, promoting persistence and adaptive engagement. Conversely, fixed mindset orientations are likely to coincide with negative attitudes, such as boredom, avoidance, or undervaluation of mathematics, which may suppress engagement and achievement. Accordingly, this study examines the relationships between fixed and growth mindsets and two key attitudinal dimensions: enjoyment and perceived value of mathematics among pre-service teachers. While mindset theory typically predicts that growth mindset supports positive learning behaviours and fixed mindset promotes avoidance, theoretically diverse relationships are possible. For instance, a preservice teacher may hold a growth mindset yet experience low enjoyment due to prior negative experiences or inadequate instructional support, highlighting the role of contextual and emotional factors in shaping attitudes. Likewise, a teacher with a fixed mindset may still value mathematics as useful for future teaching responsibilities, even if they feel less confident in their ability to master it. These theoretical possibilities warrant empirical investigation, particularly in teacher education contexts such as Nigerian universities, where structural constraints, pedagogical traditions, and cultural beliefs may intersect with personal beliefs to shape attitudes toward mathematics.

The relevance of mindset theory is especially pronounced for pre-service mathematics teachers. Teachers' mindsets and attitudes not only affect their own learning but also shape their future instructional practices, classroom climate, and students' engagement with mathematics. Growth-oriented beliefs and positive attitudes are theorised to foster persistence, confidence, and supportive teaching practices, whereas fixed beliefs and negative attitudes may perpetuate cycles of low engagement and avoidance. Within this theoretical framing, the present study investigates how fixed and growth mindsets predict pre-service teachers' enjoyment and perceived value of mathematics, while also exploring potential differences by sex. By explicitly modelling mindset as a predictor of attitudinal orientations, this study provides a theoretically grounded basis for understanding psychological determinants of mathematics engagement among pre-service teachers in Nigeria.

3 Materials and Methods

3.1 Research Design

This study employed a quantitative cross-sectional survey research design to examine the relationships between pre-service mathematics teachers' mindset (fixed and growth) and their attitudes toward mathematics (enjoyment and perceived value). The design was appropriate because it allowed the investigation of the direction and strength of relationships among affective variables without manipulating them (Creswell & Creswell, 2017).

3.2 Population and Sample

The population comprised pre-service mathematics teachers enrolled in teacher education programmes at higher institutions in Kaduna State, Nigeria. A total of 204 pre-service mathematics teachers participated, comprising 121 males and 83 females who were selected through the proportionate sampling technique. The sample size was adequate for correlation, multiple regression, and confirmatory factor analysis procedures as reported in the literature (e.g., Hair et al., 2020).

3.3 Instruments

3.3.1 Revised Implicit Theories of Intelligence (R-ITI)

The Revised Implicit Theories of Intelligence (R-ITI), developed by De Castella and Byrne (2015) and adapted for this study. The R-ITI comprised eight items organised into two equal subscales. Four items assess growth mindset (Items 1–4), while the remaining four measure fixed mindset (Items 5–8). The instrument is well-suited for examining pre-service teachers' beliefs about their own learning capacity, particularly within mathematics education contexts. All items are positively phrased and rated on a five-point Likert scale ranging from *strongly disagree* to *strongly agree*.

3.3.2 Attitudes Toward Mathematics Inventory – Short Form (ATMI-SF)

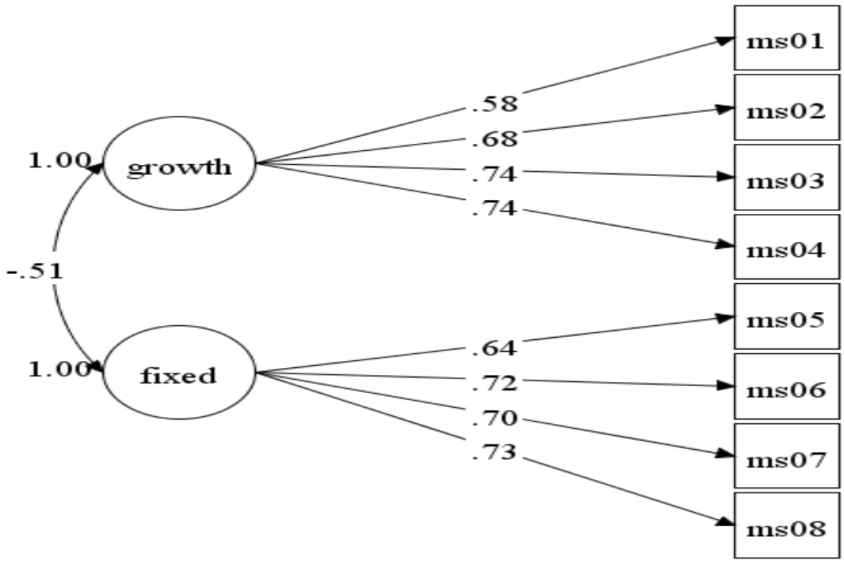
The Attitudes toward Mathematics Scale – Short Form (AtMS-SF) was adapted from Lin and Huang (2016) to measure pre-service attitudes toward mathematics. The adapted version of the ATMI-SF is a 7-item instrument measuring two dimensions: enjoyment of mathematics and perceived value of mathematics. Items were scored on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

