

Investigating the Relationship Between Interest and Academic Achievement in Introductory Analysis Among Undergraduate Students

Stephen Daniels Sarfo¹ , Jeremiah Addai² 

¹Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Ghana

²University of Skills Training and Entrepreneurial Development: Kumasi, Ashanti, Ghana

Corresponding author(s):

Stephen Daniels Sarfo

E-mail: [sarfstephendaniels3@gmail.com](mailto:sarfostephendaniels3@gmail.com)

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Abstract

This study investigated the relationship between undergraduate students' interest and their academic achievement in Introductory Analysis at a Ghanaian university. While analytical reasoning is a foundational skill for pre-service teachers, many students approach proof-based mathematics courses with significant apprehension and cognitive overload. Employing a descriptive survey design, data were collected from 314 Level 200 undergraduate students using a validated 5-item interest questionnaire and a 30-item multiple-choice achievement test. Data were analysed using descriptive statistics and Spearman's rank-order correlation. The results revealed that students possessed a moderately high interest in the course ($M = 3.81$, $SD = 0.73$) but achieved only moderate academic performance ($M = 59.5\%$, $SD = 5.11$). Crucially, the study found no statistically significant correlation between students' interest and their academic achievement ($\rho = -.060$, $p = .288$). This counter-intuitive finding challenges the prevailing assumption that high interest automatically yields high achievement. Drawing on Bandura's theory of self-efficacy and Skemp's framework of relational understanding, the study concludes that in cognitively demanding, proof-based courses, affective interest remains inert without foundational logical skills. The study recommends that university mathematics educators supplement interest-fostering strategies with explicit metacognitive training, scaffolded mastery experiences, and utility-value interventions to bridge the gap between affective engagement and measurable academic success.

1. Introduction

It should be acknowledged that courses involving quantitative and analytical reasoning, such as statistics and analysis, are of paramount importance at any educational institution, ranging from elementary school to university level ([Larbi, 2019](#)). The reason for this lies in the fact that such courses equip students with the ability to apply deductive reasoning in analysing data, making evidence-based decisions, and exploring relationships among abstract mathematical concepts. Undergraduate students, especially those preparing to become teachers, must develop competencies in conducting research, solving complex problems, and analysing empirical evidence ([Rosli & Maat, 2017](#)). Introductory Analysis provides students

studying mathematics-related disciplines with a transition from computational mathematics to formal mathematical reasoning and proof construction (Häsä *et al.*, 2023). Within undergraduate education, quantitative and analytical courses promote relational thinking by enabling learners not only to work with abstract concepts but also to organise mathematical knowledge systematically while supporting mathematical arguments through formal logic.

These competencies are valuable across various disciplines because they enhance cognitive abilities, critical thinking, and academic achievement (Street *et al.*, 2024). Furthermore, they enable students to understand how theoretical knowledge and deductive reasoning can be applied in authentic situations, thereby making learning more meaningful, practical, competitive, and relevant in a rapidly changing global society (Emmioğlu & Capa-Aydin, 2025; Chu, 2025). Nevertheless, despite the recognised educational value of such courses, considerable apprehension exists among undergraduate students in Ghana regarding their study (Inglis & Alcock, 2012; Weber, 2018). Emotional barriers are particularly prevalent among preservice mathematics teachers, many of whom have previously experienced difficulties in learning, understanding, and engaging with abstract mathematical ideas (Granello *et al.*, 2025). Studies further suggest that students' confidence in their mathematical abilities and their perceptions of cognitively demanding tasks substantially influence their engagement and persistence in higher-level mathematics courses (Street *et al.*, 2024; Granello *et al.*, 2025).

2. Statement of the Problem

Ghanaian universities, particularly technical universities and teacher education institutions, have increasingly recognized the importance of analytical mathematics courses by making them compulsory for students enrolled in mathematics-related programmes (Stylianides *et al.*, 2024; Speer *et al.*, 2022). At institutions such as the University of Skills Training and Entrepreneurial Development (USTED), Introductory Analysis is a core course for pre-service mathematics teachers because it facilitates their academic development and equips them with the analytical and logical reasoning skills required for contemporary teaching and learning (Buchbinder & McCrone, 2023). Consequently, strong analytical reasoning skills are no longer optional but have become essential for students' academic success and future professional practice (Davor *et al.*, 2026).

