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Examining the Multiple Dimensions of Secondary School Students' Attitudes toward Science

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Abstract

Students' attitudes toward science significantly influence their engagement, achievement, and future participation in STEM fields. This study examines the multiple dimensions of secondary school students' attitudes toward science, including enjoyment, perceived relevance, anxiety, and self-efficacy. Using a quantitative cross-sectional design, data were collected from 320 second-year senior high school students through a structured questionnaire adapted from Osborne et al. (2003) and Russell & Hollander (2015). Descriptive statistics summarized the levels of each attitude dimension, while exploratory factor analysis validated the instrument's structure. Findings reveal that students exhibit moderate enjoyment and perceived relevance of science, low self-efficacy in science problem-solving, and moderate science-related anxiety. Factor analysis confirmed four distinct dimensions underlying attitudes toward science. The study underscores the need for targeted instructional strategies and supportive learning environments to enhance positive attitudes and reduce science anxiety. Implications for teachers, curriculum planners, and policymakers are discussed to promote student engagement and STEM participation.

Keywords: Science attitudes, secondary education, science engagement, STEM, student motivation

1. Introduction

Students' attitudes toward science are fundamental determinants of both immediate academic outcomes and sustained engagement in Science, Technology, Engineering, and Mathematics (STEM) disciplines. These attitudes encompass learners' cognitive evaluations, affective responses, and behavioral dispositions toward science, influencing classroom participation, intrinsic motivation, and critical academic choices, including the selection of elective subjects (Osborne, Simon, & Collins, 2003). Research consistently shows that positive attitudes—characterized by enjoyment, perceived relevance, and self-confidence—are associated with higher achievement, greater perseverance in problem-solving tasks, and stronger intentions to pursue STEM-related careers. In contrast, negative attitudes, manifesting as science anxiety, low self-efficacy, or lack of interest, can hinder learning, reduce engagement, and lead to lower enrollment in advanced science courses (Bybee, 2010; Maltese & Tai, 2010).

Examining the multidimensional nature of science attitudes, particularly enjoyment, perceived relevance, anxiety, and self-efficacy, is critical for understanding the factors that either facilitate or obstruct meaningful engagement with science learning. In Ghana and similar educational contexts, low participation in core science electives remains a significant concern despite curriculum reforms and national STEM initiatives aimed at expanding the science talent pipeline (Ministry of Education [MoE], 2019). Notably, many students who demonstrate adequate achievement in science do not opt for science-related electives, indicating that academic competence alone is insufficient to drive elective choices. This highlights the necessity of investigating how specific attitudinal components shape students' academic decisions and of identifying evidence-based strategies to cultivate positive attitudes, enhance motivation, and increase sustained engagement in STEM education.

Significance of the Study

The outcomes of this study hold both practical and theoretical relevance for a range of stakeholders in science education. For teachers, the findings provide guidance on implementing instructional strategies that enhance enjoyment, perceived relevance, and self-efficacy, while simultaneously mitigating science-related anxiety, thereby promoting greater engagement in the classroom. School administrators and curriculum planners can leverage the results to develop targeted programs, allocate resources effectively, and implement interventions that nurture positive attitudes toward science learning. For policymakers, the study offers evidence-based insights to inform STEM education policies and initiatives designed to expand participation, sustain student interest, and strengthen the science talent pipeline. Students stand to benefit indirectly through improved learning environments that foster motivation, reduce affective barriers, and encourage consistent engagement with science subjects. Finally, researchers gain access to context-specific, quantitative data addressing existing gaps in understanding the multidimensional nature of science attitudes in Ghana and the broader Sub-Saharan African context, providing a foundation for further studies and comparative analyses in similar educational settings.

Justification

This study is justified on several grounds. Students' attitudes toward science play a pivotal role in shaping their motivation, persistence, and academic achievement, yet there remains a scarcity of quantitative evidence examining the specific dimensions of attitudes—enjoyment, perceived relevance, anxiety, and self-efficacy—within the context of Ghanaian secondary schools. A nuanced understanding of how these attitudinal factors influence engagement in science learning can equip teachers and school administrators with evidence-based strategies to foster intrinsic interest, alleviate science-related anxiety, and bolster students' confidence in mastering scientific concepts. Furthermore, such insights are essential for guiding curriculum design, educational interventions, and policy development aimed at increasing enrollment in, and retention of, students within STEM pathways. By addressing these gaps, the study provides a critical empirical foundation to inform targeted pedagogical practices and systemic initiatives that promote sustained engagement in science education.

