

Test anxiety's influence on attitudes, confidence and efficacy in STEM courses: a pilot study

STEM anxiety:
confidence,
efficacy, and
attitudes

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Received 29 June 2023
Revised 26 September 2023
Accepted 28 October 2023

Abstract

Purpose – This pilot study aims to examine the prevalence of test anxiety and its interplay with attitudes, confidence, efficacy, academic performance and socio-demographic factors within the domain of science, technology, engineering and mathematics (STEM) courses.

Design/methodology/approach – The authors employed a quantitative, cross-sectional design with 549 sixth-grade students from public lower secondary schools in Prishtina, Kosovo, using the Student Attitudes Toward STEM Survey (S-STEM) for middle/high schools and the test anxiety questionnaire.

Findings – Over 70% of Kosovo's sixth-grade students reported moderate to severe test anxiety. The age of students was found to be inversely related to academic performance in STEM. The father's employment was associated with favorable STEM attitudes, confidence, efficacy and academic performance. Having a personal study environment was connected with favorable STEM attitudes, confidence and efficacy in STEM, whereas access to technology was associated with positive academic performance. Test anxiety, academic performance and personal study space predicted students' attitudes, confidence and efficacy in STEM and 21st-century learning.

Practical implications – Educational institutions should prioritize student well-being. By addressing test anxiety, these institutions can create supportive learning environments that improve attitudes, confidence and efficacy in STEM fields. These efforts are crucial for STEM career development and student success in the 21st-century workforce.

Originality/value – The current study findings contribute to a deeper understanding of the factors influencing STEM student engagement and performance, highlighting the importance of addressing test

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The authors would like to thank the public lower secondary schools from the municipality of Prishtina: "Ismail Qemali", "Zenel Hajdini", "Pjeter Bogdani", and "Nazim Gafuri" for their participation in the project; the school counselors Trendelina Bytyqi, Albana Desku, Arbnore Ismaili, and Albana Bytyqi for their support and collaboration during the data collection process. In addition, the authors thank the expert involved in the project, Prof. Dr. Moshe Landsman, for his valuable support and contribution to manuscript enhancement and development.

Funding: This work was implemented by the Department of Psychology, University of Prishtina (Hasan Prishtina), with financial support from the Ministry of Education, Science, Technology, and Innovation in Kosovo, under the small scientific project grants: promoting the importance of STEM-related fields while reducing anxiety and improving self-efficacy of the students [Project nr. 2-2459-16]. The content and recommendations do not represent the official position of the Ministry of Education, Science, Technology, and Innovation in Kosovo and the Department of Psychology, University of Prishtina. *Note:* This financial support does not include the research publication fee.



anxiety for positive learning outcomes while emphasizing the need to consider socio-economic and contextual factors in education.

Keywords Students, Anxiety, Self-efficacy, Confidence, Learning

Paper type Research paper

Introduction

Science, technology, engineering and mathematics (STEM) education, encompassing science, technology, engineering and mathematics forms the bedrock for the acquisition and evolution of cognitive knowledge (cognitive), affective attitudes (affective) and specific skills (Nugroho *et al.*, 2021). STEM education empowers individuals to become problem-solvers, innovators, inventors, independent and technologically adept (Morrison, 2006; Sandrone *et al.*, 2021). Furthermore, it cultivates logical and creative thinking, collaboration and resilience (Huang *et al.*, 2022), which are integral to the 21st-century skill set (Trilling and Fadel, 2009) and essential for success in 21st-century occupations (St Louis *et al.*, 2021).

Recognizing the significance of a knowledgeable STEM workforce (Gonzalez and Kuenzi, 2012), STEM education has gained worldwide prominence as the cornerstone of national development, economic competitiveness and social well-being (Marginson *et al.*, 2013; Tytler, 2020). It is seen as a fitting approach to societal advancement (Saxton *et al.*, 2014). Merrill and Daugherty (2009) define STEM education as a standards-based, interdisciplinary discipline where all educators, particularly those in STEM, adopt an integrated approach to teaching and learning, treating discipline-specific content as a unified field of study rather than fragmented information and practices (Dugger, 2010). This interdisciplinary approach has driven educational reforms in several nations (Saxton *et al.*, 2014). Governments worldwide, including those in Finland, France, Portugal, Russia, the United States of America, Canada, New Zealand, China, the United Kingdom, Australia, South Africa, Asia, Latin America and the Middle East, are actively investigating factors affecting students' performance and motivation in STEM education while concurrently developing strategies and programs to bolster STEM fields (Tytler, 2020).