3.4 Validity and Reliability of the Instruments

The two instruments were validated by experts for their content validity. Meanwhile, the construct validity of the R-ITI was ascertained by using confirmatory factor analysis (CFA). The two-factor model of R-ITI demonstrated excellent global fit to the data: $\chi^2 = 41.884$, df = 19, $\chi^2/df = 2.204$, SRMR = 0.041, RMSEA = 0.077 (90% CI [0.045, 0.108], p = 0.077), CFI = 0.964, and TLI = 0.947. Figure 1 presents the local fit statistics of R-ITI.

Figure **1**

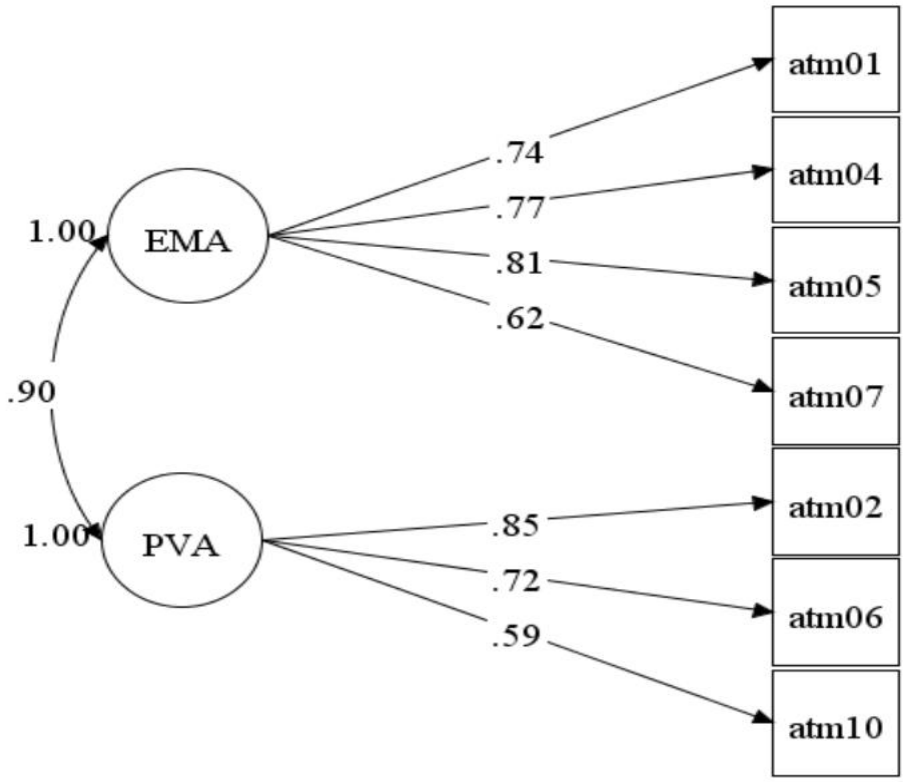
Standardised estimates of model parameters for the 2-factor R-ITI



The reliability of the MMS was estimated using the coefficient omega, which indicated acceptable reliability. The growth mindset has a reliability coefficient of ω = .781, the fixed mindset has a reliability coefficient of ω = .792, while a reliability coefficient of ω = .641 was found for the whole 8-item R-ITI. As for the construct validity of the AtMS-SF, the CFA was also used to assess it. The two-factor AtMS-SF model showed excellent global fit of the model with the generated dataset: $\chi^2 = 22.949$, df = 13, $\chi^2/df = 1.765$, SRMR = 0.022, RMSEA = 0.061 (90% CI [0.011, 0.102], p = 0.291), CFI = 0.991, and TLI = 0.986. Figure 2 presents the local fit statistics of AtMS-SF.