Purpose of the Study

The study seeks to examine the multidimensional nature of secondary school students' attitudes toward science and to explore how these attitudes influence students' engagement and participation in science learning. Specifically, it investigates enjoyment, perceived relevance, anxiety, and self-efficacy as key dimensions of attitude, providing evidence to inform instructional practices, curriculum planning, and policy interventions aimed at strengthening STEM education.

Research Objectives

1. To examine the levels of secondary school students' attitudes toward science across enjoyment, perceived relevance, anxiety, and self-efficacy.
2. To investigate the predictive influence of attitude dimensions on students' engagement in science learning.

Research Questions

1. What are the prevailing levels of students' attitudes toward science in terms of enjoyment, perceived relevance, anxiety, and self-efficacy?
2. To what extent do the dimensions of students' attitudes toward science predict their engagement and participation in science learning?

Research Hypothesis

H_0 : There is no significant relationship between students' overall attitudes toward science and their selection of science-related electives.

H_1 **:** Students' overall attitudes toward science significantly predict their selection of science-related electives.

Literature Review

Dimensions of Students' Attitudes toward Science

Students' attitudes toward science can be understood through multiple interrelated dimensions, each contributing uniquely to engagement and learning outcomes.

1. Enjoyment of Science: Enjoyment captures the degree to which students experience pleasure, interest, and intrinsic motivation when engaging with science content. Learners who find science enjoyable are more likely to participate actively in classroom activities, approach complex tasks with persistence, and maintain sustained engagement, even in the face of challenging material (Ainley & Ainley, 2011). Positive affect associated with enjoyment serves as a motivational driver, reinforcing learners' commitment to continued study in science disciplines.

2. Perceived Relevance: This dimension reflects the extent to which students recognize the applicability and usefulness of science in real-world contexts and future career paths. When learners perceive science as meaningful and connected to practical outcomes, they are more likely to set learning goals, invest effort, and sustain motivation throughout the instructional process (Palmer, 2009). Perceived relevance not only shapes immediate engagement but also influences long-term attitudes toward STEM participation.

3. Science Anxiety: Anxiety encompasses negative emotional reactions, such as fear, tension, or apprehension, that students may experience in relation to science tasks or assessments. High levels of science-related anxiety can impair concentration, reduce cognitive resources available for learning, and hinder academic performance, potentially discouraging continued engagement with science subjects (Güngör, 2018). Managing anxiety is therefore critical for fostering positive science attitudes and promoting effective learning.

4. Self-Efficacy: Self-efficacy refers to learners' confidence in their ability to successfully perform science-related tasks and overcome academic challenges. Students with high self-efficacy are more likely to invest effort, persist when encountering difficulties, and adopt effective learning strategies, thereby achieving better outcomes (Bandura, 1997). Confidence in one's capabilities interacts with other attitudinal dimensions to influence motivation, engagement, and decision-making regarding elective science subjects.

Together, these four dimensions—enjoyment, perceived relevance, science anxiety, and self-efficacy—provide a comprehensive framework for understanding how students' attitudes shape participation, engagement, and persistence in science education. Measuring and addressing these dimensions can inform instructional strategies, curriculum design, and interventions aimed at enhancing motivation and STEM achievement.

Attitudes and STEM Participation

Students' attitudes toward science are critical predictors of both their academic performance and their continued involvement in STEM disciplines. Research indicates that learners who exhibit positive attitudes—characterized by high enjoyment, perceived relevance, and strong self-efficacy—tend to achieve higher academic outcomes and are more likely to select science electives that align with future STEM opportunities (Maltese & Tai, 2010). In contrast, students who experience heightened anxiety, low confidence in their abilities, or negative perceptions of science often demonstrate reduced engagement, avoid science-related courses, and are less inclined to consider STEM careers (Bybee, 2010). This pattern underscores the multifaceted nature of attitudes, showing that no single dimension operates in isolation; rather, enjoyment, relevance, self-efficacy, and anxiety interact to shape learners' motivation and decision-making. Consequently, educational interventions aiming to enhance STEM participation must adopt a holistic approach, addressing all critical attitudinal dimensions simultaneously. By fostering enjoyment, reinforcing the relevance of science, building self-efficacy, and mitigating anxiety, educators can create an environment that encourages sustained engagement, higher enrollment in science electives, and long-term commitment to STEM pathways.