Despite the importance of the course, many undergraduate students continue to experience considerable difficulties in learning Introductory Analysis. Students often perceive the course as highly abstract, technically demanding, and intellectually challenging. The extensive use of formal definitions, mathematical proofs, and rigorous logical arguments can make the course particularly difficult for students who enter university with weak mathematical foundations (Davor *et al.*, 2026; Granello *et al.*, 2025). As a result, many students approach the subject with fear, anxiety, and resistance rather than confidence and curiosity, reducing their willingness to engage actively in the learning process (Street *et al.*, 2024).

The problem is further compounded by the fact that some students begin the course with pre-existing negative attitudes toward proof-based mathematics. According to recent studies conducted in Ghana, exposure to cognitively demanding mathematical tasks may overload students' working memory, resulting in reduced engagement and increased learning difficulties (Nyantah *et al.*, 2025). Similarly, contemporary research has shown that excessive cognitive demand and low mathematics self-efficacy can negatively influence students' persistence and achievement in higher-level mathematics courses (Street *et al.*, 2024). Consequently, students may become easily discouraged, avoid participating in classroom activities, and give up when confronted with difficult mathematical problems. When prospective mathematics teachers develop low interest and high of anxiety toward analytical mathematics, their academic performance is likely to decline (Barroso *et al.*, 2021; Richland *et al.*, 2020). More importantly, these negative experiences may later influence their classroom practices, affecting how they

teach mathematics and the confidence they instil in their future students ([Granello et al., 2025](#)). Therefore, it is important to investigate the relationship between undergraduate students' interest in Introductory Analysis and their academic achievement within the Ghanaian university context.

3. Research Questions

1. What is the level of interest among undergraduate students in learning Introductory Analysis?
2. What is the level of academic achievement of undergraduate students in Introductory Analysis?
3. What is the relationship between undergraduate students' interest and their academic achievement in Introductory Analysis?

4. Literature Review

Theoretical Framework

This study is anchored in Bandura's Self-Efficacy Theory ([Bandura, 1994](#)) and Skemp's Theory of Relational Understanding ([Skemp, 2006](#)). These theories provide complementary perspectives for explaining the relationship between undergraduate students' interest and academic achievement in Introductory Analysis. While Self-Efficacy Theory explains how learners' beliefs about their capabilities influence their motivation, persistence, and academic performance ([Bandura, 1994](#)), Skemp's theory explains the nature of mathematical understanding required for meaningful learning in proof-based mathematics ([Skemp, 2006](#)). Both theories have continued to guide contemporary research on mathematics learning and achievement in higher education (Street et al., 2024; Stylianides et al., 2024).

According to [Bandura's \(1994\)](#) Self-Efficacy Theory, students who believe they possess the capability to complete challenging academic tasks are more likely to invest effort, persist when difficulties arise, and regulate their learning behaviours, thereby improving their academic performance. Conversely, students with low self-efficacy are more likely to avoid demanding tasks, experience anxiety, and disengage from learning. Recent mathematics education research continues to demonstrate that self-efficacy remains an important theoretical explanation for students' engagement, persistence, and success in mathematics (Zakariya, 2022; Street et al., 2024). Although the present study focuses on students' interest rather than self-efficacy, the theory suggests that interest alone may not necessarily result in improved academic achievement unless students also possess confidence in their ability to engage successfully with abstract mathematical reasoning.

Similarly, [Skemp's \(2006\)](#) Theory of Relational Understanding distinguishes between instrumental understanding, which involves applying mathematical rules and procedures, and relational understanding, which involves understanding both the procedures and the underlying concepts. Skemp argued that meaningful mathematical learning depends on developing conceptual understanding rather than relying solely on procedural knowledge. This distinction is particularly relevant to Introductory Analysis because the course requires students to construct mathematical proofs, justify logical arguments, and reason abstractly. Contemporary research on proof-based mathematics continues to emphasise the importance of relational understanding in developing mathematical reasoning and improving students' performance in university mathematics (Häsä et al., 2023; Speer et al., 2022; Stylianides et al., 2024).