However, despite significant strides made by many nations in preparing their workforce and bolstering their economies through STEM education, several factors hinder students' readiness to contribute to economic development, navigate the global landscape in multiple modalities and confront 21st-century challenges. An important factor is the quality of education and its capacity to enhance students' STEM-related knowledge and cultivate 21st-century learning skills (Merrill and Daugherty, 2009). Many young learners worldwide still lack exposure to STEM education in pre-university settings. This deficiency arises from countries' inadequate education policies that fail to effectively integrate STEM education, offer STEM courses and separate subjects without connections between STEM disciplines (Vahidy, 2019; Word Economic Forum, 2017) or lack knowledge regarding the value of STEM (Murphy, 2020).

Moreover, numerous countries lack holistic perspectives on children's education and fail to implement programs that consider students' emotional states and their impact on learning and motivation (Berg *et al.*, 2021), even though emotional state does impact student's learning, attitudes toward learning, their lives and future careers (Morrison, 2006; Nugroho *et al.*, 2021). For example, studies show that test anxiety is an important predictor of students' academic performance and influences students' attitudes, efficacy and confidence toward learning. Students who are more anxious have a passive attitude toward their studies, such as a lack of interest in learning and poor performance on exams and assignments (Herzer *et al.*, 2014). High levels of math anxiety negatively affect students' learning and interest in pursuing a career in mathematics and science (Huang *et al.*, 2019). Moreover, test anxiety symptoms are associated with impairments in memory, cognitive functions and emotional equilibrium, which affect students' abilities in problem-solving, comprehension, reasoning, knowledge

acquisition and connection-making, impacting their learning confidence (Romero *et al.*, 2014) and their overall educational attainment (Marks, 2013).

Students' attitudes toward STEM are also crucial for students' performance in STEM fields (Berger *et al.*, 2020). Students' self-confidence plays a crucial role in their perceptions of various STEM disciplines and their interest in pursuing related careers. For example, students with a strong self-concept in science are more inclined to pursue science-related careers (Taskinen *et al.*, 2013), and a positive self-concept in mathematics influences students' aspirations for future STEM education (Parker *et al.*, 2014). Those with high self-concepts (Sáinz and Eccles, 2012) and self-interest (Tsakissiris and Grant-Smith, 2021) in technology are more likely to choose technology as their future profession. Furthermore, students who believe in their proficiency in STEM fields are more interested in those fields, affecting their inclination to explore related career paths (Brown *et al.*, 2016).

Research also suggests that students' attitudes, self-efficacy, academic performance and future STEM career prospects are influenced by socio-contextual factors. Garriott *et al.* (2013) posit that students' self-efficacy in math and science is influenced by social class and learning experiences. Parental support also shapes students' learning experiences and academic performance, subsequently affecting self-efficacy and STEM career interests (Garriott *et al.*, 2014). Environmental factors, such as socio-economic elements, impacting the availability of learning resources further influence academic performance and interest in STEM subjects (Khanlari, 2013), as well as shape self-belief, a significant determinant of students' choices in pursuing STEM-related majors (Lent *et al.*, 2000).

Nevertheless, evidence regarding the impact of school-related stressors, particularly test anxiety, in conjunction with contextual and socio-economic factors on students' academic performance in STEM-related fields and their attitudes, confidence and efficacy in these areas, especially in pre-university education, is lacking. Therefore, this study aims to provide new scientific evidence by examining the interplay between test anxiety and academic performance in STEM courses and its effects on sixth-grade students' attitudes, confidence and efficacy in STEM fields. It also assesses the impact of socio-economic factors on academic performance, test anxiety and students' attitudes, confidence and efficacy in STEM fields.