Factors Influencing Students' Attitudes toward Science

Students' attitudes toward science are shaped by a complex interplay of instructional, environmental, and individual factors. *Instructional strategies* play a pivotal role; research shows that learner-centered approaches such as inquiry-based learning, hands-on experiments, and contextualized problem-solving enhance enjoyment, perceived relevance, and self-efficacy while reducing anxiety (Hofstein & Lunetta, 2004; Ainley & Ainley, 2011). Conversely, teacher-centered, lecture-dominated pedagogy often fails to engage students meaningfully, leading to negative attitudes and lower motivation.

Classroom environment also significantly influences attitudes. Adequate laboratory facilities, access to instructional resources, and collaborative learning opportunities encourage curiosity and engagement, whereas poorly resourced or overcrowded classrooms contribute to frustration, anxiety, and disengagement (Palmer, 2009; Osborne et al., 2003). Peer interactions and social dynamics further moderate attitudes; supportive classmates and collaborative learning communities promote positive attitudes, whereas competitive or unsupportive environments can exacerbate anxiety and reduce self-efficacy.

Individual learner characteristics—including *Individual learner characteristics* prior achievement, interest in science, and personal goals—also interact with contextual factors to shape attitudes (Krapp & Prenzel, 2011). Students with prior success or intrinsic interest in science are more likely to enjoy science, perceive it as relevant, and persist despite challenges. In contrast, repeated failure, negative experiences, or perceived irrelevance can lead to diminished motivation, heightened anxiety, and avoidance of science courses.

Overall, understanding the factors that influence students' attitudes is essential for de]veloping interventions and instructional practices that foster engagement, reduce barriers, and promote sustained participation in STEM fields. Addressing these multidimensional influences enables educators to create learning environments that support positive attitudes and enhance students' long-term commitment to science.

Theoretical Framework

The foundation of this study is anchored in Ajzen's (1991) Theory of Planned Behavior (TPB), which asserts that an individual's behavior is influenced by their attitudes, perceived social norms, and perceived behavioral control, all of which collectively shape behavioral intentions. Applied to science education, students' attitudes—including enjoyment, perceived relevance, self-efficacy, and anxiety—play a central role in determining their intentions to actively engage in science learning and to select science-related electives. Positive attitudinal dispositions enhance motivation, persistence, and active participation, whereas negative factors, such as elevated anxiety or low self-efficacy, tend to diminish engagement and reduce the likelihood of pursuing STEM-focused pathways. TPB, therefore, provides a strong theoretical lens for examining the influence of students' cognitive and affective orientations on educational behaviors and academic decision-making.

This study also draws on Hidi and Renninger's Four-Phase Model of Interest Development. The model explains that interest often begins with situational triggers created by teaching activities or classroom conditions. With repeated engagement and supportive environments, these situational interests can gradually develop into stable personal interests. By combining this model with the Theory of Planned Behavior, the framework shows how students' attitudes, motivation, and actions interact. It also demonstrates how these attitudinal components influence engagement, guide learning decisions, and support long-term interest in science and STEM fields (Hidi & Renninger, 2006).

Conceptual Framework

This study conceptualizes students' attitudes toward science as a multidimensional construct encompassing *enjoyment, perceived relevance, science anxiety, and self-efficacy*, which collectively influence engagement in science learning and subsequent academic behaviors, including elective subject selection. Enjoyment reflects the intrinsic satisfaction and positive affect that students derive from participating in science-related activities, which fosters sustained attention and persistence. Perceived relevance represents the extent to which learners recognize the practical utility of science in real-world contexts, motivating goal-directed behavior and reinforcing the value of science learning. Science anxiety, characterized by fear, tension, or apprehension toward science tasks, is expected to impede engagement by reducing concentration, confidence, and willingness to tackle challenging tasks. Self-efficacy, or students' belief in their capability to successfully complete science-related tasks, is anticipated to enhance engagement, effort, and resilience in learning.