Together, Self-Efficacy Theory and Relational Understanding Theory provide an appropriate theoretical foundation for this study. While Self-Efficacy Theory explains the motivational processes that encourage students to engage with challenging mathematical tasks, Relational Understanding Theory explains the conceptual understanding required to succeed in proof-based mathematics. Consequently, these theories provide a useful lens for interpreting

whether undergraduate students' interest is associated with their academic achievement in Introductory Analysis and for explaining why interest may not necessarily translate into high academic performance.

5. Empirical Review

Self-Efficacy and Cognitive Demand

The relationship between students' internal beliefs and academic achievement is grounded in Bandura's theory of self-efficacy ([Bandura, 1994](#)). Self-efficacy influences how individuals think, feel, motivate themselves, and respond to academic challenges. Contemporary evidence also indicates that mathematics self-efficacy is strongly associated with students' learning behaviours, persistence, performance, and future career aspirations (Street *et al.*, 2024; Zakariya, 2022). Mastery experiences remain the strongest source of self-efficacy; repeated academic success strengthens students' confidence, whereas repeated failures, particularly in mathematics, weaken their beliefs in their capabilities (Bandura, 1994; Street *et al.*, 2024). Within the Ghanaian mathematics education context, students' self-efficacy plays a critical role in determining whether they strive to attain what Skemp (1976) described as relational understanding (knowing both what to do and why) or merely rely on instrumental understanding, which involves the rote application of rules without conceptual understanding. Recent Ghanaian evidence further demonstrates that students' achievement motivation and self-efficacy are significant predictors of success in mathematics learning ([Akayuure & Akayuure, 2024](#)).

This distinction is particularly important in Introductory Analysis, a course characterised by high cognitive demand. Unlike computational mathematics, Introductory Analysis requires students to construct rigorous mathematical proofs, manipulate abstract concepts, and reason logically. Consequently, students with low confidence in their mathematical abilities are more likely to experience cognitive overload, anxiety, and disengagement when confronted with abstract reasoning tasks (Street *et al.*, 2024; Zakariya, 2022). Such students often struggle to sustain the persistence required for proof-based learning, resulting in poorer academic performance.

The Ghanaian Classroom: The Role of Interest and Attitude

Attitude is a multifaceted psychological disposition shaped by individuals' experiences and has a significant influence on how they respond to academic activities. Interest represents one of the most important affective factors underpinning positive attitudes toward learning. [Renninger and Hidi \(2011\)](#) conceptualised interest as a developmental construct that evolves from externally stimulated situational interest into internally developed personal interest. Students generally achieve better learning outcomes when situational interest gradually develops into sustained personal interest. Recent studies further demonstrate that mathematics self-efficacy and interest reinforce one another and jointly contribute to students' engagement and persistence in mathematics learning ([Street *et al.*, 2024](#)).

Within the Ghanaian context, increasing attention has been given to developing students' interest through relevance-oriented instruction rather than passive knowledge transmission ([Liebendörfer & Schukajlow, 2020](#)). Utility-value interventions have shown that students become more interested in mathematics when they recognise its relevance to everyday life and future careers ([Ashaari *et al.*, 2011](#)). Similarly, recent Ghanaian research found that integrating the history of mathematics into instruction significantly enhances students' interest, with mathematics self-efficacy serving as an important mediating factor ([Asare *et al.*, 2025](#)). When instructors fail to connect abstract mathematical ideas with authentic applications, students often perceive the subject as irrelevant. Consequently, low engagement is frequently accompanied by diminished self-confidence and an inability to appreciate the professional

value of mathematics (Li, 2012). This issue is particularly problematic for pre-service teachers, who are expected to contextualise mathematical concepts for their future students.