This study is grounded in Bandura's social cognitive theory (SCT), which underscores the interactions between personal factors, environmental factors and behavior. The personal factors under scrutiny in this study encompass students' attitudes, confidence and efficacy in STEM subjects. Behavioral factors include test anxiety and academic performance, while environmental factors are explored through socio-economic factors. According to the SCT, widely employed in the field of education, these factors do not operate in isolation but have reciprocal relationships that impact students' actions and behaviors (Abedini *et al.*, 2023). For instance, students with positive attitudes, confidence and efficacy in STEM subjects are more likely to experience less test anxiety and better academic performance. Students from diverse socio-economic backgrounds may have varying access to learning resources and support systems, influencing their academic performance and affecting their attitudes, confidence and self-efficacy concerning STEM. In turn, students' attitudes, confidence and efficacy in STEM can also influence their test anxiety, which may be influenced by environmental factors and learning experiences. As SCT emphasizes, self-efficacy, attitudes and confidence are important indicators of academic achievement, motivation and learning (Artino, 2012).

Therefore, the findings of this study hold relevance for educational institution administrators, policymakers, school counselors, teachers and parents/caregivers, especially in countries at the early stages of STEM integration in pre-university education, such as Kosovo and neighboring countries. Understanding the intricate interplay of personal and environmental factors impacting students' test anxiety, academic performance and attitudes toward STEM can inform necessary changes and adjustments to enhance learning and safeguard student well-being. Furthermore, this evidence can contribute to advocating

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for the development of holistic educational strategies that enable students to realize their full potential (McDaid *et al.*, 2020).

The Kosovo context

According to the latest statistics, Kosovo, in Southern Europe had a total of 224,429 primary (grades 1–5) and lower secondary education (grades 6–9) students, with 97.1% enrolled in public institutions (Kosovo Agency of Statistics, 2022). In the recent years, there have been initiatives in Kosovo aimed at promoting STEM education. These initiatives initiated by the Kosovo Ministry of Education, Science and Technology aim to foster interest and enhance students' STEM knowledge and skills, provide teacher training, develop STEM curriculum and enhance information and communications technology skills in the education system (Ministry of Education Science Technology and Innovation, 2015, 2023a, b).

However, at the lower secondary school level in the country's public school system, courses are still offered as separate individual subjects but are organized within seven curriculum themes: (1) language and communication, which includes subjects such as Albanian (native language) and foreign languages (obligatory: English, elective: German or French); (2) arts: music and art; (3) math; (4) natural sciences: physics and biology; (5) social sciences: history, geography and civic education; (6) sports and health: physical education and (7) life and employment: technology (Ministry of Education Science Technology and Innovation, 2018). Academic performance is evaluated through various activities throughout the academic year, including class engagement, homework, quizzes, tests, debates, oral presentations and essays (Ministry of Education, Science, Technology and Innovation, 2022).

Despite the progress in STEM promotion in the country, several factors contribute to higher education dropouts from STEM fields, such as the inadequate integration of STEM curricula in pre-university education, insufficient teacher training for interdisciplinary courses and a lack of laboratory equipment for scientific activities (Kabashi *et al.*, 2022).

Kosovar students' performance in Program for International Student Assessment (PISA) remains subpar, scoring significantly below the Organization for Economic Cooperation and Development (OECD) average: 362 in mathematics, 345 in reading and 361 in science (OECD, 2018). Teaching quality, along with the absence of critical thinking and problem-solving skills, are cited as major factors impacting Kosovar students' PISA performance (Shala *et al.*, 2021).

Additional challenges include low Internet and technology integration within school resources, as well as socio-economic factors that hinder young learners in Kosovo, particularly within the public education system, from accessing quality education, especially in STEM fields. Nearly 23% of Kosovo's children are considered to live in poverty, with 7% in extreme poverty. Despite a relatively high percentage of household Internet connectivity, parents often lack the skills to support their children academically, compounded by limited available resources. Furthermore, digital learning is still relatively new, primarily associated with remote learning during the coronavirus disease 2019 (COVID-19) pandemic (Hyseni Duraku, 2021; United Nations Children's Fund, 2023).

Methods

This quantitative and cross-sectional study used convenience sampling for the recruitment of sixth graders from four lower secondary public schools in the capital of Kosovo, Prishtina. Prior to survey administration, approval from the Municipality of Prishtina's Directorate of Education and informed consent from student's parents were obtained. Participants were also informed that their responses would remain confidential and that they could cease participation at any time. The questionnaire was administrated to the sixth graders by

graduate students from the Department of Psychology, at the University of Prishtina and school counselors from the above schools, both of whom had prior training in data collection and ethical principles. The survey took approximately twenty minutes to complete. The data were collected in December 2022 during students' regular classes.

