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Research Article

Family and teacher predictors of mathematics achievement in senior high school students: Evidence from SEM

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This study examined the effects of family background and teacher factors on the academic performance of students in mathematics. It highlights the significance of understanding these influences to enhance educational outcomes and improve policy and practice in the region. A descriptive research design was employed which is anchored on the quantitative research approach of the positivism research paradigm, utilizing both simple random sampling and stratified sampling techniques to select participants from senior high schools in the Ahafo Region. Data were collected through structured surveys. Data analysis was conducted using Structural Equation Modeling, which enabled a detailed examination of the direct effects of family background and teacher factors on academic performance, as well as the moderating role of family type. The analysis revealed that family background had a direct but statistically insignificant effect on students' academic performance in mathematics, indicating that it does not significantly influence academic outcomes in this context. In contrast, teacher factors had a substantial and statistically significant positive effect on academic performance, accounting for the variation in students' performance. Additionally, family type did not significantly moderate the relationship between family background and academic performance. The findings suggest the need for policy reforms focused on improving teacher effectiveness and engaging teachers in educational policy development. Enhancing the learning environment and integrating effective teaching strategies are crucial for improving academic performance in mathematics. These improvements are also essential for advancing related disciplines such as technology, sciences, engineering, economics, and accounting.

Keywords: Mathematics performance, family background, family type, moderation analysis, teacher factor

1. Introduction

Education plays a vital role in shaping individuals, communities, and nations. It equips learners with essential skills, values, and competencies needed for personal development and national progress (Li & Qiu, 2018; Muola, 2010). Globally, education is increasingly recognized as a key driver of innovation, economic growth, and social mobility (Heckman, 2011). In this context, mathematics stands out as a foundational subject due to its universal application and relevance to science, technology, engineering, and problem-solving in daily life (Aithal & Aithal, 2019; Karim et al., 2023).

In Ghana, mathematics is a compulsory subject at all educational levels. Despite its importance, students' performance in mathematics remains a persistent concern, as shown in national and international assessments (Maamin et al., 2020). This has raised questions about the various factors influencing students' academic performance in mathematics. Among these, family background and teacher factors have been identified as critical yet underexplored variables. Globally, research shows that family characteristics such as parents' education level, family type (nuclear or extended), and socio-economic status significantly influence students' learning outcomes (Jæger, 2012; Mutodi & Ngirande, 2014; Riccomini et al., 2015). In Ghana, the traditional extended family structure continues to play a major role in shaping children's values, educational attitudes, and

access to support, while nuclear families may present different dynamics regarding parental involvement and academic support.

Similarly, teacher-related factors such as qualifications, teaching practices, support, and relationships with students are consistently linked to academic achievement worldwide (Darling-Hammond, 2014; Roorda et al., 2011). In the Ghanaian context, disparities in teacher quality and classroom effectiveness remain key challenges affecting students' performance in mathematics, especially in rural and underserved areas (Muijs et al., 2014). This study therefore seeks to examine how family background including type and parental education and teacher factors influence students' performance in mathematics in the Ahafo Region of Ghana. Understanding these relationships is essential for developing targeted interventions to improve mathematics outcomes and promote equitable educational opportunities.

2. Background

Numerous studies have been undertaken to examine the factors contributing to this issue. Previous research has not been without flaws, either, particularly when it comes to teacher influences (Firmender et al., 2014; Kitsantas et al., 2011; Murayama et al., 2013). However, in the last five years of research, particularly in mathematics achievement, there has been very little understanding of the prevailing factors of teachers. Other studies reported a teacher's personal qualities like linguistic intelligence, locus of control, and self-efficacy are essential to their performance as an educator (Scheerens & Blömeke, 2016). As a result, it seems that a variety of teacher traits could help to explain why there is variance in teacher effectiveness. Minute research have considered recognized qualification indicators with apparent competence indicators, like teacher self-efficacy beliefs, despite the fact many have examined a single facet of teacher quality in connection to student outcomes, or multiple formal competence indicators solely.

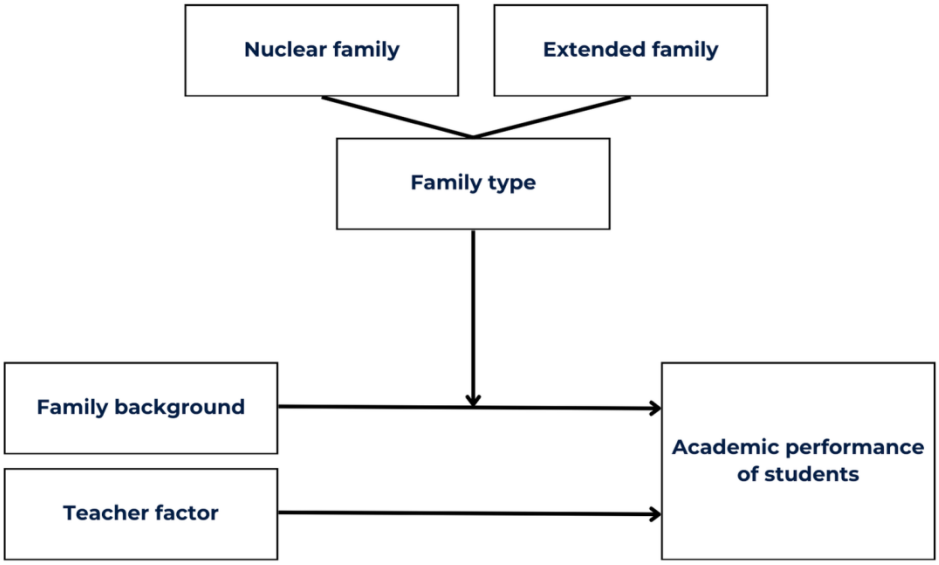
However, Scheerens and Blömeke (2016) argue that the teacher factor is a multidimensional construct that includes both cognitive (knowledge) and non-cognitive (beliefs, attitudes, etc.) components. Therefore, by linking indicators from both teacher component dimensions to student outcomes, a more precise explanation for variances in teacher effectiveness may be discovered (Cochran-Smith & Zeichner, 2005; Goe, 2007). Overall, the findings showed that most schools are more likely to have students perform poorly in mathematics on both internal and external exams. The government, parents, educators, and students all place blame on one another for the low academic performance or math proficiency of their pupils.

