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Research article

Navigating academic performance: Unravelling the relationship between emotional intelligence, learning styles, and science and technology self-efficacy among preservice science teachers

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ABSTRACT

This research investigated the effects of emotional intelligence, learning styles, and science and technology self-efficacy on academic performance. Ninety-one preservice science teachers enrolled in the Bachelor of Science degree programs (Science) in education at the University of Ghana for the academic year 2020–2021 participated in this research. The researchers collected data using grade point averages, the Science and Technology Self-Efficacy scale, and the Schutte Self Report Emotional Intelligence Test scale. Data were analyzed using mean, standard deviation, independent samples *t*-test, Pearson product moment correlation, and hierarchical multiple regression. The key findings in this research were that the study underscores the pivotal role of STEM field self-efficacy, especially for males, emphasizes the significance of nurturing confidence within the STEM field, and reveals a relationship between emotional intelligence and academic performance among preservice science teachers. This study adds to the literature examining factors influencing preservice science teachers' academic performance.

1. Introduction

The idea of emotional intelligence (EI) has attracted increasing attention in the field of education in the last few years. Observers have noted this trend over several decades. According to research, those with high levels of emotional intelligence tend to succeed in various areas, including academic performance [1]. EI influences the academic performance of preservice science teachers [2,3]. Numerous countries, such as Ghana, have prioritized science education as a national imperative [4]. This emphasis is vital for cultivating a proficient workforce capable of adapting to the rapidly evolving technological landscape. Unfortunately, many aspiring science teachers have trouble finishing their degrees or fulfilling their teaching responsibilities [5]. This challenge has raised questions regarding the professional competencies of science education and the capacity of science teacher candidates to satisfy the needs of the field.

EI plays a significant role in preservice STEM teachers' academic performance. For instance, an investigation by Ref. [6] discovered that preservice Science teachers with greater EI tended to achieve more academically than those with lower levels of EI. Similarly, their

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research [7] revealed that preservice science teachers who participated in an EI training program improved their academic performance. The significance of EIin preservice is that teaching is very emotional, and science teaching demands the capacity to handle difficult and complex tasks that support science teacher education even more. High EI preservice science teachers are more capable of balancing the emotional and cognitive demands of the content while teaching. The idea of EI has grown significantly in education, especially in preparing science teachers [7]. According to research, preservice science teachers with greater levels of EI perform better academically, and specialized training programs help enhance these abilities [8].

The study of the connection between EI and academic performance has attracted more investigation. According to some of that research, there is a correlation between the two factors [9,10]. For instance, using the EI Scale and a science achievement test [9], studied Turkish high school students and discovered a favorable link between EI and science achievement. [10], studying Indian high school students, made similar findings using the Emotional Quotient Inventory and a physics achievement test to quantify the variables. There was a positive link between EI and academic performance in physics. Thus, EI might be a critical factor in success in science education. Despite some studies pointing to a link between EI and academic performance in science education, more recent university-level research has generated more ambiguous results. Scholars have demonstrated that the connection between Emotional Intelligence (EI) and academic performance remains to be determined, as empirical research has indicated significant variability in results depending on how the academic performance variable is operationalized [11]. Researchers utilized the [12] Emotional Quotient Inventory and students' GPA to study medical learners in an Iranian university, reporting a significant relationship between EI and academic performance [13]. These studies emphasize the need for additional studies to contribute to the unsettled debate on the relationship between students' academic performance and their EI (in university-level science education).

1.1. Statement of the problem

Factors such as IQ, socioeconomic status, constraints, perception of learning science, motivation, peer interactions, teacher-student relationships, parental involvement, and personality influence academic performance [14–17]. [16] found that parental involvement and peer interactions were significant predictors of academic performance among university students. Xu et al. [17] demonstrated a favorable correlation between IQ and EI and academic performance among Chinese college students. IQ, as [18] indicated, is not a reliable indicator of a student's success in the classroom despite its connection to academic performance. Thus, there is a need for larger educational models that include contextual and personal information, such as non-cognitive traits, to enhance the prediction of academic performance [19]. Personality traits, like drive and emotional control, are associated with academic performance [20]. EI is one of the non-cognitive traits investigated in academic performance [21]. According to Ref. [22], EI is the ability to perceive, access, and generate emotions to assist thought, understand emotions and emotional knowledge, and reflectively regulate emotions to promote emotional and intellectual growth. Studies have shown EI to predict academic performance strongly [23].

Science education is gaining increasing importance, and EI plays a role in science education [24]. Preservice science teachers, who will soon begin teaching, will benefit from developing EI skills, as they require both technical expertise and interpersonal skills [25]. Emotional labor, a crucial aspect of EI, is significant for educators who must express suitable emotions to succeed in their careers [26]. This correlational study examines the level of Emotional Intelligence (EI) among aspiring science teachers at institutes of education and explores its correlation with academic performance. The study seeks to determine the respondents' EI and whether EI enhances their pursuit of a bachelor's degree in education. Recognizing the link between preservice science teachers' academic performance and EI will provide valuable insights into the role of non-cognitive traits in predicting academic performance and inform the development of educational models that include personal and contextual information.