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Measures

To measure the study variables, the following validated questionnaires were employed. Before validation and administration, the questionnaires were translated into Albanian and back-translated.

Students' attitudes toward STEM survey (S-STEM): This tool assessed students' attitudes, confidence and efficacy in STEM subjects and 21st-century learning skills (6th–12th grades; [Friday Institute for Educational Innovation and the Golden LEAF Foundation, 2012](#)). The survey consisted of 37 items categorized into 4 main constructs, evaluating attitudes toward science, math, engineering/technology and 21st-century skills. Responses were rated on a five-point scale (1 = *strongly disagree* to 5 = *strongly agree*), with negatively framed items reverse-scored. Sum scores were calculated based on the average of all items within a construct, with higher scores indicating more positive attitudes, efficacy and confidence. The questionnaire demonstrated satisfactory reliability in prior research (Cronbach's $\alpha = 0.89$ – 0.92 ; [Unfried et al., 2015](#)). In the study, internal consistency for each construct was strong (attitudes toward science: $\alpha = 0.82$, math: $\alpha = 0.80$, engineering/technology: $\alpha = 0.84$ and 21-century skills: $\alpha = 0.87$), and the overall scale was excellent ($\alpha = 0.92$).

Text anxiety questionnaire: To test anxiety, the study employed a ten-item questionnaire adopted from [Nist and Diehl \(1990\)](#). Participants were asked to rate the severity of their test anxiety on a five-point scale (1 = *never* to 5 = *always*) while considering their experiences in STEM-related courses as part of their regular school curriculum. Scores ranged from 10 to 50 points, with 10–19 points indicating no test anxiety, 20–35 points indicating moderate test anxiety and 35 points and above indicating severe test anxiety. The questionnaire demonstrated strong internal consistency in a previous study ([Ogundokun, 2011](#); Cronbach's $\alpha = 0.90$), and in this sample, the overall scale also showed good reliability ($\alpha = 0.87$).

Additionally, socio-demographic data (including, age, sex, family financial income-conditions, parents' education level and employment, the availability of personal room and technology devices for studying) and academic performance in STEM-related courses data were collected at the beginning of the survey.

Participants' characteristics

The sample included a total of 549 sixth-grade Albanian students from public lower secondary schools in Prishtina, Kosovo. Of these participants, 53.6% were male, and a majority of the sample (55.3%) had parents with a university education. The mean age of participants was 11.2 years ($SD = 0.43$). [Table 1](#) summarizes the general characteristics of the participants.

Analysis

Data preparation and analysis were conducted using Statistical Package for the Social Sciences- SPSS version 24. After data cleaning and weighting, descriptive statistics, including means and standard deviations were calculated to provide an overview of the data. Bivariate analysis, incorporating chi-square analysis and Spearman's correlation, was employed to examine the relationships between test anxiety, academic performance in STEM-related courses, attitudes, confidence, efficacy in STEM (STEM Survey scores) and

JRIT	<i>n</i>	%
<i>Sex</i>		
Female	255	46.4
Male	294	53.6
<i>Age (years)</i>		
10	436	79.0
11	94	17.0
12	19	4.0
<i>Academic performance in the previous semester</i>		
Insufficient	5	0.9
Sufficient	7	1.3
Good	43	7.8
Very good	98	17.9
Excellent	396	72.1
<i>Parents with university degree</i>		
Both parents	304	55.3
Only mother	69	12.6
Only father	64	11.7
None	112	20.4
<i>Self-reported family financial conditions-income</i>		
Low	4	0.7
Lower than average family	19	3.5
Average	321	58.5
Above average	146	26.6
Affluent	59	10.7
<i>Availability of personal room for studying</i>		
No	131	23.9
Yes	418	76.1
<i>Availability of personal technology for studying purposes (computer, laptop or tablet)</i>		
No	119	21.7
Yes	430	78.3
Source(s): Table by authors		

Table 1.
Participants' general
characteristics
(*N* = 549)

relevant socio-demographic variables. Multiple regression analysis, including stepwise regression models and linear regression, was utilized to evaluate the combined impact of predictor variables on attitudes, confidence and efficacy in STEM.