The governments of Ghana, both past and current, have implemented a number of programs to enhance the country's infrastructure and other educational resources. To address the issue, some of the measures included "Free Compulsory Universal Basic Education" [FCUBE], school lunches, capitation grants, Ghana Education Trust Fund [GETFund], free books and uniforms, and the construction of new schools as well as the rehabilitation of existing ones. Furthermore, the Ghana Educational Service [GES] has benefited from contributions made by non-governmental organizations [NGOs] like World Vision International, Action Aid Ghana, donors (DFID, USAID, JICA, DANIDA, and ADB), as well as other groups like civil society and educators. These contributions have taken the form of cash, human resources, infrastructure, and material resources.

Students' academic performance in Ahafo region schools has not improved despite these interventions especially in mathematics. It is possible that the majority of programs implemented have not prioritized teacher factor and student family background as well as the type of family being it nuclear family and extended family variables in the study area. Insufficient study has been done to determine whether teacher factor and family background have a major impact on students' academic success in mathematics in the Ahafo region. Therefore, the study would determine the effect of family background and teacher factor on academic performance [AP] of students in mathematics and the moderating effect of family type on the family background and AP of student in mathematics.

Figure 1 indicates the conceptual framework of the study. The figure represents study variables in the stance of Family Background [FB], Teacher Factor [TF], Family Type [FT] (extended and nuclear family) and AP of students in mathematics. The direction from FB to AP indicates the relation as well as the direction from TF to AP. The family is measured to two strands namely nuclear family and extended family as the moderating variable on the association between the FB and AP. In this regard, the family background and teacher factor represent the main independent variable and the AP represents the dependent variable, which is moderated by the third variable family type in the stance of nuclear family and extended family.

Figure 1
Conceptual Framework of the Study



Based on the research objectives and the framework, the following hypotheses are presented:

H1: Family background has a direct positive effect on the academic performance (AP) of students in mathematics in the Ahafo Region.

H2: Teacher-related factors have a direct positive effect on the academic performance of students in mathematics in the Ahafo Region.

H3: Family type moderates the relationship between family background and the academic performance of students in mathematics in the Ahafo Region.

3. Theoretical Framework

This study was grounded in Social Learning Theory and Human Capital Theory.

3.1. Social Learning Theory

Social learning theory, as proposed by Albert Bandura, posits that individuals learn new abilities by imitating and observing the behaviors of others. Bandura referred to this process as "observational learning." In essence, learning does not always necessitate firsthand experience; instead, it can occur through the observation of others (Bandura, 1977). He contended that all actions are learned via social imitation rather than being inherited. In the early 1960s, Bandura conducted a series of influential studies known as the Bobo doll experiments, which provided empirical support for his theory (Bandura, 1977). His work is closely associated with behavioral learning theories, which assert that all human behaviors are acquired through conditioning and interactions with the external environment. Behaviorists argue that, under the right conditions and instruction, anyone can be trained to perform any task, irrespective of their background or ability level (Pavlov, 1927; Skinner, 1953). While Bandura's conception of social learning aligns with the behaviorist perspectives put forth by psychologists B.F. Skinner and Ivan Pavlov who are known for classical and operant conditioning, respectively he maintains that not all learning can be

accounted for by direct reinforcement. In fact, learning can often transpire during both childhood and adulthood without the learner having directly experienced or practiced the new behavior (Bandura, 1977).

3.2. Human Capital Theory

According to human capital theory, much of the variation in children's academic performance can be attributed to differences in family investment in education. This perspective posits that families make educational decisions based on a "cost-benefit" framework, weighing the perceived returns of investing in their children's education. Financial investments in schooling such as tuition, learning materials, and educational support are viewed as key avenues for building human capital. However, families with limited financial resources may struggle to make adequate investments, which in turn negatively affects their children's academic performance (Becker, 1964).

Research has shown that students' cognitive abilities are positively correlated with the socioeconomic status [SES] of their parents (Langensee et al., 2024). In line with cultural capital theory, a family's cultural resources and environment play a significant role in shaping children's academic aspirations and outcomes. Parents with high cultural capital are often more familiar with school systems, more likely to assist their children with schoolwork, and better equipped to support their academic development (Bourdieu & Passeron, 1990).

Additionally, social capital theory emphasizes the importance of parental involvement in children's learning behaviors and educational outcomes. More affluent parents tend to engage more actively in school activities, maintain regular communication with teachers, monitor their children's behavior, and provide consistent academic support (Coleman, 1988). While human capital theory focuses on the financial aspect of educational investment, cultural and social capital theories highlight the broader roles of parental engagement and values in supporting academic success. Taken together, these frameworks suggest that a family's socioeconomic status not only influences access to resources but also affects the quality of schooling and the likelihood of sustained academic achievement.

4. Literature Review

4.1. Family Background and Academic Performance of Students in Mathematics

Families greatly influence children's learning habits and academic success since they are their first and most important environment. Families may have an even bigger influence on a student's academic achievement than communities and institutions, as evidenced by Coleman's 1966 report. Since then, empirical research has shown that social and economic standing within the family may have a bigger impact on a child's academic success than the educational system, as evidenced by studies on the relationship between a child's achievement and their family history (Cheadle, 2008; Coleman et al., 1966; Sirin, 2005; White, 1980;). Worldwide fieldwork and research have supported Coleman's idea.

For example, Fang and Feng (2008) found that a child's academic success is highly influenced by their family's social and economic standing based. Sun et al. (2009) discovered a significant beneficial influence of parents' wealth and educational attainment on the academic success of primary school pupils. Expanding upon Coleman's discoveries, scholars have investigated the ways in which families impact their children's academic success through concepts such as social capital, cultural capital, and human capital.

