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An empirical study on influencing factors of STEM career interest among Chinese primary and middle school students

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Abstract:
This study investigates the factors influencing STEM career interest among primary and middle school students. Drawing on social cognitive theory and social cognitive career theory, it examines the roles of self-efficacy and subject-specific attitudes in shaping students' vocational aspirations. Using a questionnaire adapted from validated international scales, data were collected from 734 Grades 3 to 8 students in China. The results indicate that STEM self-efficacy significantly predicts students' attitudes toward STEM subjects, which in turn influence their career interests. Science and engineering/technology attitudes emerged as direct predictors of career interest, while mathematics attitude played an indirect role. Gender and grade-level differences were also observed, with girls in lower or upper grades showing greater interest. The findings highlight the need to cultivate STEM attitudes and confidence during key developmental periods to sustain students' long-term interest in STEM careers.

1. Introduction

STEM education has long be considered as vital for national innovation and economic competitiveness across the globe, and systemic reform efforts have been exerted (National Research Council, 2011; Organization for Economic Cooperation and Development, 2016). In spite of these efforts, young people in many countries continue to show growing lack of interest STEM careers (Sjøberg & Schreiner, 2010; Wang & Degol, 2017). However, STEM career interest is not inborn, but emerges through dynamic interactions between individual beliefs, learning experiences, and contextual factors (Lent et al., 1994; Bandura, 1997). Two key constructs identified in this process are self-efficacy, or students' beliefs in their capability to perform STEM tasks, and disciplinary attitudes, including how much value or enjoyment students assign to subjects like mathematics, science, and engineering (Britner & Pajares, 2006; Eccles & Wigfield, 2002; Wang & Degol, 2013). Prior studies have consistently shown that these variables influence students' engagement, persistence, and vocational goals across diverse cultural and educational settings (Archer et al., 2013; Nugent et al., 2015).

The upper elementary and middle school years represent a pivotal stage during which students begin to develop academic identities and envision possible career trajectories (Tai et al., 2006; Maltese & Tai, 2011). This study builds on this theoretical foundation by examining how self-efficacy and STEM attitudes jointly predict career interest in students from Grades 3 to 8. Using structural equation modeling and a large cross-sectional sample, the research investigates both direct and indirect pathways, while accounting for gender and grade-level differences. The results provide practical insights for designing targeted interventions to foster interest in STEM careers from an early age.

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2. Literature review

Interest in STEM (Science, Technology, Engineering, and Mathematics) careers emerges through a complex interplay of psychological, contextual, and social factors. Over the past two decades, international research has increasingly focused on understanding how young students develop aspirations in STEM fields and what educational environments are most effective in fostering this interest. This literature emphasizes three core constructs: career interest, self-efficacy, and disciplinary attitudes—as well as the demographic and structural factors that mediate their relationships.

2.1 Early development of STEM career interest

Career interests in STEM often begin to take shape during the late elementary and middle school years (ages 10-15), a critical developmental window when students begin to align academic experiences with possible future selves (Tai et al., 2006; Maltese & Tai, 2011). Studies show that students who express STEM career intentions during these years are more likely to pursue STEM-related coursework and degrees later on (Archer et al., 2013; DeWitt & Archer, 2015). However, a substantial proportion of students, particularly from underrepresented groups, lose interest in STEM as they age (Sadler et al., 2012), pointing to a need for early and sustained interventions.

2.2 Self-efficacy as a motivational foundation

Self-efficacy—the belief in one's ability to perform specific tasks successfully—is one of the most robust predictors of students' engagement, persistence, and achievement in STEM (Bandura, 1997; Schunk & Pajares, 2002). Research demonstrates that students with high self-efficacy in science and math are more likely to persist in STEM coursework and express interest in STEM careers (Britner & Pajares, 2006; Wang & Degol, 2017). Furthermore, self-efficacy mediates the impact of other factors such as classroom climate, teacher support, and hands-on experiences (Liu et al., 2021). As Lent et al. (1994) Social Cognitive Career Theory posits, self-efficacy shapes both interest and outcome expectations, thus directly influencing career intentions.