Results

Results showed that 21.7% of participants reported experiencing severe test anxiety in STEM-related courses (cut-off score of <35 points), while 50.3% experienced moderate test anxiety (with scores ranging from 23 to 35). The overall scores for attitudes, confidence and efficacy toward STEM-related courses were as follows: mean (*M*) = 133.35 and standard deviation (*SD*) = 22.25. Among the specific constructs, the highest positive scores for attitudes, confidence and efficacy were observed for 21st-century skills (*M* = 42.98 and *SD* = 8.23), followed by engineering/technology (*M* = 31.85 and *SD* = 7.32), math (*M* = 30.56 and *SD* = 6.35) and science (*M* = 28.39 and *SD* = 8.00).

Spearman's correlation and chi-square analysis were employed to examine the relationship between attitudes, confidence and efficacy in STEM, test anxiety and

academic performance in STEM-related courses with several socio-demographic factors, including parental education, parental employment (disaggregated), having a personal room and devise for studying and economic background of the family. The results revealed several significant correlations. Father's employment was positively correlated with attitudes, confidence and efficacy in STEM ($p = 0.006$) as well as academic performance in STEM-related courses ($p = 0.000$). Having a personal study room was positively correlated with attitudes, confidence and efficacy in STEM scores ($p = 0.000$), as was the possession of a computer, laptop or tablet with academic performance in STEM-related courses ($p = 0.002$). Age showed a significant negative correlation with academic performance ($r = -0.166$, $p = 0.001$), suggesting that older students tended to perform less effectively in STEM-related courses. The details are provided in [Table 2](#).

Stepwise linear regression analyses revealed that students test academic performance in STEM-related courses predicted 9% of attitudes, confidence and efficacy in STEM ($F(1, 547) = 56.997$, $p < 0.000$, $R^2 = 0.094$). The addition of the variable "having a personal room" strengthened the model ($F(2, 456) = 36.821$, $p < 0.000$ and $R^2 = 0.119$) and predicted 11% of attitudes, confidence and efficacy in STEM ($b = 0.157$ and $p < 0.000$). Test anxiety was also a predictor of attitudes, confidence and efficacy in STEM ($F(1, 547) = 8.294$ and $p < 0.004$) explaining 15% of the variance ($b = -0.122$ and $p < 0.004$) ([Table 3](#)).

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Factors	Attitudes, confidence and efficacy in STEM	Test anxiety in STEM-related courses	Academic performance in STEM-related courses
Age (years)	$r = -0.013$ ($p = 0.839$)	$r = -0.006$ ($p = 0.898$)	$r = -0.166$ ($p = 0.001$ *)
Parental education	$r = -0.074$ ($p = 0.084$)	$r = 0.021$ ($p = 0.629$)	$r = -0.141$ ($p = 0.001$ *)
Mother employment	$r = 0.043$ ($p = 0.549$)	$r = 0.020$ ($p = 0.640$)	$r = 0.053$ ($p = 0.212$)
Father employment	$r = 0.117$ ($p = 0.006$ **)	$r = -0.005$ ($p = 0.904$)	$r = 0.167$ ($p = 0.000$ **)
Availability of personal room for studying	$r = 0.155$ ($p = 0.000$ **)	$r = -0.078$ ($p = 0.070$)	$r = 0.077$ ($p = 0.070$)
Availability of technology (e.g. laptop, computer, tablet) for learning purposes	$r = 0.064$ ($p = 0.133$)	$r = -0.054$ ($p = 0.208$)	$r = 0.135$ ($p = 0.002$ **)
Family financial conditions-income	$r = 0.043$ ($p = 0.317$)	$r = -0.041$ ($p = 0.338$)	$r = 0.045$ ($p = 0.288$)

Note(s): * $p < 0.05$ and ** $p < 0.01$
Source(s): Table by authors

Table 2.
Bivariate analysis (Spearman's correlation and chi-square) of attitudes, confidence and efficacy in STEM, test anxiety and academic performance with socio-demographic characteristics among the study participants