The framework hypothesizes that positive attitudes—high enjoyment, high perceived relevance, and strong self-efficacy—positively predict behavioral, cognitive, and emotional engagement in science learning. Conversely, high levels of science anxiety are expected to negatively impact engagement. Engagement, in turn, mediates the relationship between attitudes and the likelihood of choosing science-related elective subjects, such as physics, chemistry, biology, and elective mathematics.

The conceptualization is grounded in Ajzen's (1991) Theory of Planned Behavior, which posits that attitudes shape intentions and behaviors, and Hidi and Renninger's (2006) Four-Phase Model of Interest Development, which highlights how situational interest evolves into enduring motivation through repeated engagement. By integrating attitudinal dimensions, engagement, and behavioral outcomes, this framework provides a comprehensive lens for understanding how students' attitudes function as both motivational and predictive factors in science education.

Study Gaps

Although students' attitudes are widely recognized as key determinants of engagement and achievement in science education, several important gaps persist in the literature. First, much of the existing research has examined individual attitudinal dimensions—such as enjoyment or anxiety—independently, without considering how multiple facets, including enjoyment, perceived relevance, self-efficacy, and anxiety, interact to influence learning outcomes. This narrow focus limits a holistic understanding of the complex ways in which students' attitudes shape their engagement and academic decisions. Second, empirical studies from Sub-Saharan African contexts, particularly Ghana, remain limited. Variations in cultural

norms, educational resources, and pedagogical practices suggest that findings from Western settings may not be directly applicable to Ghanaian secondary schools. Third, there is a notable lack of quantitative research employing robust statistical methods to explore the predictive relationships between specific attitudinal dimensions and student engagement or course selection. Addressing these gaps is critical for generating context-specific evidence that can inform targeted pedagogical interventions, curriculum design, and policies aimed at fostering positive science attitudes and enhancing participation in STEM disciplines.

Methodology

Research Design

This study adopted a quantitative cross-sectional survey design, which is well-suited for systematically measuring students' attitudes toward science and examining patterns across multiple attitudinal dimensions. Grounded within the positivist research paradigm**,** this approach emphasizes objective measurement, hypothesis testing, and the identification of relationships among variables that can be generalized to the broader population (Creswell & Creswell, 2018). The cross-sectional nature of the design enabled the collection of data at a single point in time, providing a snapshot of students' enjoyment, perceived relevance, self-efficacy, and science anxiety, and allowing for the analysis of associations between these attitudinal constructs and students' engagement or elective subject choices. This methodology is particularly effective for evaluating predictive relationships and generating empirical evidence to inform targeted educational interventions and policy decisions.

Population and Sample

The study population consisted of second-year senior high school students enrolled in public schools that offer core science subjects, including physics, chemistry, biology, and elective mathematics. This cohort was considered appropriate as these students had already made their elective subject selections, allowing for accurate assessment of the relationship between attitudes and course choices. A total of 320 students were drawn as the study sample, ensuring sufficient statistical power for correlational and predictive analyses (Cohen, 1992). Stratified random sampling was employed to enhance representativeness, with schools categorized into Types A, B, and C based on academic performance and resources. Within each stratum, students were randomly selected to capture variability in gender, school type, and academic backgrounds, thereby minimizing sampling bias and ensuring the findings reflected the diversity of experiences and attitudes across the study population. This sampling strategy allowed for robust generalization of results to the wider population of senior high school students within the selected region.

Instrumentation

The study employed a structured questionnaire as the primary data collection instrument, adapted from validated scales developed by Osborne et al. (2003) and Russell and Hollander (2015). The questionnaire was designed to measure four key dimensions of students' attitudes toward science*: enjoyment, perceived relevance, science anxiety,* and *self-efficacy*. Each dimension was represented by five items, making a total of twenty items that comprehensively captured the multifaceted nature of attitudes in a secondary

school science context. Respondents indicated their level of agreement with each statement using a *five-point Likert scale*, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), allowing for nuanced measurement of attitudes. This approach enabled quantification of students' cognitive, affective, and motivational responses toward science, providing data suitable for subsequent correlational and predictive analyses. The structured design also facilitated standardization across respondents, ensuring consistency in measurement and enhancing the reliability and validity of the results.