This research is novel in its specific focus on EI within science education, directing attention to the emotional aspects of science teaching. While the significance of EI has been recognized across various fields, this study uniquely emphasizes its impact on the tasks involved in science teacher education. Furthermore, the research contributes to the literature by advocating for broader educational models that encompass contextual and personal information, particularly non-cognitive traits, to enhance the prediction of AP. By examining the relationship between EI, learning styles, science and technology self-efficacy in science, and AP, the study enriches the understanding of non-cognitive factors that influence the AP of preservice science teachers.

2. Review of related literature

2.1. Conceptual framework

2.1.1. Concept of emotional intelligence

Identifying, comprehending, and controlling one's emotions and those of others is called emotional intelligence (EI) [18]. This definition encompasses essential elements such as self-awareness, self-control, intrinsic motivation, empathy, and social skills. A profound understanding of one's emotions, motives, and how these affect relationships is a prerequisite for self-awareness [18]. Another crucial component is self-regulation, which is the ability to effectively control one's mood, impulses, and control so one will healthily react to emotions [18]. Passion and internal rewards fuel internal motivation, which supports dedication and perseverance in achieving objectives [18]. According to Ref. [18], empathy is the capacity to understand and experience another person's ideas and feelings, leading to acts of kindness and support in social situations. Leadership, cooperation, conflict resolution, and communication skills are all part of social skills, including successfully managing relationships and participating in social interactions [18]. These five elements of emotional intelligence influence the comprehension and regulation of emotions, interpersonal relationships, and adeptness in social circumstances. Fig. 1 illustrates the relationship between these components and EI.

Recent studies have revealed an association between university students' academic performance and EI. For instance, a study by Ref. [27] discovered a substantial positive link between undergraduate students' academic performance and EI. Researchers discovered that students with more significant emotional quotients typically outperform academically. Like the previous study [28], looked at the connection between academic performance and emotional intelligence in a sample of college students. The results showed that, compared to children with lower emotional intelligence scores, individuals with more excellent emotional intelligence scores had higher levels of academic performance. A 2019 study by Ref. [29] also investigated how their emotional intelligence impacted university students' academic performance. According to the findings, emotional intelligence had a favorable impact on academic performance, meaning that students with higher emotional intelligence were more likely to succeed in their studies. These studies show a link between academic performance and emotional intelligence in university students, emphasizing the value of fostering the growth of emotional intelligence competencies in learning environments.

Researchers have recently suggested a relationship between EI and AP, and there has been an increase in interest in examining this possibility [30]. Self-regulated learning (SRL) is a famous theoretical framework for explaining the probable link between EI and academic performance. According to Ref. [31], the ability to govern one's learning processes includes setting goals, tracking progress, and modifying tactics as necessary. Numerous studies have associated self-regulated learning (SRL) with improved academic performance (AP) [32]. Theoretical connections between EI and AP have been the subject of numerous studies, shedding insight into the possible impact of EI on students' educational success. For instance, a recent study by Ref. [33] examined the connection between AP and EI among university students.

The research indicates a positive correlation between higher emotional intelligence (EI) levels and improved academic performance (AP), suggesting a potential link [34]. A different study looked at how EI affects learners' AP in primary schools. The findings showed that pupils with higher levels of EI performed better academically, as seen by their higher grades and test scores. Additionally, a study by Ref. [35] stressed the significance of EI in fostering academic performance. It highlighted how EI influences learning, such as greater self-regulation, successful interpersonal skills, and improved problem-solving ability. These studies offer empirical support for the theoretical relationships between EI and academic performance, indicating the link between greater EI levels and more favorable educational results. Including EI training and development programs in educational environments might enhance students' academic performance.

2.2. Science and technology self-efficacy

Self-efficacy in science and technology refers to a person's confidence in their capacity to carry out activities successfully and achieve success in these areas. It includes confidence in their problem-solving ability and understanding of science, technology, engineering, and math (STEM) subjects. People often view self-efficacy as critical in determining motivation, engagement, and AP in science and technology. [36], known for his contributions to social cognition theory, was the first to propose the idea.

[36]'s theory emphasizes the influence of self-efficacy beliefs on behavior, performance, and accomplishment results. Fig. 2 illustrates this self-efficacy theory, demonstrating Bandura's four efficacy belief sources. These four sources of self-efficacy are performance accomplishments, vicarious experience, social persuasion, and physiological and emotional states. Self-efficacy, the belief in one's ability to accomplish tasks, is influenced by personal accomplishments, vicarious experiences, and physiological and emotional states, wherein successes elevate expectations, modeling fosters improvement through observation, social persuasion shapes beliefs, and emotional reactions can impact judgments of capability. Researchers are still investigating the association between science and technology self-efficacy and diverse outcomes. For instance, a study by Ref. [37] investigated the effect of science and technology self-efficacy on college student's academic performance in STEM subjects. The results showed a substantial positive correlation between academic performance and science and technology self-efficacy, indicating that those with greater self-efficacy levels in these fields typically perform better in academic settings.