Drawing on theories like social capital, cultural capital, and human capital, studies have examined how families affect their children's academic achievement based on Coleman's study. Research suggests that a child's parents' social and economic status might have a significant influence on the quality of their schooling. Children from households with greater socioeconomic status attend better schools (Wu, 2013). Selvam (2013) investigated the relationship between 150 students in Class XI and their parents' educational attainment. He employed a 50-point vector analysis achievement test. The findings demonstrated that, in terms of the influence of parents'

education, there are no appreciable differences between male and female, rural and urban, and educated and illiterate parents of higher secondary students. Regarding the impact of parents' education, he did discover a noteworthy distinction between government, assisted, and higher secondary students.

Kundu (2017) studied 351 children in Class XI geometry performance and parents' educational status. The findings showed a substantial discrepancy between student geometric thinking and parent qualification. On the other hand, he discovered that pupils' geometric reasoning levels increased with parental qualifications. Amuda and Ali (2016) studied the academic accomplishment of NCE students at colleges of education and the educational attainment of their parents on 1200 sample of the 13529 NCE students from six colleges. The findings suggest that there was no significant correlation between academic achievement and the educational attainment of the mother and father. Nevertheless, they discovered no connection between academic achievement and parents' educational attainment. Qadri (2018) also studied the academic achievement of 500 secondary school pupils and the educational attainment of their parents. He measured the academic achievement of the students using the results of their most recent exam. The findings showed a strong correlation between students' academic achievement and their parents' educational attainment. Imam and Singh (2015) studied the effects of parental education and gender on the arithmetic proficiency of 1127 secondary school pupils. The findings show that pupils' performance in mathematics was comparable for male and female students. However, he discovered that, in comparison to children of less educated parents, children of highly educated parents are likely to have much higher mathematics success scores.

4.2. Teacher Factor and Academic Performance of Students in Mathematics

Kimani el al. (2013) examined the connections between students' academic achievement and the demographic traits of a sample of instructors chosen at random and classroom instructional techniques in a subset of secondary schools. From a pool of 153 instructors from 18 different schools, research participants were chosen at random. The study found a substantial correlation between academic achievement and the age, gender, professional credentials, and teaching experience of teachers. In contrast, there was a strong and favorable correlation between the job group of instructors and the academic success of their students in secondary schools.

Ladd and Sorensen (2014) discovered that a teacher's background influences several non-test score outcomes, such as the amount of time spent on homework and leisure reading, the frequency of disruptive behavior, and the number of absences. These behaviors, which are partially influenced by a student's home or community setting, highlight significant aspects of learning motivation, perseverance, and self-control that have a significant impact on the success middle school children. Their data indicate that middle school math and English language arts [ELA] teachers have higher exam scores. Despite the findings, the study group's focus was on middle school pupils rather than those from primary schools, which contributes to the current research's relevance.

In fact, a meta-analysis of over 60,000 research papers revealed that teachers were the contextual (external) element that had the biggest impact on students' achievements (Hattie et al., 2016). International studies on the effects of hundreds of interventions on students worldwide were included in this meta-analysis. According to the study, among environmental factors such as classmates, principals, other school-related factors, and home environment, teacher-related factors were the most powerful in predicting student learning. Numerous research revealed the influence of teacher characteristics on student motivation and achievement when examined in isolation. More precisely, there are strong correlations between teacher characteristics and student outcomes and the educational background of the teachers (Hill & Dalton, 2013).

Additionally, the impact of teacher factors on students' academic performance in mathematics has been a subject of significant research. In particular, teacher effective communication has been identified as a critical component influencing students' interest and performance in mathematics. Akendita, Boateng et al. (2025) conducted a study that investigated how teacher-effective

communication mediated the relationship between students' mathematics interest and their performance. The findings revealed a positive correlation, indicating that students who experienced effective communication from their teachers demonstrated higher levels of interest in mathematics, which subsequently enhanced their academic performance in the subject.

Research demonstrates the close relationships between decision-making, instructional planning and practices of teachers and their educational views about teaching (which are a component of their certification) as well as their specialized content knowledge for teaching (Hill et al., 2012). It is clear that teacher qualifications have a direct bearing on student outcomes when you combine this with the information demonstrating how teaching methods inherently affect student results. Furthermore, these teacher elements which were rarely studied and their effects on pupils were typically examined separately (that is, solely professional background factors were examined, rather than in connection with family background and structure). This study looked at several aspects of the teacher factor, such as how the type and structure of the family affects them all together.

5. Method

5.1. Research Design

The study employed the descriptive design, which is anchored on the quantitative research approach of the positivism research paradigm, this design analyses the nature of current situations and uses numbers to characterize people or groups in order to summarize an actual reality. The researcher used the descriptive design in order to accurately describe the current state of affairs (Maksimović & Evtimov, 2023).

5.2. Participants

For this study, the target population comprised form Achirensua Senior High School and Hwidiem Senior High School, both located in the Ahafo Region. Primary data were collected from a total of 300 students (see Table 1). Out of the 1,208 students enrolled in the two schools, 300 Form Two students were selected to constitute the study's sample.

Table 1
Demographic Characteristic of the Respondents

Demographic Characteristic	*N*	*Percent (%)*
Gender		
Male	144	48.0
Female	156	52.0
Age		
11-15	19	6.3
16-20	277	92.3
20-25	3	1.0
Above 25	1	.3
Family type		
Nuclear Family	163	54.3
Extended Family	137	45.7
Program		
General Arts	67	22.3
Visual Arts	46	15.3
General Science	69	23.0
Technical	35	11.7
Home Economics	64	21.3
Business	19	6.3

The study employed a combination of stratified sampling and simple random sampling techniques. Initially, the stratified sampling method was used to categorize students into distinct

strata based on their respective academic programmes. Subsequently, simple random sampling was applied within each stratum to select participants. This dual approach ensured that all students had an equal probability of selection while maintaining the representativeness of the sample across academic disciplines. The use of both techniques minimized selection bias and contributed to the reliability of the study's findings. Analysis of the demographic data revealed a fairly balanced gender distribution, with a slightly higher proportion of female respondents. Most participants were in their late teenage years, and a majority came from nuclear family backgrounds. The sample included students from various academic programs, with General Science, General Arts, and Home Economics being the most prominently represented.