2.3 Subject-specific attitudes and perceived value

Students' attitudes toward STEM subjects—such as enjoyment, perceived utility, and confidence—also strongly predict career interest. Positive attitudes toward science and engineering are often fostered through engaging instruction, inquiry-based activities, and real-world applications (Eccles & Wigfield, 2002; Osborne et al., 2003). However, mathematics presents a unique paradox: while it is frequently recognized as foundational for STEM careers, students often perceive it as abstract, difficult, or anxiety-inducing (Gaspard et al., 2015). This disconnect between perceived value and affective experience can weaken long-term interest in STEM, especially among students with low math self-efficacy.

2.4 Demographic and contextual moderators

Studies have consistently shown that demographic variables such as gender, socioeconomic status, and ethnic background interact with psychological constructs to shape STEM aspirations. For example, girls often report lower self-efficacy in STEM, even when their performance is equal to that of boys, resulting in lower persistence rates in advanced STEM coursework (Wang & Degol, 2013; Master, 2021). Access to high-quality STEM learning environments—including qualified teachers, hands-on projects, and mentorship—has been shown to mitigate these disparities (LaForce et al., 2016).

Furthermore, research highlights the importance of early, authentic exposure to STEM careers. Programs that connect students with real professionals, involve them in collaborative problem-solving, or simulate engineering design processes show positive effects on both attitudes and vocational identity (Nugent et al., 2015; Cannady et al., 2014).

2.5 Toward an integrated understanding

Given the multifaceted nature of STEM career interest development, scholars call for integrated models that link self-efficacy, disciplinary attitudes, and environmental supports. Structural equation modeling has been increasingly used to explore how these variables interrelate (Bottia et al., 2015; Simpkins et al., 2015). This study contributes to this literature by modeling how STEM self-efficacy influences students' career interest directly and indirectly via subject-specific attitudes, across early adolescence—a stage that is both understudied and developmentally crucial.

3. Theoretical framework

This study integrates two complementary theoretical perspectives: Bandura's Self-Efficacy Theory and Social Cognitive Career Theory (SCCT).

3.1 Self-efficacy theory

Self-efficacy theory (Bandura, 1997) posits that individuals' beliefs in their capabilities significantly influence their motivation, learning, and performance. These beliefs are shaped through four sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological states. In STEM education, students with high self-efficacy are more likely to take on challenging tasks, persevere through setbacks, and develop interest in related careers (Schunk & Pajares, 2002).

Empirical studies demonstrate the predictive power of self-efficacy on academic choices and persistence in STEM domains (Britner & Pajares, 2006; Liu et al., 2021). Self-efficacy not only affects students' engagement with STEM content but also moderates their emotional experience—transforming anxiety into resilience and disengagement into curiosity.

3.2 Social cognitive career theory (SCCT)

Social Cognitive Career Theory (SCCT), developed by Lent et al. (1994), extends Bandura's social cognitive framework by explicitly linking self-efficacy, outcome expectations, and interest development in career decision-making. According to SCCT, students' beliefs about their competencies and expectations of outcomes shape career interests. Environmental affordances, such as teacher support and resource availability, interact with personal variables like gender and grade level to influence career trajectories (Lent & Brown, 2006).

Within this framework, STEM career interest results from the triadic interaction of personal cognitive factors (e.g., self-efficacy), behavioral engagement (e.g., attitudes toward STEM), and contextual influences (e.g., social support). Studies show that these constructs collectively inform students' vocational interests and decisions (Wang & Degol, 2013; Nugent et al., 2015).

This study draws on SCCT to examine how STEM self-efficacy influences career interest indirectly through attitudes toward mathematics, science, and engineering/technology, and how these relationships may vary across student subgroups.

4. Research methodology

4.1 Research participants

The study employed a questionnaire-based survey as the primary method of data collection. Using convenience sampling, the researchers distributed 800 questionnaires to students in Grades 3 to 8 in a township school in northeastern China. A total of 734 valid responses were collected, representing a 91.75% response rate. The remaining 66 questionnaires were either invalid or not returned. Collected responses were compiled and analyzed using SPSS.