Figure **2**

Standardised estimates of model parameters for the 2-factor AtMS-SF



The reliability of the AtMS, estimated using coefficient omega, was acceptable with enjoyment subscale of AtMS-SF having a coefficient of ω = .848, perceived value subscale having a coefficient of ω = .746, and a coefficient of ω = .887 was found of the overall 7-item AtMS-SF.

3.5 Procedure for Data Collection and Analysis

The collected data were first screened, coded, and entered into IBM SPSS Statistics version 20 for analysis. Descriptive statistics, including means and standard deviations, were computed to summarise participants' responses. Scatter plots were created to visually inspect the relationships between fixed mindset and attitudes, as well as growth mindset and attitudes. Additionally, clustered bar charts were produced to illustrate mean differences in fixed mindset, growth mindset, enjoyment, and perceived value of mathematics by sex. Pearson's product–moment correlation analysis was conducted to examine the relationships between fixed mindset, growth mindset, and attitudes toward mathematics (enjoyment and perceived value). Confidence intervals were calculated using Fisher's r-to-z transformation with bias adjustment. Multiple linear regression analysis was performed to determine the joint predictive contribution of fixed and growth mindsets to attitudes toward mathematics. General Linear Model (GLM) analyses were used to investigate whether these variables differed by sex, with effect sizes interpreted using partial eta squared. Assumptions underlying correlation, regression, and GLM analyses including linearity, normality, homoscedasticity, and absence of multicollinearity were carefully assessed and satisfied.

Finally, permission to conduct the study was obtained from the relevant university authorities. Participants were fully briefed on the purpose of the study, assured of confidentiality, and informed that participation was voluntary. The questionnaires were administered in classroom settings, with researchers available to clarify any ambiguous items. Completed questionnaires were collected immediately to ensure a high response rate and data completeness. All statistical tests were conducted at a significance level of $p < .05$, with regression coefficients (B), standardised coefficients (β), R^2, adjusted R^2, t-values, and F-values reported to assess the strength, direction, and significance of the predictive relationships.

4 Results

4.1 Addressing Research Question 1

To address the first research question, a scatter plot was used to examine the relationship between fixed mindset and pre-service teachers' enjoyment of mathematics. Figure 3 presents the visualisation of this relationship.

Figure **3**

Scatter plot of pre-service teachers' enjoyment by fixed mindset

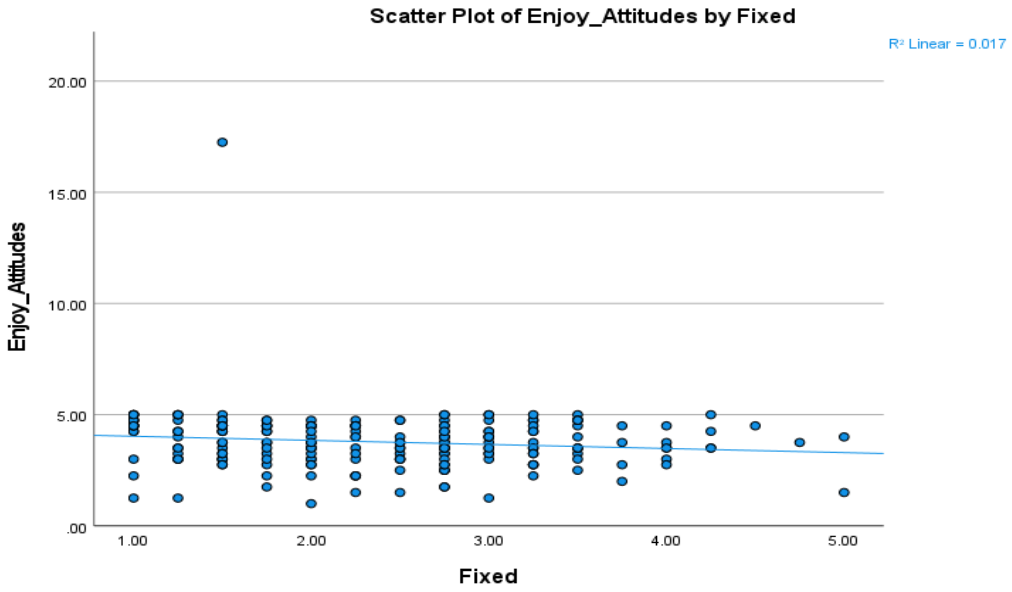


Figure 3 shows a very weak negative association between the two variables, indicating that pre-service teachers' enjoyment of mathematics tends to slightly decrease as fixed mindset increases. The data points are widely dispersed around the linear trend line, suggesting considerable variability in enjoyment levels. Fixed mindset accounts for approximately 1.7% of the variance in enjoyment ($R^2 = .017$). In an attempt to examine the statistical nature of this relationship, we formulated and tested the following null hypothesis using Pearson's product–moment correlational analysis:

H_{01}: There is no significant relationship between fixed mindset and pre-service teachers' enjoyment of mathematics.