5.3. Instrument

The study employed a structured questionnaire as the primary data collection instrument, organized into four sections. Section A gathered demographic information, including gender, age, family type, and academic program. Sections B to D were designed to align with the study's objectives and contained items measured using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). This scale enabled respondents to express their level of agreement with statements related to family background, teacher-related factors, and students' academic performance in mathematics. The structured format ensured consistency, eases of response, and facilitated the generation of quantifiable data for statistical analysis.

To ensure the validity of the instrument, a content validity assessment was conducted. Experts in the relevant field reviewed the questionnaire to determine whether the items were clear, aligned with the study objectives, free of ambiguity, and appropriate for the target population. This process confirmed that the instrument was suitable for its intended purpose.

Following content validation, convergent validity was examined using factor loadings and Average Variance Extracted (AVE) values. Convergent validity is considered adequate when the AVE exceeds the recommended threshold of 0.50 (Akendita, Boateng et al., 2025). As shown in Table 4, all constructs met this criterion, confirming the instrument's convergent validity.

To further establish the reliability of the instrument, Cronbach's Alpha coefficients were calculated using SPSS (v.23) for the three key constructs: Family Background, Academic Performance in Mathematics, and Teacher Factor. The results indicated acceptable levels of internal consistency across all constructs.

Additionally, the questionnaire was presented to a panel of experts for face validity assessment. This step ensured that the items were not only technically valid but also appeared credible and appropriate to respondents.

In summary, the instrument underwent a rigorous validation process—including content, convergent, and faces validity—as well as reliability testing. These measures ensured that the questionnaire was both valid and reliable for assessing the key constructs of interest in the study.

5.4. Data Analysis

The data collected for this study were analyzed using the Statistical Package for the Social Sciences (SPSS v.23) and Analysis of Moment Structure (AMOS v.23). For inferential statistical analysis, Structural Equation Modeling (SEM) was employed to test the hypothesized relationships among variables. According to Zainudin (2015), SEM is a modern multivariate analysis technique widely used in questionnaire-based research for its ability to model complex relationships. AMOS software enhances the precision of SEM analysis, making it a suitable tool for this study (Mustafa et al., 2020).

A Confirmatory Factor Analysis (CFA) was conducted to assess the adequacy of the measurement model and determine the compatibility of observed items with their underlying latent constructs. Factor loadings ranging between 0.50 and 1.00 were considered acceptable indicators of construct validity. The study addressed three key aspects of measurement quality: convergent validity, construct validity, and reliability. Convergent validity was evaluated using the Average Variance Extracted (AVE), with a minimum threshold of 0.50 as recommended by

Fornell and Larcker (1981). Reliability was assessed through the Composite Reliability (CR), which was required to be ≥ 0.70 to indicate sufficient internal consistency.

To evaluate model fitness, a range of goodness-of-fit indices were examined. The Root Mean Square Error of Approximation (RMSEA) was expected to be ≤ 0.08, indicating a reasonable fit. In addition, the Goodness of Fit Index (GFI), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI/NNFI) were required to be ≥ 0.90 to reflect acceptable model fit. The combined use of SPSS and AMOS, alongside rigorous criteria for validity and reliability, ensured that the analysis was both robust and statistically sound, providing a strong foundation for drawing reliable inferences from the data.

6. Results

The Exploratory Factor Analysis [EFA] was conducted to identify the underlying factor structure of the variables related to Family Background, Teacher Factor and Academic Performance. EFA is an essential statistical technique used to reduce a large number of variables into fewer dimensions by identifying the underlying relationships between the variables, ensuring that they represent distinct factors (Akendita, Arthur et al., 2025).

Table 2
Exploratory Factor Analysis [EFA]

Rotated Component Matrix[a]			
Measurement	Component		
Item	1	2	3
FAB3		.873	
FAB4		.896	
FAB5		.885	
FAB6		.866	
ACAP3	.859		
ACAP4	.865		
ACAP5	.865		
ACAP6	.873		
ACAP7	.816		
TFA2			.834
TFA3			.870
TFA4			.842
TAF5			.802
KMO and Bartlett's Test			
Total Variance Explained			84.151%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.854
Bartlett's Test of Sphericity	Approx. Chi-Square		3951.024
	df		78
	Sig.		<.001
Determinant			1.45E-006

To explore the underlying structure of the constructs and determine the alignment of observed variables with their respective latent variables, Exploratory Factor Analysis (EFA) was conducted using SPSS (version 23). This approach was employed to reduce the number of items by eliminating those that did not load appropriately onto the intended factors, as recommended by Surh (2005). The analysis yielded a coefficient of determinant of 1.45E–006 and a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.854, indicating that approximately 85% of the variance among the observed variables could be explained by underlying factors. Furthermore, Bartlett's Test of Sphericity produced a Chi-square value of 3,951.024 with 78 degrees of freedom and a p <.001, confirming the suitability of the data for factor analysis. The EFA also revealed that the four extracted factors accounted for a cumulative variance of 84.151%, reflecting a strong factor

structure. Observed variables that failed to load properly on their respective constructs or cross-loaded on multiple factors were eliminated, consistent with the procedures outlined in related studies (Akendita, Arthur et al., 2025). Following this refinement, the Family Background construct retained four items, Academic Performance retained five items, and Teacher Factor retained four items. The final structure of the retained items and their respective factor loadings are presented in Table 2.