Relationship Between Interest, Attitude, and Academic Achievement

Students' attitudes toward learning constitute an important predictor of their academic performance. Drawing on Ajzen's Theory of Planned Behaviour, favourable attitudes promote desirable learning behaviours such as persistence, effective study habits, classroom participation, and sustained effort, all of which contribute to academic success. Consequently, interest and attitude have consistently been identified as important predictors of mathematics achievement ([Bayaga & Wadesango, 2014](#)). Recent research further indicates that mathematics interest is associated with achievement both directly and indirectly through self-efficacy and mathematics anxiety (Lee & Stankov, 2018; Han, 2021). In addition, Hamenu and Davor (2026) reported that the positive relationship between students' use of digital learning platforms and mathematical problem-solving ability became stronger among learners with self-regulated learning, highlighting the importance of learning processes alongside students' affective characteristics. When learners perceive mathematics as valuable and believe they possess the capability to succeed, they allocate greater cognitive resources to solving complex problems rather than coping with frustration and anxiety ([Else-Quest et al., 2010](#)).

Local empirical evidence also supports a positive relationship between pre-service teachers' affective characteristics and mathematics achievement (Larbi, 2019; Nyantah et al., 2025). Collectively, these findings suggest that higher interest and stronger self-efficacy are generally associated with improved academic performance, although the magnitude of this relationship may vary across mathematical domains and instructional contexts (Street et al., 2024; Zakariya, 2022). Despite extensive research on students' attitudes toward mathematics and geometry, empirical evidence examining the specific relationship between students' interest and achievement in Introductory Analysis at the tertiary level in Ghana remains limited. Addressing this gap is important because it can provide evidence to inform curriculum development and pedagogical interventions that better prepare future mathematics teachers both cognitively and affectively for proof-based mathematics.

6. Methodology

Research Design

The study employed a descriptive survey design. This design was adopted because the research aimed to examine the relationship between undergraduate students' interest in Introductory Analysis and their academic achievement. A descriptive survey design was considered appropriate because it enables researchers to collect quantitative data from a relatively large sample and investigate relationships among variables without manipulating them ([Sarantakos, 2005](#)).

Participants and Sampling Procedure

The study targeted Level 200 undergraduate students enrolled in the Bachelor of Education programme at a public university in Ghana who were registered for the compulsory Introductory Analysis course during the 2025/2026 academic year. The target population comprised 658 students, as obtained from the official departmental class register, which served as the sampling frame.

A sample of 314 students was selected for the study. The sample size was considered adequate based on established sample size determination guidelines for finite populations and exceeded the minimum requirement for conducting correlation analyses, thereby providing sufficient statistical power to detect meaningful relationships (Cohen, 1988; Hair et al., 2022).

A simple random sampling technique was employed to ensure that every eligible student had an equal chance of being selected. Each student on the departmental class register was assigned a unique identification number, and a computer-generated random number procedure was used to select the participants. Of the 314 students selected, all agreed to participate and completed the questionnaire, yielding a 100% response rate. The completed questionnaires were screened for completeness prior to analysis, and no questionnaire was excluded due to missing or incomplete responses.

Instrumentation

Two instruments were used to collect data for the study. Students' academic achievement was measured using their actual scores obtained in the mid-semester examination for the Introductory Analysis course. Students' interest in Introductory Analysis was measured using a self-constructed, closed-ended questionnaire.

The questionnaire was subjected to expert validation to ensure the clarity, relevance, and appropriateness of the items. It was subsequently pilot-tested with students who were not included in the main study to establish its internal consistency reliability. The instrument employed a five-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1). The questionnaire comprised both positively and negatively worded items. Positively worded items were scored from 5 to 1, whereas negatively worded items were reverse-coded prior to data analysis so that higher scores consistently represented students' interest in Introductory Analysis.

Data Collection and Analysis

This study employed a quantitative research approach. All completed questionnaires were sorted, coded, and screened for completeness before data entry. The data were entered into IBM SPSS Statistics and analysed using descriptive and inferential statistics. Descriptive statistics (means and standard deviations) were used to answer Research Questions 1 and 2. Spearman's rank-order correlation was employed to examine the relationship between undergraduate students' interest in Introductory Analysis and their academic achievement. The interest score served as the independent variable, while the academic achievement score served as the dependent variable.