The results of this analysis are presented in Table 1.

Table **1**

Correlation Between Fixed Mindset and Pre-Service Teachers' Enjoyment of Mathematics

Variables	N	r	p-value	95% CI Lower	95% CI Upper
Fixed Mindset vs Enjoyment	204	–.129	.065	–0.262	0.009

Note: Estimation is based on Fisher's r-to-z transformation with bias adjustment.

As presented in Table 1, the analysis showed a very weak, negative, and non-significant relationship between fixed mindset and pre-service teachers' enjoyment of mathematics, ($r = –0.129$, $p = 0.065$, 95% CI [−0.262,0.009], $N = 204$). This indicates that higher levels of fixed mindset are only slightly associated with lower enjoyment, but the relationship is not statistically significant. Accordingly, the null hypothesis one (H_{01}) is not rejected.

4.2 Addressing Research Question 2

In order to address the second research question, a scatter plot was used to examine the relationship between fixed mindset and pre-service teachers' perceived value of mathematics. Figure 4 presents the scatter plot of value of mathematics by fixed mindset.

Figure **4**

Scatter plot of pre-service teachers' perceived value of mathematics by fixed mindset

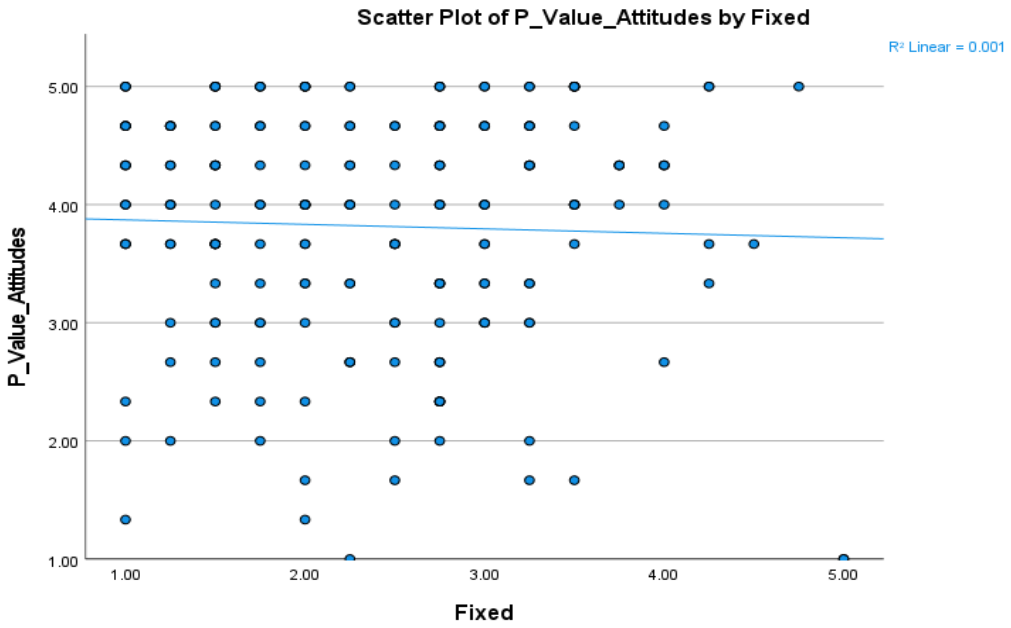


Figure 4 shows a very weak negative association between the two variables, indicating that pre-service teachers' perception of the value of mathematics tends to slightly decrease as fixed mindset increases. The data points are widely dispersed around the linear trend line, suggesting considerable variability in perceived value. Fixed mindset accounts for approximately 0.1% of the variance in value perception ($R^2 = .001$). In an attempt to examine the statistical nature of this relationship, we formulated and tested the following null hypothesis using Pearson's product–moment correlational analysis:

H_{02}: There is no significant relationship between fixed mindset and pre-service teachers' perceived value of mathematics.

The results of this correlational analysis are summarised in Table 2.