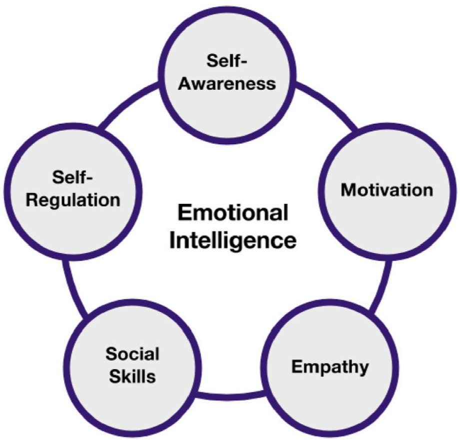

Fig. 1. Concept of emotional intelligence (Goleman, 1995).

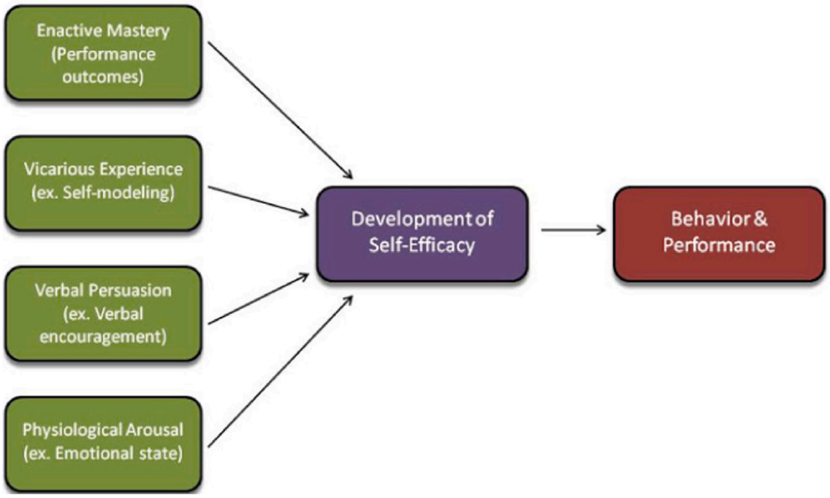

Fig. 2. Self-efficacy theory (Bandura, 1986).

[38] examined Science and Technology Self-Efficacy's role in predicting students' career aspirations and intentions in STEM disciplines. According to the findings, more interest in and motivation to pursue STEM occupations related to higher levels of self-efficacy in science and technology. These studies emphasize the necessity to promote and enhance self-efficacy beliefs in science and technology education by highlighting the significance of science and technology self-efficacy in determining individuals' academic and career results in STEM disciplines.

2.3. Gender and science and technology self-efficacy

Researchers have investigated the disparities in self-efficacy beliefs between males and females in science and technology domains on gender and self-efficacy. Numerous research studies have investigated the connection between gender and self-efficacy in science and technology, illuminating any potential differences and their effects.

For instance, a recent study by Ref. [39] examined the gender variations in college students' science and technology self-efficacy levels. The results showed that, on average, females reported lower levels of self-efficacy in science and technology than males, indicating a gender difference in these views. Similarly [40], investigated the gender differences in high school students' self-efficacy beliefs and career interests in science, technology, engineering, and mathematics STEM. According to the findings, males were likelier than females to have higher science and technology self-efficacy levels, which was linked to males' more substantial interest in and drive for STEM careers. These studies show gender inequalities in self-efficacy in science and technology, with women typically expressing lower levels of self-efficacy than their male colleagues. The underrepresentation of women in STEM disciplines is likely to be a result of such gender differences in self-efficacy beliefs, which also have an impact on the career choices and goals of these women.

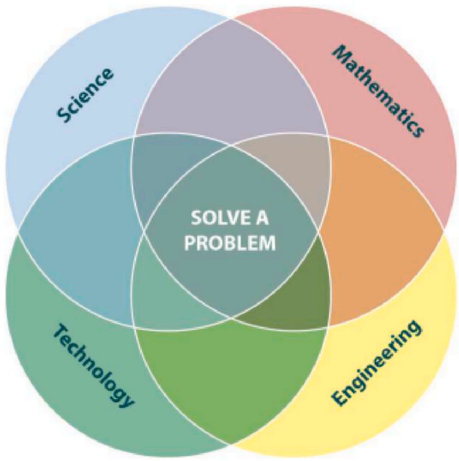

Fig. 3. "Science, technology, engineering, and mathematics (Southeast et al., 2011). The use of STEM curriculum and concepts in educational settings can solve problems".