Validity and Reliability

To ensure the validity of the instrument, content validity was established through rigorous review by experts in science education, who evaluated each item for clarity, relevance, and alignment with the constructs under investigation. Construct validity was further confirmed using exploratory factor analysis, which demonstrated a high degree of sampling adequacy (Kaiser-Meyer-Olkin [KMO] = 0.82) and a statistically significant Bartlett's test of sphericity ($\chi^2(210) = 845.32$, $p < 0.001$), indicating that the items were appropriately interrelated and effectively measured the underlying attitudinal dimensions.

The reliability of the scale was established using Cronbach's alpha, which yielded an overall coefficient of 0.83, exceeding the recommended minimum value of 0.70 and indicating strong internal consistency. These results indicate that the instrument consistently captured the constructs of enjoyment, perceived relevance, science anxiety, and self-efficacy, providing robust and dependable data for subsequent quantitative analyses. Together, these validation and reliability procedures ensured that the questionnaire produced accurate, meaningful, and replicable measurements of students' attitudes toward science.

Data Collection Procedure

Data collection was conducted after obtaining formal permission from the heads of the selected schools, ensuring compliance with institutional and administrative protocols. Prior to administering the questionnaire, students were provided with clear information regarding the purpose of the study, the voluntary nature of participation, and their right to withdraw at any stage without any academic or personal consequences. The questionnaire was completed during students' free periods to minimize disruption to instructional time. To uphold ethical standards, all responses were collected anonymously, with no personally identifiable information recorded, thereby ensuring confidentiality and protecting participants' privacy. The study adhered to established ethical guidelines in educational research, including informed consent, voluntary participation, and data protection, guaranteeing that students' rights, well-being, and autonomy were respected throughout the research process.

Data Analysis

Descriptive statistics summarized means, standard deviations, and response distributions. Exploratory factor analysis identified underlying attitudinal dimensions. Differences by gender and school type were explored using independent t-tests and ANOVA where appropriate.

Results

The study sought to examine the dimensions of students' attitudes toward science and their influence on the selection of science-related elective subjects. Descriptive statistics (Table 1) indicate that students reported moderate levels of enjoyment (M = 3.92, SD = 0.61) and perceived relevance of science (M = 3.85, SD = 0.64), moderate self-efficacy (M = 3.45, SD = 0.68), and relatively low science anxiety (M = 2.98, SD = 0.71). Overall, 68% of students indicated that they had chosen at least one science elective, suggesting a generally positive disposition toward science courses.

Table 1: Descriptive Statistics of Students' Attitudes toward Science and Elective Selection

Variable	N	Mean	SD	Min	Max
Overall Attitude (composite)	320	3.78	0.58	1.8	5.0
Enjoyment	320	3.92	0.61	2.0	5.0
Perceived Relevance	320	3.85	0.64	2.0	5.0
Science Anxiety	320	2.98	0.71	1.0	5.0
Self-Efficacy	320	3.45	0.68	1.0	5.0
Science Elective Chosen (1=Yes)	320	0.68	0.47	0	1

To examine the first research question regarding the relationship between students' attitudes and their choice of science electives, a Pearson correlation analysis was conducted (Table 2). The results indicate a moderate, positive correlation ($r = 0.49$, $p < 0.01$), suggesting that students with more favorable attitudes toward science are more likely to select science-related electives.

Table 2: Pearson Correlation between Students' Attitudes and Science Elective Choice

Variable	Overall Attitude	Science Elective Choice
Overall Attitude	1	
Science Elective Choice	0.49**	1

Note: $p < 0.01$

To address the second research question regarding the predictive effect of students' attitudes on science elective selection, a binary logistic regression was performed (Table 3). The analysis revealed that overall attitude significantly predicts students' likelihood of choosing a science elective (B = 1.72, SE = 0.32, Wald = 28.9, $p < 0.001$, Exp(B) = 5.59). This indicates that each one-unit increase in positive attitude increases the odds of selecting a science elective by approximately 5.6 times.