Table **2**

Pearson Correlation Between Fixed Mindset and Pre-Service Teachers' Perceived Value of Mathematics

Variables	**N**	r	**p-value**	**95% CI Lower**	**95% CI Upper**
Fixed Mindset vs Value Attitude	204	–.036	.611	–0.172	0.102

As shown in Table 2, the analysis revealed a very weak, negative, and non-significant relationship between fixed mindset and pre-service teachers' perceived value of mathematics, ($r = –0.036$, $p = 0.611$, 95% CI [−0.172,0.102], $N = 204$). This indicates that higher levels of fixed mindset are minimally associated with lower value perception, but the relationship is not statistically significant. Accordingly, the null hypothesis two (H_{02}) is not rejected.

4.3 Addressing Research Question 3

To address the third research question, a scatter plot was used to examine the relationship between growth mindset and pre-service teachers' enjoyment of mathematics. Figure 5 presents the scatter plot of enjoyment by growth mindset.

Figure **5**

Scatter plot of pre-service teachers' enjoyment by growth mindset

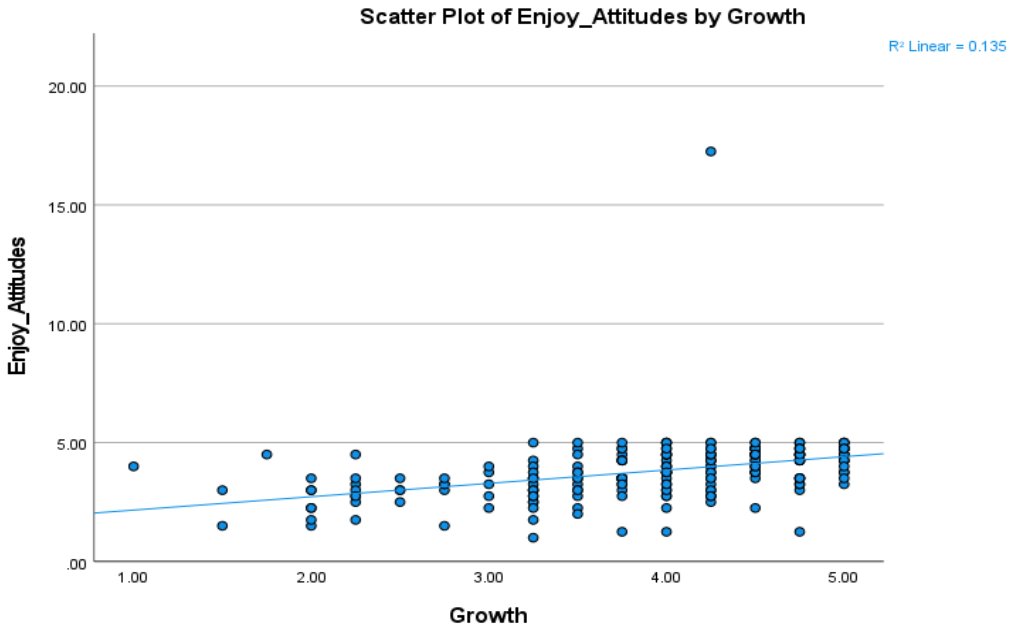


Figure 5 shows a positive association between the two variables, indicating that pre-service teachers' enjoyment of mathematics tends to increase as growth mindset increases. The data points are moderately dispersed around the linear trend line, suggesting some variability in enjoyment levels. Growth mindset accounts for approximately 13.5% of the variance in enjoyment ($R^2 = .135$). In an attempt to examine the statistical nature of this relationship, we formulated and tested the following null hypothesis using Pearson's product–moment correlational analysis:

H_{03}: There is no significant relationship between growth mindset and pre-service teachers' enjoyment of mathematics.

The results of this analysis are presented in Table 3.

Table **3**

Correlation Between Growth Mindset and Pre-Service Teachers' Enjoyment of Mathematics

Variables	**N**	r	**p-value**	**95% CI Lower**	**95% CI Upper**
Growth Mindset vs Enjoyment	204	.368**	<.001	0.242	0.480

Correlation is significant at the 0.01 level (2-tailed).

As presented in Table 3, the analysis showed a moderate, positive, and statistically significant relationship between growth mindset and pre-service teachers' enjoyment of mathematics, ($r = 0.368$, $p < 0.001$, 95% CI [0.242,0.480], $N = 204$). This indicates that higher levels of growth mindset are associated with higher enjoyment. Based on these results, the null hypothesis three (H_{03}) is rejected.