4.2 Research instruments

The questionnaire used in this study was adapted from the STEM scale developed by Unfried et al. (2015). It consisted of three sections: demographic information, attitudes toward STEM, self-efficacy, and STEM career interest.

4.2.1 STEM attitude

The attitude scale combined adaptations from Erkut & Marx (2005) and Unfried et al. (2015), with three subscales: mathematics, science, and engineering/technology. Each subscale consisted of four items assessing preferences, participation tendencies, and perceived usefulness, using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The internal consistency coefficients were: overall = 0.825, mathematics = 0.821, science = 0.759, and engineering/technology = 0.723. Fit indices for the confirmatory factor analysis (CFA) were: x^2/df = 1.671, GFI = 0.981, IFI = 0.987, TLI = 0.983, CFI = 0.987, RMSEA = 0.030.

4.2.2 STEM self-efficacy

Self-efficacy was measured using items from the Student Learning Conditions Survey (Friday Institute, 2010), consisting of seven items addressing organizational ability, action execution, and goal attainment in STEM contexts. Responses were scored on a five-point Likert scale. The internal consistency coefficient was 0.845. Fit indices were: x^2/df = 4.925, GFI = 0.974, IFI = 0.968, TLI = 0.952, CFI = 0.968, RMSEA = 0.073.

4.2.3 STEM career interest

Career interest was measured using a scale adapted from Faber et al. (2013), consisting of eight STEM-related career domains (e.g., zoology, medicine, computer science, physics, chemistry, energy, environment, engineering). Responses were scored on a four-point Likert scale (1 = Not Interested at All to 4 = Very Interested). The internal consistency coefficient was 0.819. Fit indices: x^2/df = 4.856, GFI = 0.962, IFI = 0.938, TLI = 0.913, CFI = 0.938, RMSEA = 0.073.

4.3 Data analysis

Basic data processing and correlation analysis were conducted using SPSS. Structural Equation Modeling (SEM) using AMOS was employed to explore the effects and pathways of STEM self-efficacy and attitudes on STEM career interest. The Bootstrap method was used to test the mediating role of STEM attitudes between self-efficacy and career interest.

5. Research results

5.1 Descriptive statistics and correlation analysis

Descriptive statistical analysis yielded the means and variances of participants' scores on STEM self-efficacy, STEM attitudes, and STEM career interest. Skewness and kurtosis values were also collected for each variable. As shown in Table 1, the absolute values of skewness were all less than 3, and the absolute values of kurtosis were all less than 10, indicating that the data followed a multivariate normal distribution and were suitable for further analysis.

Table 1. Descriptive statistics of research variables.

Variable	M ± SD	Skewness	Kurtosis
Math Attitude	3.32±0.92	-0.17	-0.34
Science Attitude	3.47±0.84	-0.31	0.22
Engineering/Technology Attitude	3.63±0.81	-0.33	0.29
STEM Self-Efficacy	3.68±0.74	-0.11	0.15
STEM Career Interest	2.60±0.66	0.10	0.05

Independent sample t-tests showed significant gender differences in STEM career interest: female students scored significantly higher than males. One-way ANOVA revealed significant differences by ethnicity and grade. Specifically, Mongolian students scored higher than Han students, and sixth-grade students reported the lowest interest across all grades. Post hoc LSD comparisons confirmed significant grade-level differences, with sixth grade being the turning point.

As shown in Table 2, female students demonstrated significantly higher levels of STEM career interest compared to male students. In terms of ethnicity, Mongolian students reported higher interest levels than Han students. Regarding grade-level differences, the average scores indicated a declining trend in STEM career interest from Grade 4 to Grade 6, followed by a gradual increase beginning in Grade 6. Further post hoc analysis using the LSD (Least Significant Difference) test revealed that Grade 6 students had the lowest scores in STEM career interest, while the differences among other grades were not statistically significant.

Table 2. Differences in STEM career interest by gender, ethnicity, and grade level.