Validity

In determining the content validity of the research, the researchers constructed the 5-item questionnaire and the 30-item multiple-choice achievement test in relation to the course outline provided by the university and the table of specifications. These drafts were submitted to three mathematics educators with years of teaching experience. Using a proposed content validity model, these experts rated each instrument as a weak or strong item in relation to its clarity, relevance, and alignment with the goals of the research. Two convergent rating tables with content validity coefficient of 0.86 in relation to the scale of interest, 0.84 in relation to the scale of relevance, and 0.83 for the achievement test have been established. As all content validity coefficients have exceeded the acceptable threshold of 0.70, expert feedback indicates that the tests have excellent content validity.

Ethical Considerations

Before data collection, ethical clearance for the study was obtained from the appropriate institutional research ethics committee of the university. Permission to conduct the study was also obtained from the Head of the Department and other relevant university authorities. Participation in the study was entirely voluntary, and all participants were informed about the purpose of the research before data collection commenced. Written informed consent was

obtained from all participants, who were assured that they could withdraw from the study at any stage without any adverse consequences. To protect participants' privacy, no personally identifiable information was collected, and all responses were treated confidentially and used solely for research purposes.

Reliability

The reliability of the research instruments was established through a pilot study involving 30 pre-service teachers who were not included in the main study. Internal consistency reliability of the interest questionnaire was assessed using Cronbach's alpha. The interest scale produced a Cronbach's alpha coefficient of .87, indicating good internal consistency and exceeding the recommended minimum threshold of .70. The reliability of the multiple-choice achievement test was assessed using the Kuder–Richardson Formula 20 (KR-20), which yielded a coefficient of .81, also indicating satisfactory reliability. These coefficients suggest that the instruments produced reliable and consistent measurements.

7. Results

This section presents the findings of the study in relation to the three research questions. Descriptive statistics were used to answer Research Questions 1 and 2, while Spearman's rank-order correlation was used to answer Research Question 3.

Research question 1: What is the level of interest among undergraduate students in learning Introductory Analysis?

This research question sought to determine the level of undergraduate students' interest in learning Introductory Analysis. The results are presented in Table 1.

Table 1: Mean and Standard Deviation of Interest

No.	Statement	Mean	SD
1.	Introductory Analysis is an exciting course	3.90	.88
2.	I find Introductory Analysis learning very challenging	3.91	.93
3.	The concept in Introductory Analysis is applied in other courses	3.72	.92
4.	I struggle with many concepts in Introductory Analysis	3.78	.93
5.	I find the logical progression of proving theorems in Introductory Analysis to be fascinating.	3.78	.97

This research question was answered using descriptive statistics to examine undergraduate students' level of interest in Introductory Analysis. The results are presented in Table 1. The overall mean score for the five-item interest scale was 3.81 (SD = 0.73) on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Since the negatively worded items were reverse-coded before computing the composite score, the overall mean indicates that the undergraduate students demonstrated a moderately high level of interest in studying Introductory Analysis.

At the item level, students generally expressed favourable perceptions of Introductory Analysis. They agreed that the course is exciting (M = 3.90, SD = 0.88), recognised that concepts learned in Introductory Analysis are applicable to other mathematics courses (M = 3.72, SD = 0.92), and found the logical progression of mathematical proofs fascinating (M =

3.78, SD = 0.97). The negatively worded items ("I find learning Introductory Analysis very challenging" and "I struggle with many concepts in Introductory Analysis") were reverse-coded when computing the composite interest score. Consequently, higher composite scores consistently reflected higher levels of students' interest in the course.

Research Question 2: What is the academic achievement of undergraduate students in Introductory Analysis?

This research question sought to determine the level of academic achievement of undergraduate students in Introductory Analysis. The results are presented in Table 2.