4.4 Addressing Research Question 4

To address the fourth research question, a scatter plot was used to examine the relationship between growth mindset and pre-service teachers' attitudes toward mathematics. Figure 6 presents the scatter plot of attitudes by growth mindset.

Figure **6**

Scatter plot of pre-service teachers' attitudes by growth mindset

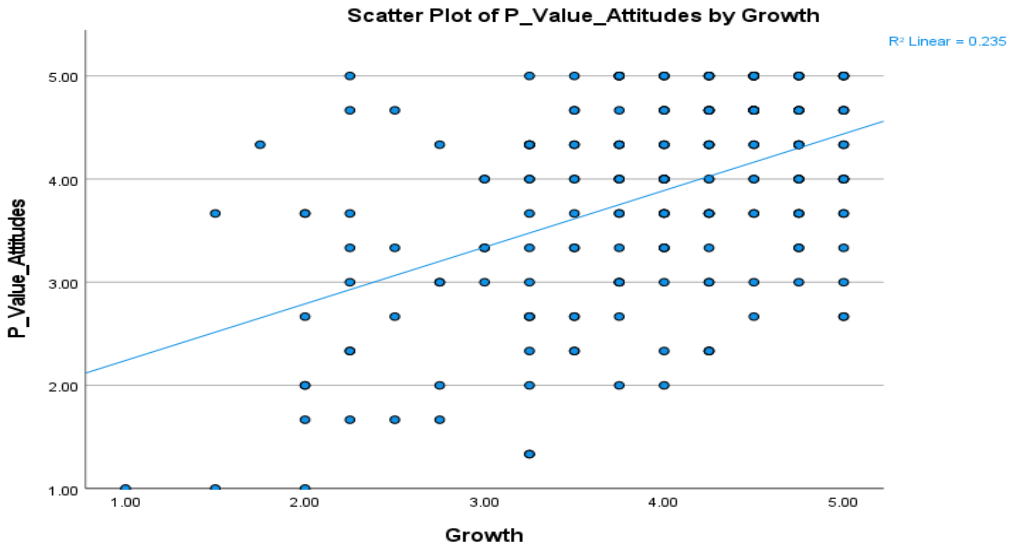


Figure 6 shows a positive association between the two variables, indicating that pre-service teachers' attitudes toward mathematics tend to improve as growth mindset increases. The data points are moderately clustered around the linear trend line, suggesting consistent trends in attitudes across varying levels of growth mindset. Growth mindset accounts for approximately 23.5% of the variance in attitudes ($R^2 = .235$). To statistically examine this relationship, the following null hypothesis was formulated and tested using Pearson's product–moment correlational analysis:

H_{04}: There is no significant relationship between growth mindset and pre-service teachers' attitudes toward mathematics.

The results of this analysis are presented in Table 4.

Table **4**

Correlation Between Growth Mindset and Pre-Service Teachers' Attitudes Toward Mathematics

Variables	**N**	**r**	**p-value**	**95% CI Lower**	**95% CI Upper**
Growth Mindset vs Attitudes	204	0.484**	0.000	0.371	0.582

Correlation is significant at the 0.01 level (2-tailed).

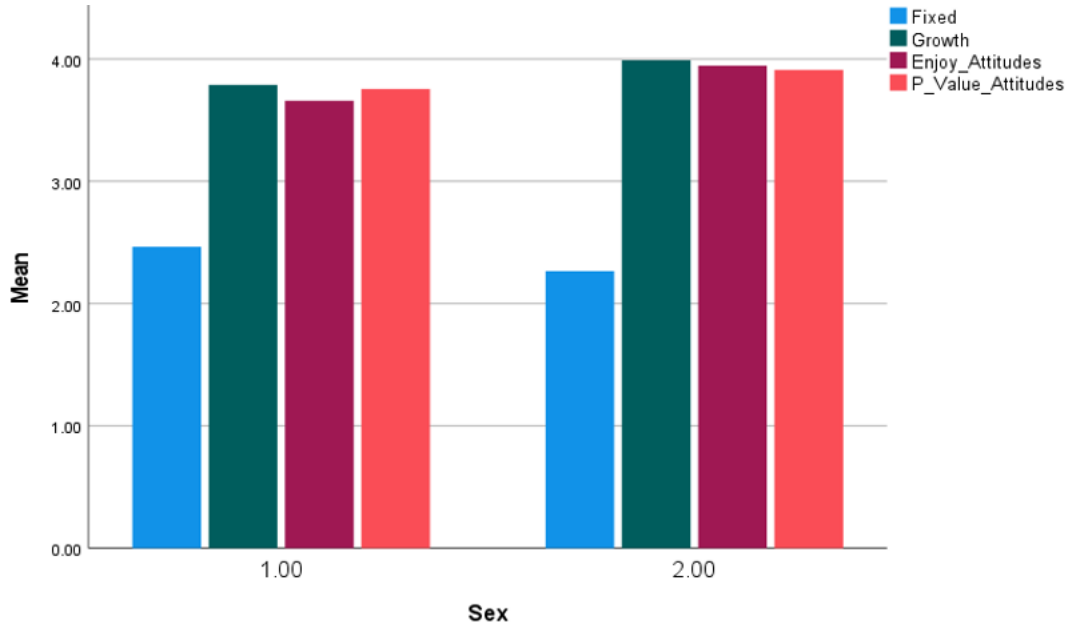
As shown in Table 4, the analysis revealed a moderate, positive, and statistically significant relationship between growth mindset and pre-service teachers' attitudes toward mathematics ($r = 0.484$, $p < 0.001$, 95% CI [0.371, 0.582], $N = 204$). This indicates that higher levels of growth mindset are associated with more positive attitudes toward mathematics. Consequently, the null hypothesis four (H_{04}) is rejected.