6.1. Reliability Analysis

To ensure that the measurement instruments used in the study are both reliable and consistent, a reliability analysis was conducted. One widely used indicator of internal consistency is Cronbach's Alpha, which assesses how closely related a set of items are as a group. A Cronbach's Alpha coefficient of 0.70 or higher is generally considered acceptable for demonstrating adequate internal consistency (Pomegbe et al., 2020). This analysis was crucial in confirming that the items within each construct reliably measured the same underlying concept.

Table 3
Reliability analysis

Variables	*Number of Items*	*Cronbach Alpha*
Family Background (FB)	4	.949
AP of students in mathematics (ACAP)	5	.946
Teacher Factor (TF)	4	.932

To assess the internal consistency of the measurement items for the three constructs—Family Background, Academic Performance (AP) of Students in Mathematics, and Teacher Factors—a reliability analysis was conducted. The Cronbach's Alpha values for each construct are presented in the following table. All three constructs demonstrated alpha values well above the generally accepted threshold of 0.70, indicating a high level of internal consistency and reliability of the measurement items (Fornell & Larcker, 1981).

The Family Background construct, comprising four items, yielded a Cronbach's Alpha value of .949, reflecting excellent internal consistency. This high reliability suggests that the items consistently measure the underlying construct, and elicit dependable responses regarding students' family-related variables. Similarly, the Academic Performance of Students in Mathematics construct, measured with five items, recorded a Cronbach's Alpha of .946. This value confirms that the items reliably capture students' academic achievement in mathematics, and that participants responded consistently to these indicators. The Teacher Factors construct also demonstrated strong reliability, with four items producing a Cronbach's Alpha value of .932. This result indicates that the items effectively and consistently measure aspects related to teacher influence within the educational context. Overall, the high Cronbach's Alpha coefficients across all three constructs confirm the robustness and internal coherence of the measurement instrument used in this study.

6.2. Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was conducted to validate the factor structure identified during the Exploratory Factor Analysis (EFA) and to assess the overall fit of the hypothesized measurement model to the observed data. CFA is a multivariate statistical technique used to evaluate whether a set of observed variables accurately represents a predetermined number of latent constructs, thereby confirming the validity of the underlying theoretical framework. By testing the relationships between indicators and their respective constructs, CFA provides evidence for the construct validity of the measurement model and ensures that the proposed structure is empirically supported.

Table 4
Confirmatory Factor Analysis

Model Fitness: CMID = 101.729; DF= 56; CMIN/DF = 1.817; TLI = .984; CFI = .988; GFI = .951; RMSEA = .052; RMR = .031; PClose = .390;		*Std. Factor Loading*
Family Background : CA= .949; CR = .948; AVE = .820		
FAB3	My teachers and parents/guardians discuss my maths performance.	.864
FAB4	My parents or guardians are well educated.	.882
FAB5	My parents or guardians place a great importance on maths education.	.949
FAB6	There are numerous maths books and educational resources at my house.	.925
AP of students in mathematics: CA= .946; CR = .943; AVE = .769;		
ACAP3	I actively participate in all math discussions because	.852
ACAP4	I want to do well in math. I also start papers and projects as soon as I have math class.	.904
ACAP5	In Mathematics , I usually do well	.921
ACAP6	It Is easy to pass mathematics course	.885
ACAP7	I always complete my math assignments.	.819
Teacher Factor: CA= .932; CR = .934; AVE = .781;		
TFA2	My academic progress is important to my maths teacher.	.867
TFA3	My maths instructor knows a lot about the subject they teach.	.927
TFA4	My maths instructor presents challenging material with effectiveness.	.899
TAF5	The classroom is kept neat and orderly by my maths teacher.	.839

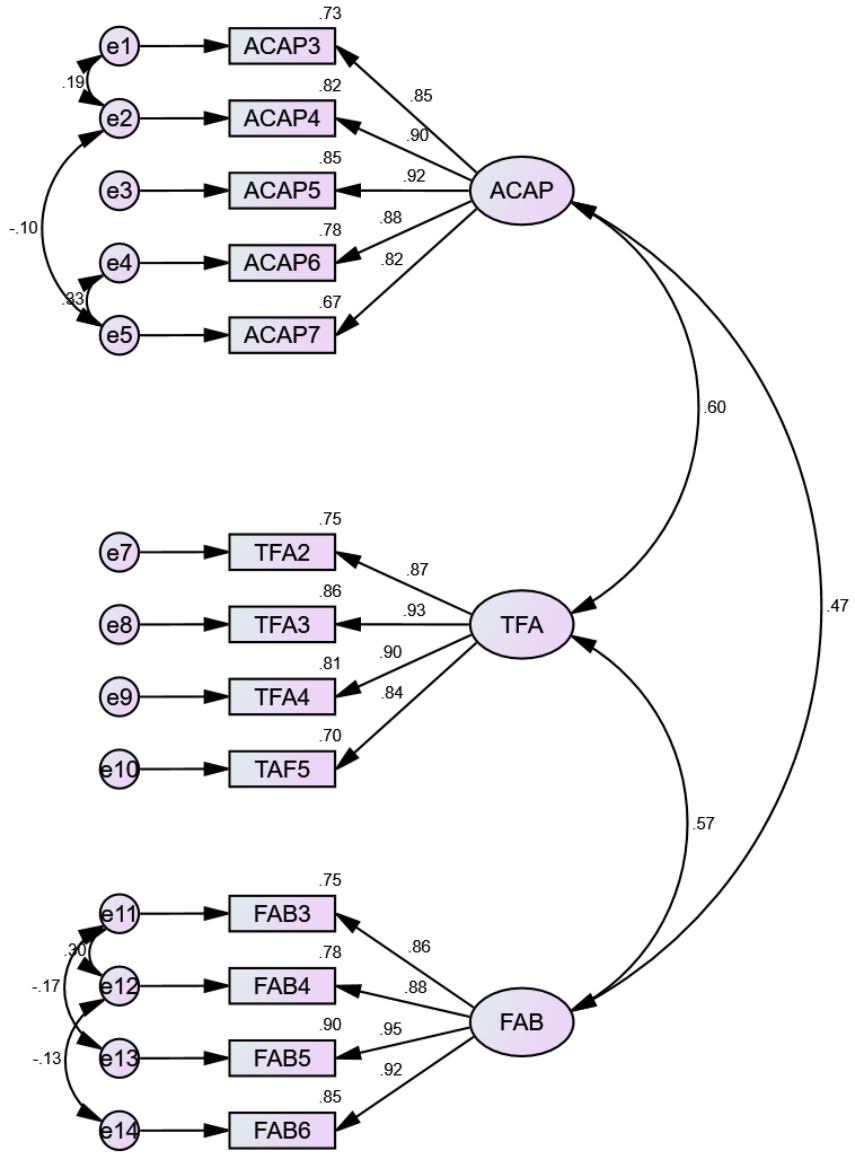
Confirmatory Factor Analysis (CFA) was conducted using Covariance-Based Structural Equation Modeling (CB-SEM) in AMOS (version 23) to validate the factor structure identified through the Exploratory Factor Analysis (EFA) and to assess the overall model fit. The results of the CFA are presented in Table 4 and Figure 2. Model fit was evaluated based on the criteria outlined by Hair et al. (2020), which recommend the following thresholds: CMIN/DF ≤ 3, GFI ≥ 0.80, PClose > 0.05, TLI ≥ 0.90, CFI ≥ 0.90, RMSEA ≤ 0.08, and RMR ≤ 0.08. As all fit indices met the specified criteria, it was concluded that the measurement model demonstrated an acceptable fit to the data.