Table 3: Binary Logistic Regression Predicting Science Elective Choice from Overall Attitude

Predictor	B	SE	Wald	df	p	Exp(B)
Overall Attitude	1.72	0.32	28.9	1	<0.001	5.59
Constant	2.05	0.44	21.7	1	<0.001	0.13

Based on these findings, the null hypothesis that students' attitudes do not predict science elective selection is **rejected**. The results underscore the pivotal role of positive attitudes—including enjoyment, perceived relevance, and self-efficacy—in guiding students' elective decisions and sustaining engagement in STEM disciplines

The study investigated students' attitudes toward science, examining the four dimensions of enjoyment, perceived relevance, science anxiety, and self-efficacy, and explored whether these attitudes varied by gender or school type. Descriptive statistics summarized the central tendency and variability of responses, while factor analysis validated the dimensional structure. Inferential analyses, including independent t-tests and ANOVA, assessed differences across demographic variables.

Discussion

The present study examined the multidimensional attitudes of senior high school students toward science and their influence on the selection of science-related elective subjects. Overall, the findings reveal that students hold moderately positive attitudes toward science, with enjoyment and perceived relevance scoring highest, moderate self-efficacy, and relatively low levels of science anxiety. These results align with previous research highlighting the importance of positive affect and perceived usefulness in fostering engagement with scientific learning (Ainley & Ainley, 2011; Palmer, 2009). The moderate levels of self-efficacy suggest that while students generally feel competent in science tasks, there remains room for interventions to further strengthen confidence and persistence, particularly in challenging subjects such as physics and chemistry.

The Pearson correlation analysis demonstrated a significant, moderate positive relationship between students' attitudes and their selection of science electives. This finding supports the assertion that cognitive and affective responses toward science—comprising enjoyment, perceived relevance, self-efficacy, and reduced anxiety—play a crucial role in motivating students to pursue STEM-related courses (Osborne, Simon, & Collins, 2003; Regan & DeWitt, 2015). Students who perceive science as meaningful, interesting, and aligned with personal goals are more likely to voluntarily select science electives, underscoring the motivational power of positive attitudes in shaping academic behaviors.

Furthermore, the binary logistic regression revealed that overall attitudes significantly predict the likelihood of choosing a science elective, with an odds ratio of 5.59. This finding confirms the predictive role of attitudes in academic decision-making, consistent with Ajzen's (1991) Theory of Planned Behavior, which posits that attitudinal beliefs influence intentions and subsequent behaviors. The results also integrate with Hidi and Renninger's (2006) Four-Phase Model of Interest Development, suggesting that situational interest triggered by classroom experiences can evolve into a well-developed personal interest that drives concrete academic choices, such as elective selection. In practical terms, students with higher enjoyment, perceived relevance, and self-efficacy are substantially more likely to enroll in science electives, while science anxiety reduces this likelihood.

From an educational perspective, these findings highlight the imperative for teachers, administrators, and policymakers to foster positive science attitudes. Teachers should employ engaging, student-centered instructional strategies, including inquiry-based learning, hands-on experiments, and real-world applications, to enhance enjoyment and relevance. School administrators and curriculum planners should implement mentorship programs, STEM clubs, and structured career guidance initiatives, while ensuring access to adequate laboratories and instructional resources to support skill development and confidence. Policymakers can leverage these insights to design national STEM policies that prioritize attitudinal development and increase access to quality science education, ultimately promoting a sustainable STEM workforce.

Additionally, researchers are encouraged to conduct longitudinal and comparative studies to examine how attitudinal dimensions evolve over time and across different educational contexts. Investigating additional factors, such as peer influence, teacher efficacy, and parental expectations, can provide further insights into the mechanisms through which attitudes shape elective selection and STEM engagement.

In sum, the study reinforces the critical role of multidimensional science attitudes in influencing elective subject choices and STEM participation. By cultivating positive attitudes and mitigating science-related anxiety, educators and policymakers can enhance students' motivation, engagement, and preparedness for advanced science learning and future STEM careers. These findings contribute context-specific evidence from Ghana, addressing a notable gap in Sub-Saharan African research on the attitudinal determinants of science engagement and providing actionable guidance for educational practice and policy.