Fig. 3 shows how science, technology, engineering, and mathematics (STEM) are interconnected to solve problems.

2.4. Purpose of the study

This research aims to investigate the role of Emotional Intelligence (EI) among preservice science teachers and its impact on academic performance. The study recognizes the growing significance of emotional intelligence in education and aims to explore its relevance, specifically in science education. The research seeks to address gaps in understanding how EI, alongside factors like self-efficacy in STEM subjects and learning styles, influences the academic performance of aspiring science teachers. The study raised the following specific objectives to achieve the research purpose.

1. Examine the impact of EI, learning styles, science and technology self-efficacy on academic performance.
2. Evaluate the gender differences in science and technology self-efficacy of preservice teachers.
3. Analyze the correlation between EI and academic performance.
4. Assess the correlation between learning styles and academic performance.
5. Examine the relationship between science and technology self-efficacy and academic performance.
6. Explore how gender moderates the interaction between science and technology self-efficacy and academic performance.

3. Methodology

3.1. Research design

Participants in this study completed a questionnaire examining different characteristics, including EI, age, gender, self-efficacy in science and technology, and academic performance in these subjects [41]. This study used a descriptive correlational research methodology.

We examined the correlations between these variables by analyzing the survey data we had gathered. It is important to remember that correlation does not imply causation. Even if two variables are determined to be correlated, this does not necessarily mean that they are connected in a clear cause-and-effect manner [42].

3.2. Population of the study

The study's target demographic was all preservice teachers in the University of Ghana's School of Education. However, the accessible population for this study explicitly included preservice science teachers in the Department of Teacher Education who were pursuing B.Ed. and B.Sc. bachelor's degrees in education during the 2019–2020 academic year. While training some preservice teachers in the B.Ed program to teach STEM courses at the junior high school level from their second year, it is essential to note that this study exclusively concentrated on preservice teachers in the B.Sc program that produces science teachers for high schools. We chose this because the B.Ed program had only 100 students enrolled in general courses unrelated to the specific concentration of the study in their first year of studies.

3.3. Sample and sampling procedure

The sample for this study consisted of students enrolled in the B.Sc. Education (Science) program across levels, including 100, 200, 300, and 400. The participants selected for this study were preservice teachers chosen through a purposive and stratified sampling technique. Stratification was based on academic levels (100, 200, 300, and 400) within the B.Sc. Education (Science) program. This ensures representation from all stages of the program. Also, purposive sampling was employed to select participants within each stratum. Purposive sampling involves deliberately choosing participants with specific characteristics relevant to the research study. An appropriate sample size is crucial to obtaining a representative statistical sample in empirical research. To address this need [43], developed a table that provides a method for calculating the required sample size for a specific population, thus filling a gap in the existing literature.

3.4. Instruments

Researchers used a combination of original and modified instruments to determine the effect of emotional intelligence on the academic performance of prospective science teachers at the Department of Teacher Education at the University of Ghana. These tests mainly collected pertinent information and examined the current study subject.

3.4.1. STEM Self-Efficacy in Science and Technology Scale

The STEM Self-Efficacy in Science and Technology Scale is a psychometric test to assess a person's self-efficacy in science, technology, engineering, and mathematics (STEM). "Self-efficacy" relates to a person's confidence to carry out actions or reach specified objectives. We designed this scale to measure individuals' confidence in their capacities to carry out STEM-related tasks, such as conducting scientific investigations, resolving mathematical puzzles, and effectively using technology. The scale typically consists of statements or questions asking participants to rate their confidence with STEM-related tasks or objectives. Typically, evaluators tally responses using a Likert scale that ranges from "strongly disagree" to "strongly agree." The scale has been widely used in research studies to explore numerous aspects impacting self-efficacy, such as gender, ethnicity, and educational background, as well as to investigate the relationship between self-efficacy and academic performance in STEM subjects. Studies conducted in the past that used the STEM Self-Efficacy in Science and Technology Scale include those by Ref. [37] and Lent et al. We used the Cronbach's Alpha test to evaluate the scale's reliability and found a coefficient of 0.81. Given that the respondents were non-native English speakers, instructors in the English unit of the department revised the language to ensure it was comprehensible to the participants.

3.4.2. Emotional intelligence scale

The TEIQue survey created by Ref. [44] was the foundation for the emotional intelligence measure used in this study. The survey consists of 13 questions, and respondents assess their agreement with each question on a Likert scale from 1 to 5. A score of 1 represents strong disagreement, while a score of 5 represents strong agreement. In a study examining the internal consistency of the TEIQue survey [45], discovered strong internal reliabilities of 0.71 and 0.91. In the current study, when measured by Cronbach's Alpha, we found the reliability of the Emotional Intelligence scale to be 0.75.