Table 2: Mean and Standard Deviation of Academic Achievement

Test	Mean	Std. Deviation
ACH	17.84	5.112

The academic achievement of undergraduate students in Introductory Analysis was assessed using achievement scores with a maximum obtainable score of 30. Students obtained a mean score of 17.84 (SD = 5.11), representing approximately 59.5% of the total obtainable score. This indicates a moderate level of academic achievement. The standard deviation suggests moderate variation in students' performance, indicating that while many students performed close to the average, some achieved considerably higher or lower scores.

Research question 3: What is the relationship between undergraduate students' interest and their academic achievement in Introductory Analysis?

Before computing Spearman's rank-order correlation, the ranked values of interest and academic achievement were visually inspected using a scatterplot to evaluate the assumption of monotonicity. The scatterplot suggested an approximately monotonic pattern, indicating that the direction of the relationship did not systematically change across the range of scores. Therefore, the assumption of monotonicity was considered to have been reasonably satisfied.

Consequently, Spearman's rank-order correlation was selected because it is appropriate for analysing monotonic relationships involving ordinal variables and does not require the assumption of multivariate normality. The significant normality tests were considered supportive rather than the primary justification for selecting the non-parametric procedure.

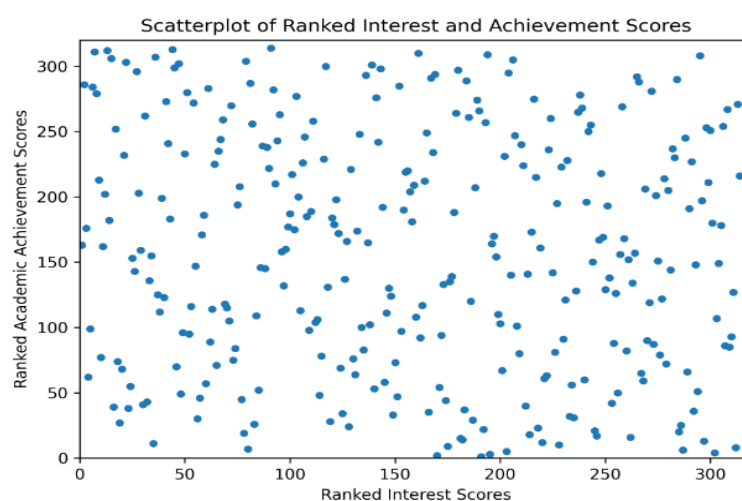


Figure 1. Scatterplot of Ranked Interest Scores and Ranked Academic Achievement Scores Used to Assess the Assumption of Monotonicity

Figure 1 illustrates the scatterplot of ranked interest scores and ranked academic achievement scores. Visual inspection revealed no substantial departures from monotonicity; therefore, the assumption required for Spearman's rank-order correlation was considered to have been satisfied.

Table 3: Tests of Normality

Variable	Kolmogorov-Smirnov. ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
INT	.079	314	.020	.964	314	.000
Test Score	.175	314	.000	.920	314	.000

INT = Interest score; Test Score = achievement score (out of 30).

Although the Kolmogorov–Smirnov and Shapiro–Wilk tests indicated statistically significant departures from normality for both variables (Table 3), these results were interpreted cautiously because normality tests are highly sensitive to large sample sizes such as the present sample ($N = 314$), where even minor deviations from normality may become statistically significant. Moreover, the interest variable was derived from Likert-scale responses, producing ordinal data that are appropriately analysed using non-parametric methods.

Prior to conducting the correlation analysis, a scatterplot of ranked scores was examined to assess whether the relationship between interest and academic achievement was approximately monotonic, which is the primary assumption underlying Spearman's rank-order correlation. Visual inspection indicated no substantial departures from monotonicity. Consequently, Spearman's rank-order correlation was considered appropriate because it does not require normally distributed variables and is suitable for examining monotonic associations involving ordinal or non-normally distributed data.

Table 4: Spearman's Rho Correlation Between Interest and Academic Achievement.