In addition, the Standardized Factor Loadings (SFLs) for all observed variables were above the minimum acceptable threshold of 0.50, indicating that each retained item significantly contributed to the explanation of its respective latent construct. This further supports the measurement model's construct validity. Following this, convergent validity was assessed by calculating the Composite Reliability (CR) and Average Variance Extracted (AVE) using the SFLs. According to Fornell and Larcker (1981), AVE values of 0.50 or higher and CR values of 0.70 or higher are indicative of acceptable convergent validity. The analysis showed that all AVE and CR coefficients exceeded the recommended thresholds, confirming convergent validity. Moreover, Cronbach's Alpha coefficients, computed using SPSS, were all above 0.70, aligning with the reliability standards proposed by Bamfo et al. (2018). These results collectively affirm that the measurement model was both valid and reliable, thereby confirming the theoretical structure of the constructs under investigation.

6.3. Discriminant Validity

Discriminant validity refers to the extent to which a construct is truly distinct from other constructs in a measurement model. It ensures that each factor in the model represents a unique concept and is not overly correlated with other factors. Establishing discriminant validity is crucial for confirming that the constructs measured in the study are distinct and not overlapping, which strengthens the credibility of the measurement model.

Figure 2
Confirmatory Factor Analysis



Conferring to Trochim and Donnelly (2001), discriminant validity quantifies how uncorrelated measurement items in one construct are with measurement items in other study constructs. The method proposed by Fornell and Larcker (1981) for evaluating discriminant validity in this study was to compare the square-root of AVEs (√AVEs) with the inter-correlation coefficients. Table 5 suggests that discriminant validity was attained in the sample because the biggest correlation coefficient of 0.605 was less than the least √AVE of 0.877. By looking at the correlation coefficients, multicollinearity was evaluated (Borah et al., 2022). According to Tabachnick et al. (2013), when correlation coefficients are higher than 0.7, there may be an indication of multicollinearity, which could lead to a confounding impact. In this investigation, the greatest correlation coefficient recorded was 0.605.

Table 5
Discriminant validity

Variable	*ACAP*	*TFA*	*FAB*
ACAP	**0.877**		
TFA	0.605***	**0.884**	
FAB	0.470***	0.572***	**0.905**

Note. √AVE are bolded and underlined; *** ~ $p < .001$.

6.4. Structural Model

Following the evaluation of the measurement model fit, the data were subjected to additional analysis by looking at the potential relationship between the endogenous and exogenous variables of the study's framework. The causal links between the predictors (Family background and teacher Factor) and outcome variable (AP of students in mathematics) that are postulated in the research framework were examined using SEM analysis and hypothesis testing. Furthermore, the analysis encompassed the control variables, which are shown in Table 6 and illustrated visually in Figure 3.

Table 6
Path Summary

Direct Path	*Std. Estimate*	*SE*	*CR*	*p-Value*
Gender → ACAP	−.007	.098	−0.071	.880
Age → ACAP	.055	.089	0.617	.232
Programme of study → ACAP	−.022	.030	−0.733	.637
Family Type → ACAP	−.110	.099	−1.111	.017
FAB → ACAP	.166	.163	1.018	.236
TFA → ACAP	.462	.060	7.700	***
INT_CEFAB_Family_Type → ACAP	.040	.113	.353	.773

Note: *** ~ p-value significant at 0.1 %(.001).

With reference to Table 6, the analysis revealed that respondents' gender had a statistically insignificant negative effect of 0.7% on students' academic performance (AP) in mathematics ($\beta = -0.007$; CR = −0.071; $p = .880$). Similarly, age showed a statistically insignificant positive effect of 5.5% on mathematics performance ($\beta = 0.055$; CR = 0.617; $p = .232$). The programme of study was found to have a 2.2% negative effect on students' AP in mathematics ($\beta = -0.022$; CR = −0.733; $p = .637$), which was also statistically insignificant.

In contrast, the family type of respondents had a statistically significant negative impact of 11.0% on students' academic performance in mathematics ($\beta = -0.110$; CR = −1.111; $p = .017$). This suggests that students' family type directly influenced their academic outcomes in mathematics, with those from certain family structures experiencing comparatively lower performance.