1. Two of the survey's comments were related to self-awareness, which is the capacity to notice and comprehend one's feelings, impulses, and moods and how they affect others. Using Cronbach's Alpha to measure reliability, the researchers discovered that this domain has a reliability of 0.75.
2. The ability to restrain judgment, reflect before acting, and redirect disruptive impulses and moods are all examples of self-regulation. The survey made use of four statements related to this domain. A Cronbach's Alpha test revealed a reliability of 0.68.
3. Intrinsic motivation is the desire to do tasks, assist others, and seek objectives. Throughout the poll, researchers used three statements related to this domain. A Cronbach's Alpha test revealed a reliability of 0.69.
4. The capacity to comprehend the emotions and feelings of others, known as empathy, was assessed in the survey with two statements. A Cronbach's Alpha test revealed a dependability of 0.71.
5. A variety of abilities that involve successfully managing relationships, creating connections, communicating with others, and generating rapport, referred to as social skills, were gauged in this study's survey using two statements. It is crucial to remember that this domain's reliability, as determined by Cronbach's Alpha, was found to be 0.700. Scholars have extensively examined social skills in the literature, with Goleman (1995) highlighting its importance in interpersonal interactions and general social functioning.

3.4.3. Learning style scale

The scale is based on the VAK Learning Styles Model, which categorizes individuals into three primary learning styles: Visual (V), Auditory (A), and Kinesthetic (K). This model suggests that people have different preferences for how they absorb and process information.

3.5. Reliability and validity

The researchers performed a face validity test to determine whether the questionnaire accurately achieved the research goals [46]. We tested the questionnaire by giving a panel of specialists who had previously conducted EI research to look at the items while considering the study's goals. The panel validated the instrument following the examination. We piloted the questionnaire with 40 prospective teachers randomly chosen from a different teacher-training university in Ghana to ensure it was reliable for gathering data. Because the Cronbach's alpha reliability coefficient of the questionnaire was 0.78, over the 0.7 threshold set by Ref. [47], the questionnaire also passed the reliability test.

3.6. Ethical clearance

The University of Ghana Ethics Committee for Humanities reviewed the proposal, evaluated the ethical implications of the study, and ensured that the research followed set standards to get ethical clearance for this research. The ethical clearance number given was ECH 023/20–21. The nature, goals, and possible hazards of the study were made clear to participants through the implementation of informed consent procedures, which also allowed for voluntary withdrawal from the study at any time without repercussions. Confidentiality procedures included the secure handling and storage of personal data, with identifiers deleted or coded to protect participants.

3.7. Data collection procedure

Due to the COVID-19 pandemic, data for the study was gathered in May 2020 using Google Forms. The Department of Teacher Education's Head provided his approval. To administer the instruments on their WhatsApp channels and help with data collection, the researchers contacted participants through their instructors. The head of the University of Ghana's teacher education department sent them a letter describing the study's objectives.

3.8. Data analysis

The data analysis in this study comprised two phases to address the six research objectives systematically. Responses were categorized and analyzed based on corresponding questionnaire sections using SPSS version 23. Descriptive statistics, including percentages, were employed to present the demographic composition of the sample. Means and standard deviation were used to assess the impact of independent variables on Academic Performance (AP). Independent samples t-tests were conducted to explore gender differences, while correlation analysis elucidated relationships between variables. Additionally, hierarchical multiple regression was employed to assess the unique contributions of multiple independent variables to the overall model. The choice of SPSS version 23 underscores the study's commitment to reliable and valid statistical procedures, contributing to the robustness of the findings through a comprehensive and nuanced exploration of the data.

4. Results

4.1. Background information

The study sought the following details about the respondents: age, gender, level, religious affiliation, and GPA. Table 1 displays the results of the responses regarding the demographic distribution. Google Forms were used to distribute survey questionnaires to undergraduates, with a response rate of 75 %.

Using Cronbach's alpha (0.72), the researchers found that the questionnaires were internally consistent for all items. There were 63 (68.5 %) males and 29 (31.5 %) females, both with an average age of 22 (see Table 1). Christians comprise the bulk of participants (92.4 %), and trainees with GPAs below 3.0 come in second (53.3 %).

4.2. Analysis of research objectives

4.2.1. The impact of EI, learning styles, science and technology self-efficacy on academic performance

The study's first objective was to examine the impact of EI scores, learning styles, and Science and Technology self-efficacy (STSE) on academic performance. As seen in Table 2, the STSE had the highest mean ($M = 3.97$, $SD = 0.867$), indicating that it significantly impacted the AP of preservice science teachers. This impact is higher for males ($M = 4.05$, $SD = 0.928$) than for females ($M = 3.80$, $SD = 0.705$). This is followed by EI ($M = 2.98$, $SD = 0.385$), which has a medium impact on AP.

The one with a low impact on AP is LS with a mean ($M = 2.23$, $SD = 0.292$), indicating the lowest impact on AP.