Variable	®	t	P	R	R ²	⊗R ²
<i>Step 1</i>				0.307	0.094	0.093
Academic performance	0.307	7.550***	0.000			
<i>Step 2</i>				0.345	0.119	0.116
Academic performance	0.307	7.550***	0.000			
Having a personal room	0.345	3.895***	0.000			

Note(s): *** $p < 0.001$
Source(s): Table by authors

Table 3.
Regression model: predictors of attitudes, confidence and efficacy in STEM

Discussion

Our findings, which are based on participants' reports, indicate high rates of test anxiety among lower secondary school students in Kosovo. This underscores the need to prioritize the mental and emotional well-being of students in this age group, as test anxiety can adversely affect their attitudes, confidence and self-efficacy toward learning (Herzer *et al.*, 2014; Wang and Li, 2017). Left unaddressed, it can also impact their future career choices (Huang *et al.*, 2019), motivation to learn and problem-solving abilities (Aosi *et al.*, 2019).

While students in our sample generally exhibited moderate attitudes, confidence and efficacy in STEM-related courses, it is important to note that the lowest levels were observed in math and science subjects. Moreover, our study reveals that academic performance predicts students' attitudes, confidence and efficacy in these fields, aligning with previous research indicating that difficulties in mastering science and math concepts can affect students' attitudes toward these subjects (Wang and Li, 2017). These finding also resonate with a study by the OECD (2018), which reported poor performance by Kosovar students in math and science subjects on international assessments and PISA results, emphasizing the need for educational institutions to take appropriate actions to enhance students' knowledge and perceptions in these subjects.

Our study results highlight the complex relationship between socio-demographic factors and attitudes, confidence, efficacy, test anxiety and academic performance in STEM-related courses. The positive correlation between fathers' employment and students' academic performance, attitudes, confidence and efficacy in STEM, along with the positive influence of factors like having a personal study room and access to technology underscores how socio-economic and environmental factors influence students' academic achievements and their perceptions of STEM education. This aligns with previous research findings indicating that socio-economic factors and learning resources do influence academic achievements and students' perceptions toward STEM-related fields (Garriott *et al.*, 2014; Khanlari, 2013; Lent *et al.*, 2000).

The current study findings also suggest a negative correlation between age and academic performance in STEM-related courses suggesting that older students may encounter specific challenges or require tailored support in STEM education. This emphasizes the importance of providing such support to prevent a decline in academic performance, which can impact students' attitudes, confidence and efficacy in STEM and their future education and career choices (Khanlari, 2013).

Furthermore, the regression analysis underscores the predictive value of test anxiety, academic performance and socio-economic factors (representing the learning environment, such as having a personal study room) on students' attitudes, confidence and efficacy in STEM. These findings align with Bandura's SCT, which posits that personal and environmental factors interact to influence student outcomes. Consequently, the study emphasizes the importance of adopting holistic educational approaches that consider both personal and environmental factors and their intricate relationship to support students' well-being and learning in STEM subjects (McDaid *et al.*, 2020; McGorry *et al.*, 2013).

Practical implications

Stakeholders should prioritize the integration of STEM education into the pre-university education system to improve its quality, providing opportunities for advancing students' attitudes, confidence and efficacy in STEM fields. To achieve this, it is recommended that discipline-specific STEM content be addressed collectively rather than segregated (Merrill and Daugherty, 2009). Teachers can play a key role in promoting literacy in science, math and other STEM-related fields among students (Tytler, 2020). Teaching STEM subjects in an integrated manner fosters a better understanding of isolated STEM subjects, enhances the contextualization of scientific principles and deepens the understanding of the practical value

of STEM subjects (Kelley and Knowles, 2016). This approach can help students overcome their fears and doubts about specific challenging STEM courses (Tasiopoulou *et al.*, 2022).

The advantages of introducing students to STEM concepts at an early stage, starting from early education, are well documented (Bagiati *et al.*, 2010; Bybee and Fuchs, 2006). Integrating engineering and math concepts with advanced science concepts during elementary education can boost students' interest in STEM career fields and foster their learning skills (Katehi *et al.*, 2009). Middle school students engaged in STEM education tend to exhibit higher interest in STEM fields, improved study skills, better practical application of these skills and enhanced academic achievement in these areas compared to peers without STEM education experience (Baran *et al.*, 2019; Kurt and Benzer, 2020). This integration positively impacts students' social-emotional learning and motivation for learning, as it improves their attitudes toward learning in STEM-related subjects, making these activities engaging and enjoyable (Durlak *et al.*, 2011). Incorporating social-emotional components into education also enhances students' academic performance (Durlak *et al.*, 2011) and students' interest in STEM fields (Garner *et al.*, 2018).