Family Background has a direct positive effect on the academic performance (AP) of students in mathematics

The first research hypothesis aimed to determine whether *Family Background* has a statistically significant effect on students' academic performance in mathematics in the Ahafo Region. As presented in Table 6, Family Background had a direct positive influence on AP ($\beta = .166$; C.R. = 1.018; $p = .236$), indicating that approximately 16.6% of the variance in students' academic performance is explained by family background. However, this effect was statistically insignificant at the 5% level. Therefore, the null hypothesis is *not rejected*, and the first research hypothesis is *not supported*.

Teacher Factor has a direct positive effect on the academic performance of students in mathematics

The second hypothesis examined the impact of *Teacher Factor* on students' academic performance in mathematics. Table 6 shows that Teacher Factor exerted a strong direct positive effect on AP ($\beta = .462$; C.R. = 7.700; $p = .001$), accounting for approximately 46.2% of the variance. This effect was statistically significant at the 0.1% level. Accordingly, the null hypothesis is *rejected*, and the

alternative hypothesis is *supported*, confirming that Teacher Factor significantly influences students' academic performance in mathematics.

Family type moderates the relationship between Family Background and the academic performance of students in mathematics

The third hypothesis explored whether *Family Type* moderates the relationship between Family Background and students' academic performance in mathematics. As shown in Table 6, the interaction term (INT_CEFAB_Family_Type) revealed a direct positive but statistically insignificant moderating effect (β = .040; C.R. = .353; p = .773). This suggests that *Family Type* does not significantly moderate the relationship between Family Background and academic performance in mathematics. Therefore, the third hypothesis is *not supported*. However, the interaction plot in Figure 4 indicates that Family Type may *strengthen* the positive relationship between Family Background and academic performance. While this visual trend offers suggestive insight, it does not override the statistical insignificance of the moderation effect.

Figure 3
Path Analysis

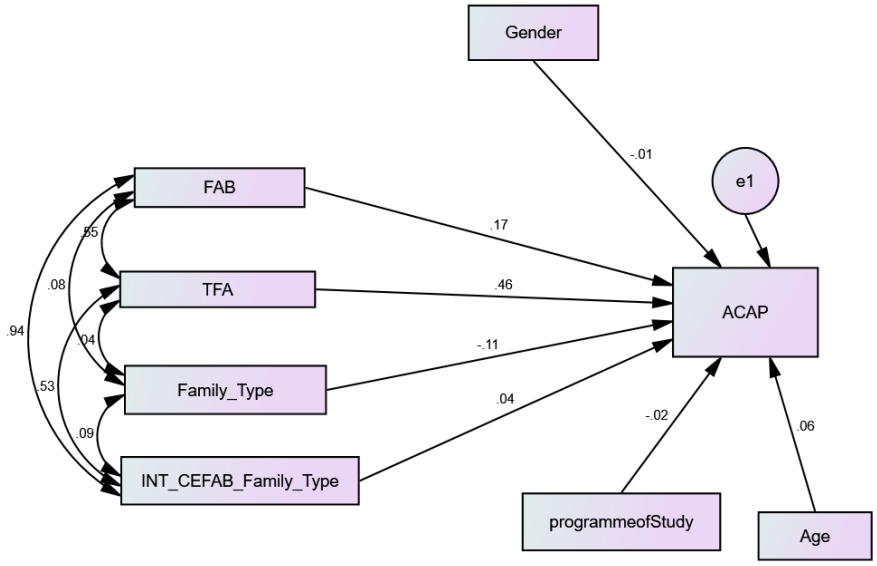
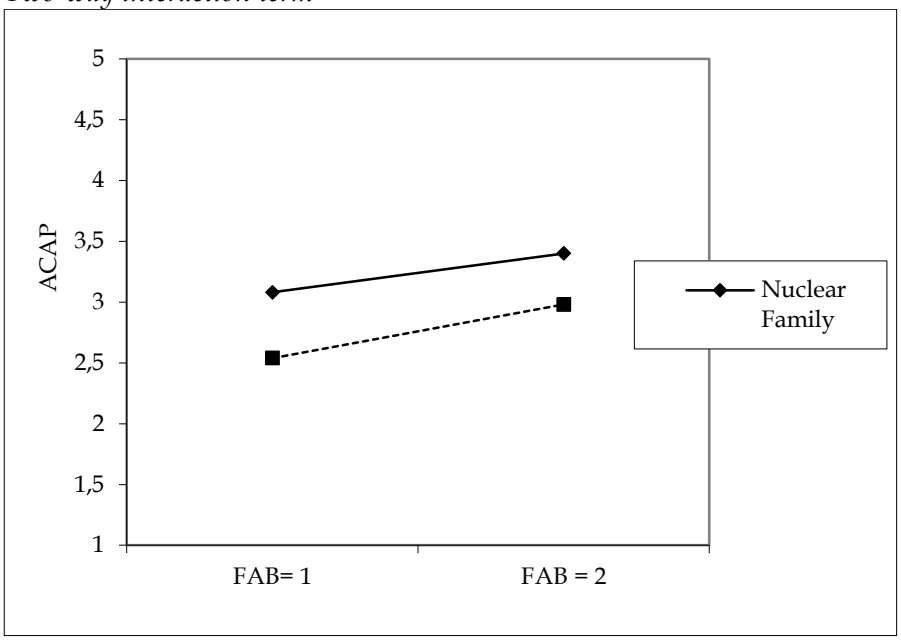


Figure 4
Two-way interaction term



7. Discussion

The analysis showed that *Family Background* had a positive but statistically insignificant effect on students' academic performance (AP) in mathematics. As such, the first hypothesis was *not supported*. According to *Social Learning Theory*, children develop behaviors, values, and attitudes through observation and interaction within the family unit. In the context of mathematics education, students may internalize their families' attitudes toward education, which could shape their own engagement and achievement. However, the lack of statistical significance in this study suggests that, although the family environment might theoretically influence academic outcomes, *other factors—such as teacher quality—may play a more prominent role* in the Ahafo Region.