4.2.2. Gender differences in science and technology self-efficacy of preservice science teachers

A comparison of STSE scores between males and females was conducted. Table 3 displays the two groups' participants, means, standard deviations, degrees of freedom (df), t-value, and p-value.

A *t*-test analysis revealed a non-significant difference between the two groups, $t(89) = -1.31$, $p = 0.193$. These results suggest no statistically significant difference in STSE between males and females.

4.2.3. The correlation between EI and academic performance

According to Table 4's correlation values, there is a marginally negative connection between academic performance and emotional intelligence, as shown by the negative r value of −0.081. However, because the p-value of 0.447 is higher than the usual cut-off point 0.05, the association is not statistically significant.

Table 1
Background description of the study sample.

Variable		N	(%)
Age (years)	21 and below	39	(42.9)
	22–25	42	(46.2)
	26 and above	10	(11.0)
Gender	Males	62	(68.1)
	Females	29	(31.9)
Level	100	16	(17.6)
	200	24	(26.4)
	300	29	(31.9)
	400	22	(24.2)
Religious Denomination	Christianity	84	(92.3)
	Islamic	5	(5.5)
	Traditional	1	(1.1)
	Other	1	(1.1)
GPA	Below 3.0	49	(53.8)
	3.0 and above	42	(46.2)

Table 2
EI score, learning styles, and STEM field self-efficacy.

Variables	Overall Mean (SD)	Male Mean SD)	Female Mean (SD)	Significant level
STEM field self-efficacy	3.97 (0.867)	4.05 (0.928)	3.80 (0.705)	0.193
Emotional Intelligence	2.98 (0.385)	3.01 (0.385)	2.91 (0.383)	0.284
Learning styles	2.23 (0.293)	2.25 (0.292)	2.21 (0.298)	0.613

Table 3
Gender differences in science and technology self-efficacy of preservice science teachers.

	Gender	*N*	*M*	*SD*	*df*	*t*	*p*
Emotional intelligence	Male	62	4.05	0.928	89	−1.31	0.193
	Female	29	3.80	0.705			

Significant at $p < 0.05$.

Table 4
Academic performance, variables of EI, learning style, and science and technology self-efficacy.

Emotional Intelligence	Academic performance (*r* values)	Correlation Significance (*p* values)
Emotional Intelligence Total	−0.081	0.447
Learning Styles	0.076	0.475
Science and technology Self-Efficacy	−0.028	0.793

4.2.4. The correlation between learning styles and academic performance

The correlational analysis indicates a weak positive relationship ($r = 0.076$) between learning styles and academic performance; however, this correlation is not statistically significant ($p = .475$) as the p-value exceeds the threshold of 0.05.

4.2.5. The relationship between science and technology self-efficacy and academic performance

The non-significant correlation coefficient ($r = -0.028$) and high p-value.793 shows no meaningful association between self-efficacy in science classes and academic performance.

4.2.6. How gender moderates the interaction between science and technology self-efficacy and academic performance

Researchers employed a moderator analysis to ascertain the relationship between the continuous dependent variable (AP) and the continuous independent variables (EI, LS, and STSE), modified by a dichotomous moderator variable (Gender). They applied the standard method of determining the existence of a moderating effect involving the addition of a (linear) interaction term in a multiple regression model. Table 5 presents the results. Model 2 contains all three variables mentioned.

From Tables 5 and in Model 2, gender was included as a moderating variable to examine its effect on the relationship between the independent variables (EI_Total, LS_Total, and STSE in STEM Classes_Total) and AP. The R Square Change values for Model 1 and Model 2 indicate the increase in the proportion of variance explained by adding the moderating variable. Specifically, for each independent variable, the R Square Change values were as follows.

Table 5
Hierarchical multiple regression on EI_Total, LS_Total, and STSE_Total to Academic Performance (Model summary).

Independent Variable	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig. F Change
EI	1	0.147[a]	0.022	−0.001	0.501	0.022	0.971	2	88	0.383
	2	0.191[b]	0.036	0.003	0.500	0.015	1.334	1	87	0.251
LS	1	0.133[a]	0.018	−0.005	0.502	0.018	0.788	2	88	0.458
	2	0.170[b]	0.029	−0.005	0.502	0.011	1.015	1	87	0.317
STSE	1	0.121[a]	0.015	−0.008	0.503	0.015	0.654	2	88	0.522
	2	0.168[b]	0.028	−0.005	0.503	0.014	1.223	1	87	0.272

Dependent Variable: Academic Performance.
AP (Academic Performance), EI (emotional intelligence), SE (self-efficacy in STEM classes).
[a] Predictors: (Constant), Gender, Zscore(FamilyBack_total), Zscore(LearnStyle_total), Zscore(EmotionIntel_total), Zscore(ScTechSelfEffic_total).
[b] Predictors: (Constant), Gender, Zscore(FamilyBack_total), Zscore(LearnStyle_total), Zscore(EmotionIntel_total), Zscore(ScTechSelfEffic_total), Int_FB_Gender.