Variable Pair	Spearman's ρ	p-value	N
Interest and Achievement	–0.060	0.288	314

Spearman's rank-order correlation analysis revealed a very weak negative association between undergraduate students' interest in Introductory Analysis and their academic achievement ($\rho = -.060$, $p = .288$). Although the correlation coefficient was negative, the relationship was not statistically significant because the obtained p-value exceeded the conventional significance level of .05. Therefore, the findings do not provide sufficient statistical evidence to conclude that undergraduate students' interest is significantly associated with their academic achievement in Introductory Analysis. Therefore, the study found no statistically significant relationship between undergraduate students' interest in Introductory Analysis and their academic achievement.

8. Discussion

Research Question 1: Undergraduate Students' Interest in Introductory Analysis

The study found that undergraduate students demonstrated a moderately high level of interest in Introductory Analysis ($M = 3.81$, $SD = 0.73$). This finding suggests that although students perceive Introductory Analysis as cognitively demanding, they generally maintain positive attitudes towards learning the course and recognise its importance within their mathematics education programme. This finding is consistent with [Renninger and Hidi's \(2011\)](#) conceptualisation of interest as a developmental construct that evolves through meaningful

learning experiences and promotes sustained engagement in academically demanding subjects. Similarly, [Liebendörfer and Schukajlow \(2020\)](#) found that when students recognise the utility value of mathematics, their interest in learning increases significantly.

The present finding is also consistent with [Asare et al. \(2025\)](#), who reported that instructional approaches that enhance students' interest simultaneously strengthen their mathematics self-efficacy and promote positive learning experiences. Likewise, [Häsä et al. \(2023\)](#) observed that undergraduate students generally exhibit favourable attitudes towards proof-based mathematics when instructional activities encourage conceptual understanding rather than rote memorisation. The finding further supports [Ajzen's \(1991\)](#) Theory of Planned Behaviour, which suggests that favourable attitudes influence learners' intentions to engage in academic activities. Although students in the present study reported relatively high interest, interest alone may not necessarily guarantee successful learning outcomes in mathematically demanding courses.

Research Question 2: Academic Achievement in Introductory Analysis

The findings showed that undergraduate students achieved a moderate level of academic performance in Introductory Analysis, obtaining an average score of 17.84 out of 30 (59.5%). This suggests that although students were interested in the course, many experienced difficulties mastering its proof-oriented and abstract concepts. This finding is consistent with the work of [Inglis and Alcock \(2012\)](#), who reported that novice learners often struggle with mathematical proofs because they lack sophisticated proof-reading and proof-construction strategies. Similarly, [Speer et al. \(2022\)](#) concluded that proof-based university mathematics remains one of the most cognitively demanding areas of undergraduate mathematics education.

The moderate achievement observed in this study can also be interpreted in light of [Buchbinder and McCrone \(2023\)](#), who emphasised that developing mathematical reasoning requires explicit instructional support through carefully selected examples and structured proof activities. Likewise, [Stylianides et al. \(2024\)](#) argued that success in proof-based mathematics depends not only on procedural competence but also on conceptual reasoning and logical argumentation. Furthermore, [Davor et al. \(2026\)](#) found that Ghanaian students frequently encounter difficulties in mathematical proving due to weak reasoning skills and inadequate conceptual understanding. These findings collectively suggest that improving achievement in Introductory Analysis requires instructional strategies that strengthen reasoning, conceptual understanding, and proof construction rather than relying solely on procedural practice. This interpretation is consistent with [Davor \(2026\)](#), who demonstrated that scaffolded generative AI instruction improved students' geometric reasoning and proof construction, suggesting that structured instructional support can strengthen learners' reasoning in proof-based mathematics.

Research Question 3: Relationship Between Interest and Academic Achievement

The study found no statistically significant relationship between undergraduate students' interest in Introductory Analysis and their academic achievement ($\rho = -.060$, $p = .288$). Although the relationship was negative, the correlation was extremely weak and not statistically significant, indicating that students' interest alone was not associated with improved academic performance in this sample. This finding contrasts with several previous studies that reported positive associations between students' attitudes or interest and mathematics achievement (Bayaga & Wadesango, 2014; Ma & Kishor, 1997; Lee & Stankov, 2018; Larbi, 2019). However, it supports earlier work by Mickelson (1990), who argued that positive attitudes do not always translate into higher academic achievement, a phenomenon referred to as the attitude-achievement paradox.