4.5 Addressing Research Question 5

To address the fifth research question, a one-way multivariate analysis of variance (MANOVA) was conducted to examine the effect of sex on pre-service teachers' fixed mindset, growth mindset, enjoyment, and attitudes toward mathematics. Figure 7 presents a clustered bar chart showing the mean scores for male and female pre-service teachers across the four variables.

Figure **7**

Clustered bar chart showing mean scores of fixed mindset, growth mindset, enjoyment, and attitudes by sex



Visual inspection of Figure 7 indicates that male and female pre-service teachers exhibited similar mean scores across all variables, with minor differences. To statistically test these differences, the following null hypothesis was formulated:

H_{05}: There is no significant effect of sex on pre-service teachers' fixed mindset, growth mindset, enjoyment, and attitudes toward mathematics.

The results of the multivariate tests are presented in Table 5.

Table **5**

Multivariate Test of the Effect of Sex on Mindset, Enjoyment, and Attitudes

Effect	Test Statistic	F	df Hypothesis	df Error	p-value	Partial η^2
Sex	Pillai's Trace	1.183	4	199	.320	0.023
	Wilks' Lambda	1.183	4	199	.320	0.023
	Hotelling's Trace	1.183	4	199	.320	0.023
	Roy's Largest Root	1.183	4	199	.320	0.023

As presented in Table 5, the multivariate analysis indicated that sex had no statistically significant effect on the combined dependent variables, Pillai's Trace = 0.023, $F(4, 199) = 1.183$, $p = 0.320$, partial $\eta^2 = 0.023$.

The results of the univariate tests are presented in Table 6.

Table **6**

Tests of Between-Subjects Effects for Each Dependent Variable

Dependent Variable	F	df	p-value	Partial η^2
Fixed Mindset	2.289	1, 202	.132	0.011
Growth Mindset	2.701	1, 202	.102	0.013
Enjoyment of Math	2.336	1, 202	.128	0.011
Attitudes toward Math	1.259	1, 202	.263	0.006

As shown in Table 6, the univariate analyses confirmed that sex did not significantly influence fixed mindset, growth mindset, enjoyment, or attitudes toward mathematics (all $p > 0.05$).

Based on these results, the null hypothesis five (H_{05}) is retained, indicating that male and female pre-service teachers do not differ significantly in their mindset, enjoyment, or attitudes toward mathematics.

5 Discussion

The present study examined how fixed and growth mindsets relate to pre-service mathematics teachers' attitudes toward mathematics in Nigerian universities. The findings show that teachers' beliefs about their ability in mathematics influence their enjoyment and perceived value of the subject, but in different ways. Growth mindset emerged as a strong positive predictor of attitudes, while fixed mindset had minimal influence. This highlights that positive and negative beliefs are separate but important in understanding teachers' engagement with mathematics.

The study found that growth mindset was moderately and positively related to pre-service teachers' enjoyment ($r = .368$) and overall attitudes toward mathematics ($r = .484$). Teachers who believe that mathematical ability can be developed tend to enjoy mathematics more and see it as more valuable. This supports Dweck's (2006) Mindset Theory and previous research showing that growth mindset encourages persistence, effort, and positive engagement (Vestad & Bru, 2024). The findings suggest that teachers with growth mindset are more likely to approach mathematics with confidence and interest, which could influence how they teach in the future.