- EI_Total: A hierarchical multiple regression was run to assess the increase in variation explained by adding an interaction term between EI and gender to a primary effects model. Gender did not moderate the effect of EI on AP, as evidenced by an increase in total variation of 1.5 %, which was not statistically significant ($F(1, 87) = 1.334$, $p = 0.251$). This suggests that the inclusion of gender as a moderating variable contributed an additional R Square Change of 0.015, suggesting that gender explains an additional 1.5 % of the variance in academic performance beyond the effects of emotional intelligence alone.
- Learning Style_Total: A hierarchical multiple regression was run to assess the increase in variation explained by adding an interaction term between LS and gender to a primary effects model. Gender did not moderate the effect of LS on AP, as evidenced by an increase in total variation explained of 1.1 %, which was not statistically significant ($F(1, 87) = 1.015$, $p = 0.317$). This suggests that the inclusion of gender as a moderating variable resulted in an additional R Square Change of 0.011, indicating that gender accounts for an additional 1.1 % of the variance in academic performance beyond the effects of learning style alone.
- Self-Efficacy in STEM Classes Total: A hierarchical multiple regression was also run to assess the increase in variation explained by adding an interaction term between STSE and gender to a primary effects model. Gender did not moderate the effect of STSE on AP, as evidenced by an increase in total variation of 1.4 %, which was not statistically significant ($F(1, 87) = 1.015$, $p = 0.272$). This suggests that the R Square Change of 0.014 indicates that including gender as a moderating variable contributes to an additional 1.4 % of the variance in academic performance beyond the effects of self-efficacy alone.
- Upon conducting the significant F Change, researchers observed non-significant values of 0.251, 0.317, and 0.272 for EI, LS, and STSE, respectively. This result implies that, although some changes occurred when using gender as a moderating variable, these changes are not significant based on the significant F Change values.

5. Discussion

In examining the impact of EI score, learning styles, and STEM field self-efficacy on AP, the findings suggest that STSE has the highest impact on AP for preservice science teachers. The mean for STSE was notably higher than that of EI and learning styles. The impact of STSE was observed to be higher for males than females. This highlights the importance of nurturing confidence and belief in one's ability within the STEM field for improved academic performance, particularly among male students. While these findings align with previous research indicating the significance of self-efficacy in AP [48], there are differing perspectives. Some studies emphasize the role of other factors, such as motivation or socioeconomic background, in influencing academic performance [49]. It is crucial to acknowledge alternative viewpoints to present a comprehensive understanding of the dynamics influencing academic performance.

Also, the study examined gender differences in STSE among preservice science teachers. The *t*-test analysis revealed a non-significant difference between males and females, suggesting no statistically significant distinction in STSE between the two genders. This finding is consistent with research that challenges traditional gender stereotypes in STEM fields, indicating that males and females can have comparable levels of self-efficacy in science and technology [50]. However, it is essential to note that this result contradicts existing literature indicating gender disparities in STEM self-efficacy and participation [51]. Acknowledging these contrasting views is vital for understanding gender dynamics in STEM education.

Furthermore, this study investigated how AP among prospective STEM teachers related to EI. According to our research, there is a modest negative correlation between AP and the overall EI score, which suggests that learners with higher EI have somewhat worse AP. This result aligns with other research done among engineering and medical students, which discovered a slight negative association between AP and EI. For instance Refs. [52,53], discovered a slight negative association between EI and AP among engineering students. Deshpande and Parappurathu [54] discovered a similar negative association between AP and EI among undergraduate engineering students. Contrary to research findings among nursing, high school, and college students that revealed associations between AP and EI, our results indicate otherwise. For instance Ref. [55], discovered a similar association among nursing students, while [56] discovered a favorable relationship between EI and AP among university students. Adigüzel and Bozdağ [57] made similar findings, discovering a link between EI and AP among engineering undergraduate students. It is crucial to emphasize that EI can still be an advantageous quality for preservice science teachers despite the small negative association between the two variables that our study and other research among engineering and medical students discovered. Improved interpersonal interactions, enhanced empathy, and better communication are all attributes of EI that are crucial for effective teaching. Because of this, promoting EI among preservice STEM teachers is crucial, even though our research suggests it is negatively related to AP.

Our research identified a slightly positive correlation between LS and AP although not significant. This suggests that individuals who favored a particular learning style tended to increase their AP slightly. This result aligns with earlier undergraduate research in many fields, which discovered positive relationships between LS and AP. For instance Ref. [58], discovered a similar association among nursing students, whereas [59] discovered a favorable relationship between LS and AP among undergraduate students, Adigüzel and Bozdağ [57]. discovered a link between LS and AP among engineering undergraduate students. Our findings, however, are at odds with research done on high school and medical students, which revealed no conclusive link between LS and AP. For instance, whereas [60] discovered a similar association among medical students, Karadeniz and Mert [61] found no significant correlation between LS and AP among high school students. Similarly, Chen et al. [62] discovered no connection between LS and AP among nursing undergraduate students.