From the perspective of *Human Capital Theory* (Becker, 1964), family background is expected to enhance children's educational success through the provision of resources, support, and parental involvement. Nevertheless, the findings suggest that such investments, while conceptually important, may not be effectively translating into improved mathematics performance. This could be due to *structural limitations in the educational system* or *inequities in resource allocation*. These results are consistent with Amuda and Ali (2016), who reported no significant relationship between students' academic achievement and their parents' educational levels. Conversely, other studies contradict this result. Qadri (2018) found a strong link between parental education and student achievement, and Imam and Singh (2015) similarly reported that students' mathematics performance is positively influenced by having educated parents. Baliyan et al. (2012) also found that parental education significantly impacts adolescents' arithmetic abilities. The inconsistency across studies suggests that the influence of family background may be *context-dependent*, and in the case of the Ahafo Region, it appears less influential—possibly due to *the overriding impact of school-level factors*, such as teacher effectiveness.

The second hypothesis, which proposed a significant effect of *Teacher Factor* on students' academic performance, was *supported* by the findings. Teacher Factor had a strong, statistically significant positive effect on students' mathematics performance. In alignment with *Social Learning Theory*, teachers serve as critical role models in the classroom; their attitudes, instructional strategies, and feedback mechanisms greatly shape how students learn. The strong effect observed in this study underscores the role of teachers in fostering effective learning environments and enhancing academic success in mathematics.

From a *Human Capital Theory* standpoint, teachers are seen as key agents in the development of human capital. The significant effect of Teacher Factor in this study supports the assertion that teacher qualifications, experience, and pedagogical skills are vital components in improving students' academic outcomes (Coleman, 1988). This finding aligns with Kimani et al. (2013), who found strong correlations between student achievement and teachers' professional qualifications and experience. Ladd and Sorensen (2014) further showed that teacher experience affects various educational outcomes beyond test scores, while Hattie et al. (2016) confirmed the critical role of teacher effectiveness in student learning. Within the Ahafo Region, this result reinforces the *urgent need to prioritize teacher quality through policy and professional development*, as it emerges as a dominant factor in shaping students' success in mathematics.

The third hypothesis investigated whether *Family Type* moderates the relationship between Family Background and students' academic performance. Although the moderating effect was positive, it was statistically insignificant, and the hypothesis was *not supported*. According to *Social Learning Theory*, family structure—whether nuclear or extended—could influence the degree and nature of parental support a child receives. However, the results suggest that family type does not significantly alter the impact of family background on students' mathematics achievement. This may imply that the *quality of the home learning environment* and *parental involvement* are more critical than the structural composition of the family.

From the lens of *Human Capital Theory* (Bourdieu & Passeron, 1990), different family types might imply different levels of investment in children's education. Yet, the insignificance of the moderating effect in this study suggests that such differences are not sufficient to alter educational

outcomes in this context. It is also plausible that factors external to the family—such as *community resources*, *school support systems*, or *peer influence*—compensate for disparities arising from family structure.

This finding aligns with studies by Quarshie (2023) and Dunst et al. (2021), which concluded that while family structure can affect child development, its influence is often overshadowed by other variables, particularly school quality and parental involvement. In this study, the lack of a significant moderating effect indicates that *policy efforts should focus more on increasing meaningful family engagement in education*, rather than emphasizing family composition.

8. Conclusion

Based on the data presented and aligned with the study's goals and objectives, several conclusions can be drawn. The primary aim of this research was to examine the effect of *family background* and *teacher factors* on the academic performance of students in mathematics within the Ahafo Region.

The descriptive analysis of all study variables indicated that the mean scores and corresponding standard deviations fell within favorable ranges. This suggests that respondents generally agreed with the items presented and that the data collected adequately represented the relevant constructs under investigation. Regarding the first research hypothesis, which addressed the relationship between *family background* and students' academic performance in mathematics, the findings revealed a direct positive relationship. However, this relationship was found to be *statistically insignificant*, indicating that while family background may play a role, its influence is not strong enough to be considered a significant predictor of mathematics performance in this context. The second hypothesis tested the effect of *teacher factors* on students' academic performance. The results demonstrated a statistically significant and direct positive effect. This confirms that teacher-related variables—such as qualifications, teaching strategies, and classroom management—are critical contributors to student success in mathematics. This finding reinforces the need to prioritize teacher quality in educational planning and policy formulation. The third hypothesis examined whether *family type* moderates the relationship between family background and students' academic performance. The results indicated a positive moderating effect, but it was statistically insignificant. This suggests that *family type* does not significantly alter the relationship between family background and mathematics performance in the Ahafo Region. The role of family structure, while potentially relevant in other contexts, appears to have a limited influence in this setting.

In summary, while both family background and teacher factors were found to be positively associated with students' academic performance, only *teacher factors* showed a statistically significant effect. The role of *family type* as a moderator was negligible. These findings highlight the dominant role of teachers in shaping students' academic outcomes and suggest that educational interventions in the Ahafo Region should focus on enhancing teacher effectiveness.

9. Future Directions

The observed research gaps identified in this study present valuable opportunities for future empirical investigation. One potential area for further research involves examining the parameter impacts of a changing educational environment, particularly by targeting a larger and more diverse population. This would allow for broader generalizations and more robust conclusions.

Additionally, it is recommended that similar studies be conducted in other regions of Ghana, encompassing a wider range of educational institutions. Such research would help determine the extent to which the findings from the Ahafo Region are applicable across different geographical, cultural, and institutional contexts. Expanding the scope to include other parts of the West African sub-region and various forms of education—such as vocational, technical, or tertiary—would contribute to a more comprehensive understanding of how family and teacher-related factors influence academic performance across diverse educational landscapes.

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Data availability: The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of interest: No conflict of interest is declared by author.

Ethics statement: The ethics committee approved this study since it's a study supervised by the Faculty supervisors for publication. No participants' names were mentioned. Informed consent was obtained from all participants involved in the study. Participants were informed of the study's purpose, procedures, and their right to withdraw at any time without any repercussions. Confidentiality and anonymity of the participants were ensured throughout the research process.

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