Fixed mindset showed very weak and non-significant relationships with enjoyment ($r = –.129$) and perceived value ($r = –.036$). This suggests that believing mathematical ability is fixed does not strongly affect pre-service teachers' attitudes. This aligns with studies showing that fixed mindset may only impact attitudes under certain conditions, such as lack of support or repeated failure (Yeager & Dweck, 2012). Therefore, focusing only on reducing fixed mindset may not be enough to improve teachers' engagement with mathematics.

The study found no significant differences between male and female pre-service teachers in mindset or attitudes. This suggests that mindset interventions can be applied equally to both sexes in Nigerian teacher education programs. Previous studies also report minimal or inconsistent gender effects in mindset and attitudes in higher education (Heyder & Pegels, 2025; Mahmud & Gagnon, 2023).

The findings have important implications for teacher education. Programs should focus on promoting the growth mindset to increase the enjoyment and perceived value of mathematics. This can be done through reflective activities, problem-solving exercises, and supportive classroom environments. Simply trying to reduce fixed mindset may not be sufficient; pre-service teachers also need experiences that make mathematics engaging, meaningful, and relevant to their future teaching.

This study contributes to the literature by showing that growth and fixed mindsets are distinct but both important in shaping attitudes toward mathematics. It provides empirical evidence from a Nigerian teacher education context, filling a gap in research from sub-Saharan Africa. It also validates the use of the Mathematics Mindset Scale and Attitudes toward Mathematics Scale for measuring these constructs among pre-service teachers. The study has some limitations which are worthy of mention. The cross-sectional design prevents conclusions about cause and effect. Self-reported measures may be affected by bias. Future research could use longitudinal or experimental designs to test how mindset interventions influence attitudes over time. It could also include other aspects of attitudes, such as confidence and anxiety, and consider factors like teaching practices or socio-economic background. Research in other Nigerian states or educational levels could help confirm these findings.

6 Conclusion

The findings of this study provide strong evidence that pre-service mathematics teachers' attitudes toward mathematics are influenced more by growth mindset than fixed mindset. Growth mindset emerged as a meaningful facilitator of enjoyment and perceived value, while fixed mindset showed minimal influence. Importantly, these results indicate that positive and negative beliefs about ability are separate constructs, each affecting teachers' engagement with mathematics differently. This supports the view that mindset is multidimensional and challenges the idea that reducing fixed mindset alone is enough to improve attitudes.

By showing that growth mindset strongly predicts positive attitudes, the study highlights the importance of fostering beliefs that mathematical ability can be developed through effort and practice. Teachers who hold such beliefs are more likely to enjoy mathematics and value it for their future teaching. From a practical perspective, this underscores the need for teacher education programs that not only reduce limiting beliefs but also provide meaningful, engaging, and supportive learning experiences that promote confidence, persistence, and interest in mathematics.

The study also adds empirical evidence from a Nigerian context, where little research has examined pre-service teachers' mindsets and attitudes. By situating these constructs within the realities of Nigerian teacher education, the research emphasizes the importance of context-sensitive interventions that consider both psychological and educational factors in improving teachers' engagement with mathematics. The following recommendations were made:

1. Teacher education programs should include activities and workshops that help pre-service mathematics teachers develop a growth mindset.
2. Pre-service teachers should be provided with opportunities to experience mathematics in ways that are enjoyable, relevant, and applicable to teaching.
3. Teacher education curricula should explicitly address the links between mindset, attitudes, and teaching practices.

7 Ethical Statement

The study was conducted in accordance with the institutional requirements. Written informed consent for participation in this study was provided by the participants.

8 Conflict of interest

No potential conflict of interest was reported by the authors.

9 Author Contributions

Kazaik Benjamin Danlami: Data curation, Formal analysis, Methodology, Software, Supervision, Visualization, Writing–original draft, Writing–review & editing. Babatunde Joseph Adeniran: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Validation, Writing original draft, Writing, review & editing; Yusuf Feyisara Zakariya: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing original draft, Writing, review & editing. Ramatu Ematum Umahaba: Conceptualization, Methodology, Supervision, Writing original draft, Writing, review & editing; Ibrahim Omeiza Idris: Conceptualization, Methodology, Supervision, Writing original draft, Writing, review & editing.

10 Funding

The research reported in this article received neither individual funding nor any agency funding.

11 Data Availability Statement

The data used for this study will be available upon request from the corresponding author.

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