Also, our research shows no connection between AP and STSE in STEM classes. These outcomes align with much research carried out among undergraduate STEM students. For instance, Ref. [63] found no significant association between undergraduate students' SE in chemistry and AP. Zeldin and Pajares [64] found no significant association between undergraduate students' SE in physics and AP. Similarly, Gong et al. [65] discovered no connection between undergraduate students' AP and STSE in mathematics at a Chinese university. Our findings, however, are at odds with research done on high school students and other demographics, which indicated a strong positive association between AP and STSE in STEM classes. For instance, Ref. [66] discovered a substantial positive association between Pakistan's high school learners' SE in mathematics and AP. Variations in the sample population, self-efficacy measuring techniques, and the academic subject or level researched could contribute to these findings' inconsistencies. It is crucial to highlight that STSE still impacts AP despite the lack of a substantial association between the two variables identified in our study and earlier research among undergraduate learners.

The study explored how gender moderates EI, LS, STSE classes, and AP interaction. The moderator analysis, incorporating gender as a moderating variable, did not show significant changes in the relationship between these factors and academic performance. The non-significant F Change values for EI, LS, and STSE in STEM classes suggest that, while gender contributes a small percentage to the variance in AP beyond these factors alone, these changes are not statistically significant. This implies that, in this context, the impact of gender as a moderating variable is minimal and does not play a substantial role in influencing the relationship between EI, LS, STSE, and AP. It is crucial to consider alternative explanations and interpretations, as some studies might emphasize the significant influence of gender as a moderator in shaping academic outcomes [67]. Balancing and integrating diverse perspectives contribute to a more comprehensive understanding of the relationship between gender and academic performance.

6. Conclusion

In conclusion, this study investigated the relationships among EI, LS, STSE, gender, and AP among preservice science teachers. Notably, STSE is a pivotal factor influencing AP, particularly for males. The findings underscore the importance of nurturing confidence within the STEM field, emphasizing its impact on AP. Gender differences in STSE present a non-significant distinction between males and females, challenging traditional stereotypes. The study emphasizes the importance of considering diverse viewpoints to understand gender dynamics in STEM education. Exploring the relationship between EI, LS, STSE, and AP, the study reveals a modest negative association between overall EI score and AP.

Conversely, a positive link between learning styles and AP was found. Additionally, no significant connection between STSE in STEM classes and very disturbing AP is found. In analyzing gender moderation, the study indicates no significant changes in the relationship between EI, LS, and STSE in STEM classes and AP when gender is incorporated as a moderating variable. Despite the findings, the study contributes valuable insights into the interplay of these factors, prompting further exploration and consideration of diverse perspectives for a comprehensive understanding of academic success among preservice science teachers.

6.1. Limitations of the study

This investigation was undertaken explicitly within the context of prospective science educators, and as such, the generalizability of the findings to other academic disciplines or broader populations is constrained. The outcomes of this study may not be directly applicable to students enrolled in non-science fields or those who do not aspire to pursue a teaching career. Furthermore, it is essential to acknowledge that the study relied on self-report measures to gauge Emotional Intelligence (EI), Learning Styles (LS), and the impact of Science, Technology Self-Efficacy (STSE) in science classes. The utilization of self-report measures introduces the potential for response biases, wherein participants may provide responses that align with perceived expectations or societal norms, leading to inaccuracies in assessing the measured constructs. Consequently, such response biases introduce uncertainty and caution regarding the study's findings, as measurement errors stemming from self-report measures may impact the robustness and reliability of the reported outcomes.

6.2. Recommendations

EI can still be a valuable quality for effective teaching, even though there was only a slight negative association between AP and EI among preservice STEM educators. Therefore, we recommend that teacher education programs integrate training and activities that cultivate EI skills, such as effective communication, empathy, and interpersonal relationships. While LS and AP among preservice Science teachers showed a weakly positive link, it is crucial to remember that other factors could also influence AP. However, providing diverse learning opportunities catering to different LSs can help improve student engagement and motivation, leading to better AP. Thus, we recommend that educators in STEM fields offer a variety of learning activities that cater to different LSs, such as incorporating visual aids, organizing group discussions, and facilitating hands-on activities.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Kwaku Darko Amponsah: Writing – review & editing, Formal analysis, Conceptualization. **Kenneth Adu-Gyamfi:** Writing – original draft, Methodology, Investigation. **Florence Christianah Awoniyi:** Writing – original draft, Investigation. **Priscilla Commey-Mintah:** Writing – review & editing, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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