The current study findings also suggest that possessing technology devices for studying purposes has a positive influence on students' academic performance in STEM-related courses, emphasizing the importance of providing students with such learning resources. Using technology for learning purposes has been previously suggested to enhance student engagement and motivation and broaden their experiences in STEM-related subjects by serving as a supplementary learning resource. Technology can also positively impact pedagogy and enrich learning environments (Smith and Mader, 2017).

Furthermore, as indicated by the current study results and various research findings, the learning environment, impact students' self-efficacy, confidence, knowledge and skills (Artino, 2012; Deci and Ryan, 2000; Hyseni Duraku and Hoxha, 2018). Therefore, policymakers and those involved in designing or evaluating educational policies are encouraged to further understand socio-economic and other contextual or education-related factors that may hinder students' academic success, as well as measure these factors and use evidence when devising interventions to improve educational approaches, protect students' well-being and improve their learning (Artino, 2012). When school-based interventions are designed based on the evidence and tailored to the needs of students, they have long-lasting effects (Hyseni Duraku, 2021). Additionally, children's mental health, academic achievement and social and emotional competence are fundamentally interconnected, reinforcing the idea that fostering all these aspects simultaneously is the most efficient approach (Grandey and Diamond, 2010).

Moreover, scholars have highlighted the vital role of school counselors in devising strategies to reduce student anxiety and supporting teachers in enhancing their STEM-related pedagogical skills to promote positive emotions (Furner, 2017; Murphy *et al.*, 2019). Collaboration and increased cooperation with parents concerning the importance of STEM fields and students' well-being can also contribute to positive attitudes toward STEM subjects and safeguard students' well-being (Rozek *et al.*, 2017).

Limitations and future directions

While providing valuable baseline scientific data on test anxiety's relationship with academic performance and students' attitudes, efficacy and confidence, this pilot study has some limitations. These include reliance on convenience sampling, a limited sample size and a simplistic analytic approach. Future studies should prioritize more diverse and extensive samples to enhance the generalizability of findings. Moreover, larger sample sizes and advanced analytic methods can delve deeper into the interplay between study variables.

Future studies could explore additional factors influencing students' test anxiety and their attitudes, efficacy and confidence in STEM-related subjects. These factors are crucial for

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evidence-based interventions tailored to learners' needs. Investigations might consider the interaction of these factors while considering sex differences and other contextual and socio-demographic factors impacting student self-concept, attitudes and text anxiety in STEM subjects (Sáinz and Eccles, 2012). Further research into teachers' attitudes toward STEM, teaching and assessment methods in STEM courses, levels of knowledge and professional development opportunities should be conducted (Knezek *et al.*, 2013; Milner-Bolotin, 2018). These can serve as indicators of students' attitudes toward STEM fields and their test anxiety levels. Exploring students' perspectives on the school environment, assessment methods and the availability of school-based mental health services can provide valuable insights (Hyseni Duraku and Hoxha, 2018).

Examining the influence of parents, their expectations regarding their children's academic performance and future education, and their aspirations can provide a more detailed understanding of the factors needing attention to support students' learning and attitudes while preventing anxiety related to STEM subjects (Harackiewicz *et al.*, 2012; Sjaastad, 2012). Moreover, examining teachers' expectations and other school-related factors, such as negative feedback or discrimination, can shed light on students' decisions to pursue or avoid STEM-related fields and their impact on well-being and academic performance (Williams *et al.*, 2022).

Future research should also consider incorporating other theoretical perspectives to underpin their studies, such as social cognitive career theory (SCCT), which is widely used to explore career development and the pursuit or avoidance of STEM-related coursework and academic majors. Viewing STEM education through Bronfenbrenner's ecological systems theory can also help understand the dynamic interaction between various systems, from the microsystem (including family, school and peers) to the macro-system (including cultural norms and values), in shaping students' STEM experiences (Bronfenbrenner and Morris, 2007).

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