One possible explanation for the present finding is that proof-based mathematics places substantial cognitive demands on learners. According to [Sweller's \(1988\)](#) Cognitive Load

Theory, students may remain interested in learning while simultaneously experiencing cognitive overload during complex reasoning tasks, thereby limiting achievement. Similarly, [Bandura \(1994\)](#) proposed that students' beliefs about their capabilities are more influential in determining persistence and performance than interest alone. Recent studies have consistently demonstrated that mathematics self-efficacy is a stronger predictor of academic success than affective interest (Street *et al.*, 2024; Zakariya, 2022; Meng & Zhang, 2023). Similarly, [Davor *et al.* \(2026\)](#) found that metacognitive awareness, epistemological beliefs, and mathematical resilience influenced university students' perceived mathematical problem-solving ability indirectly through student engagement, suggesting that cognitive and motivational factors may explain mathematical performance more effectively than interest alone. Moreover, [Akayuure and Akayuure \(2024\)](#) found that achievement motivation and self-efficacy significantly predict mathematics achievement, suggesting that motivational beliefs may explain academic success more effectively than interest by itself.

Another plausible explanation relates to the inherent nature of Introductory Analysis as a proof-based course. Students may enjoy learning mathematics yet still experience difficulties constructing rigorous proofs because they lack relational understanding and formal reasoning skills. [Skemp \(2006\)](#) distinguished between instrumental understanding, which focuses on applying rules, and relational understanding, which emphasises conceptual meaning. Students possessing only instrumental understanding may express considerable interest in mathematics while continuing to perform poorly in proof-oriented tasks. Similar conclusions were reached by [Häsä *et al.* \(2023\)](#), [Inglis and Alcock \(2012\)](#), and [Stylianides *et al.* \(2024\)](#), who reported that proof construction requires sophisticated reasoning abilities that extend beyond positive attitudes or interest. Consequently, improving students' academic achievement in Introductory Analysis may require instructional approaches that simultaneously foster conceptual understanding, mathematical reasoning, self-efficacy, and effective proof-construction skills rather than focusing solely on increasing students' interest.

Limitations of the Study

This study has some limitations that should be considered when interpreting the findings. The cross-sectional design does not permit causal inferences regarding the relationship between students' interest and academic achievement. In addition, the study was conducted in a single Ghanaian university, which may limit the generalisability of the findings to other higher education contexts. Furthermore, students' interest was measured using a self-report questionnaire and may therefore be subject to response bias. Future research should employ longitudinal or multi-institutional designs and include additional cognitive and motivational variables to provide a more comprehensive understanding of academic achievement in proof-based mathematics courses.

9. Conclusion

The present study investigated the relationship between undergraduate students' interest in Introductory Analysis and their academic achievement at a Ghanaian university. The findings showed that students demonstrated a moderately high level of interest in the course ($M = 3.81$, $SD = 0.73$), whereas their academic achievement was moderate ($M = 17.84$ out of 30, equivalent to 59.5%). Contrary to findings reported in several previous studies that identified positive associations between students' interest and mathematics achievement, the present study found no statistically significant relationship between undergraduate students' interest in Introductory Analysis and their academic achievement.

The findings suggest that increasing students' interest alone may not be sufficient to improve performance in cognitively demanding, proof-based mathematics courses. Other factors, including prior mathematical knowledge, self-efficacy, cognitive load, and effective

learning strategies, may play more influential roles in explaining students' academic achievement. Therefore, instructional approaches designed to increase students' interest should be complemented by strategies that strengthen conceptual understanding, mathematical reasoning, and confidence in proof construction. Future research should replicate this study across multiple universities using longitudinal, mixed-methods, or experimental designs and include broader sets of cognitive and motivational variables. Such studies would provide a more comprehensive understanding of the factors that influence academic achievement in proof-based mathematics courses and strengthen the generalisability of the findings across higher education contexts.

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