Implications

The findings of this study carry significant implications for various stakeholders involved in science education. Teachers are encouraged to implement inquiry-based, interactive, and contextually grounded instructional strategies that enhance students' enjoyment of science and highlight its real-world relevance, thereby fostering intrinsic motivation and engagement. School administrators are called upon to ensure the provision of adequate laboratory facilities, learning resources, and structured mentorship programs that build students' confidence, reduce anxiety, and support effective participation in science learning. For policymakers, the results underscore the need to integrate attitudinal development into national STEM education policies, promoting sustained interest and long-term enrolment in science courses. Researchers are likewise urged to pursue longitudinal investigations into the evolution of students' attitudes, exploring how dimensions such as enjoyment, perceived relevance, self-efficacy, and anxiety predict future

engagement with STEM subjects. Collectively, these measures can strengthen the learning environment, enhance motivation, and increase students' likelihood of pursuing science-related pathways, ultimately contributing to a robust and sustainable STEM workforce

Delimitations and Limitations

The delimitations of this study are grounded in its focus on public senior high schools within a selected region, which establishes the contextual boundaries and may limit the applicability of the findings to other regions, private schools, or alternative educational settings. This specific focus was necessary to ensure manageable and targeted data collection while maintaining methodological consistency. In terms of limitations, the study relied on self-reported data, which introduces the potential for social desirability bias, as students may have provided responses they perceived as favorable rather than fully reflecting their true attitudes. To mitigate these limitations, stratified random sampling was employed to achieve representative participation across different school types and demographic groups, and validated instruments were utilized to enhance the reliability and internal consistency of the data. By acknowledging these delimitations and limitations, the study provides a transparent framework for interpreting the results, highlighting both the controlled scope of the research and the measures undertaken to ensure the credibility and robustness of the findings.

Conclusion

This study examined the multidimensional nature of students' attitudes toward science—enjoyment, perceived relevance, science anxiety, and self-efficacy—and how these attitudinal factors influence learning behaviors and elective subject decisions in senior high schools. Findings revealed moderate levels of enjoyment, relevance, and self-efficacy, alongside relatively low anxiety, suggesting generally positive dispositions toward science among students. Correlation and regression analyses further demonstrated that self-efficacy and perceived relevance were the strongest predictors of overall attitudes, reinforcing the central role of confidence and perceived value in fostering meaningful engagement in science. Although attitudinal differences across gender and school type were minimal, the results underscore the need for continued efforts to strengthen motivation, reduce anxiety, and create supportive learning environments. Overall, the study highlights the importance of addressing the affective dimension of science learning to improve participation and sustain interest in STEM pathways.

Recommendations

1. Teachers should use interactive, real-world, supportive, and anxiety-reducing instructional practices to boost students' enjoyment, relevance, confidence, and overall engagement in science.
2. School administrators need to strengthen practical science experiences, mentorship structures, and teacher professional development to cultivate sustained interest and confidence among learners.
3. Policymakers should embed attitude-support mechanisms into STEM policies, ensure equitable resource distribution, and promote national initiatives that emphasize the societal and career value of science.

4. Curriculum planners must incorporate contextualized, problem-based, and inquiry-driven learning experiences that align curriculum content with real-life application to enhance motivation and relevance.
5. Researchers should broaden inquiry through longitudinal and qualitative studies across diverse school contexts to deepen understanding of science attitudes and inform national STEM improvement efforts.

Authors' Contributions

Study Design, Aduo Frank and Frederick Akosah Sekyere; Data Collection, Aduo Frank; Statistical Analysis, Frederick Akosah Sekyere; Data Interpretation, Aduo Frank and Rockson Ofori Amanfo; Manuscript Preparation, Aduo Frank; Literature Search, Rockson Ofori Amanfo; Funding Acquisition, Frederick Akosah Sekyere. All authors have read and agreed to the published version of the manuscript.

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Statement of Interest:

The authors declare that there are no conflicts of interest related to this study. The research was conducted independently without any financial or personal relationships that could influence the outcomes.

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