Variable	Category	*n*	M ± SD	*t/F*
Gender	Male	350	2.43±0.61	-6.94***
	Female	384	2.75±0.66	
Ethnicity	Han	586	2.57±0.64	2.42*
	Mongolian	148	2.71±0.71	
Grade	Grade 3	122	2.61±0.67	2.94*
	Grade 4	162	2.71±0.77	
	Grade 5	168	2.51±0.58	
	Grade 6	119	2.46±0.66	
	Grade 7	68	2.66±0.59	
	Grade 8	95	2.65±0.56	

Notes:*$p<0.05$; **$p<0.01$; ***$p<0.001$

Correlation analysis was conducted among STEM self-efficacy, the three dimensions of STEM attitudes, and STEM career interest, as shown in Table 3. The results indicated that STEM self-efficacy, all three dimensions of STEM attitudes, and STEM career interest were significantly and positively correlated. These findings provide preliminary support for the research hypotheses and justify further analysis using structural equation modeling to examine the relationships among variables.

Table 3. Correlation matrix of variables.

Variable	1	2	3	4	5
1. Math Attitude	1				
2. Science Attitude	0.241***	1			
3. Engineering/Tech Attitude	0.374***	0.500***	1		
4. STEM Self-Efficacy	0.272***	0.455***	0.498***	1	
5. STEM Career Interest	0.222***	0.355***	0.414***	0.287***	1

Notes:*$p<0.05$; **$p<0.01$; ***$p<0.001$

5.2 Structural equation modeling analysis

Given the limitations of traditional regression analysis in examining multivariable relationships, this study employed Structural Equation Modeling (SEM) to test the relationships among the research variables. This approach allowed for a more comprehensive analysis of the effects of STEM self-efficacy and STEM attitudes on STEM career interest, as well as the practical pathways through which these effects may operate.

Following the two-step SEM procedure, the analysis began with an evaluation of the measurement model through Confirmatory Factor Analysis (CFA), which included five correlated latent factors. The model fit indices for the measurement model were as follows: x^2/df = 2.437, GFI = 0.925, IFI = 0.932, TLI = 0.924, CFI = 0.932, and RMSEA = 0.044. These results indicated that the measurement model fit the data well, supporting the validity of the factor structure.

In the second stage, a structural model was constructed to examine the hypothesized relationships among the variables. As shown in Fig. 1, the structural model yielded the following fit indices: x^2/df = 2.619, GFI = 0.919, IFI = 0.923, TLI = 0.914, CFI = 0.923, and RMSEA = 0.047. These values confirmed that the structural model also demonstrated a good fit with the data.

As shown in Fig. 1, seven path relationships among the study variables were found to be statistically significant. Specifically, STEM self-efficacy (STEM SE) showed significant positive correlations with science attitude (SA) (β=0.53, $p<0.001$), math attitude (MA) (β=0.32, $p<0.001$), and engineering/technology attitude (ETA) (β=0.56, $p<0.001$). However, the direct effect of STEM self-efficacy on STEM career interest (STEM CI) was not significant (β=-0.10, $p>0.05$). Both science attitude (β=0.26, $p<0.001$) and engineering/technology attitude (β=0.45, $p<0.001$) were significantly and positively associated with STEM career interest, while the effect of math attitude on STEM career interest was not significant (β=-0.01, p>0.05). Additionally, math attitude had a significant positive effect on both engineering/technology attitude (β=0.33, $p<0.001$) and science attitude (β=0.16, $p<0.001$).

To examine the significance of the mediating effects in the structural model, the study employed a bias-corrected percentile bootstrap method with 2,000 resamples within a 95% confidence interval. The results indicated that the confidence interval for the mediating effect of math attitude included zero, suggesting the mediation was not significant. In contrast, the confidence intervals for both engineering/technology attitude and science attitude did not include zero, indicating that these two variables had significant mediating effects.

Since the direct effects of STEM self-efficacy and science attitude on STEM career interest were not significant, it can be concluded that science attitude and engineering/technology attitude serve as full mediators in the relationship between STEM self-efficacy and STEM career interest. Similarly, they also fully mediate the relationship between math attitude and STEM career interest. Furthermore, the analysis revealed significant chain mediation effects between STEM self-efficacy and STEM career interest through the pathways of math attitude to science attitude and math attitude to engineering/technology attitude. Detailed results are presented in Table 4.

6. Discussion and conclusion

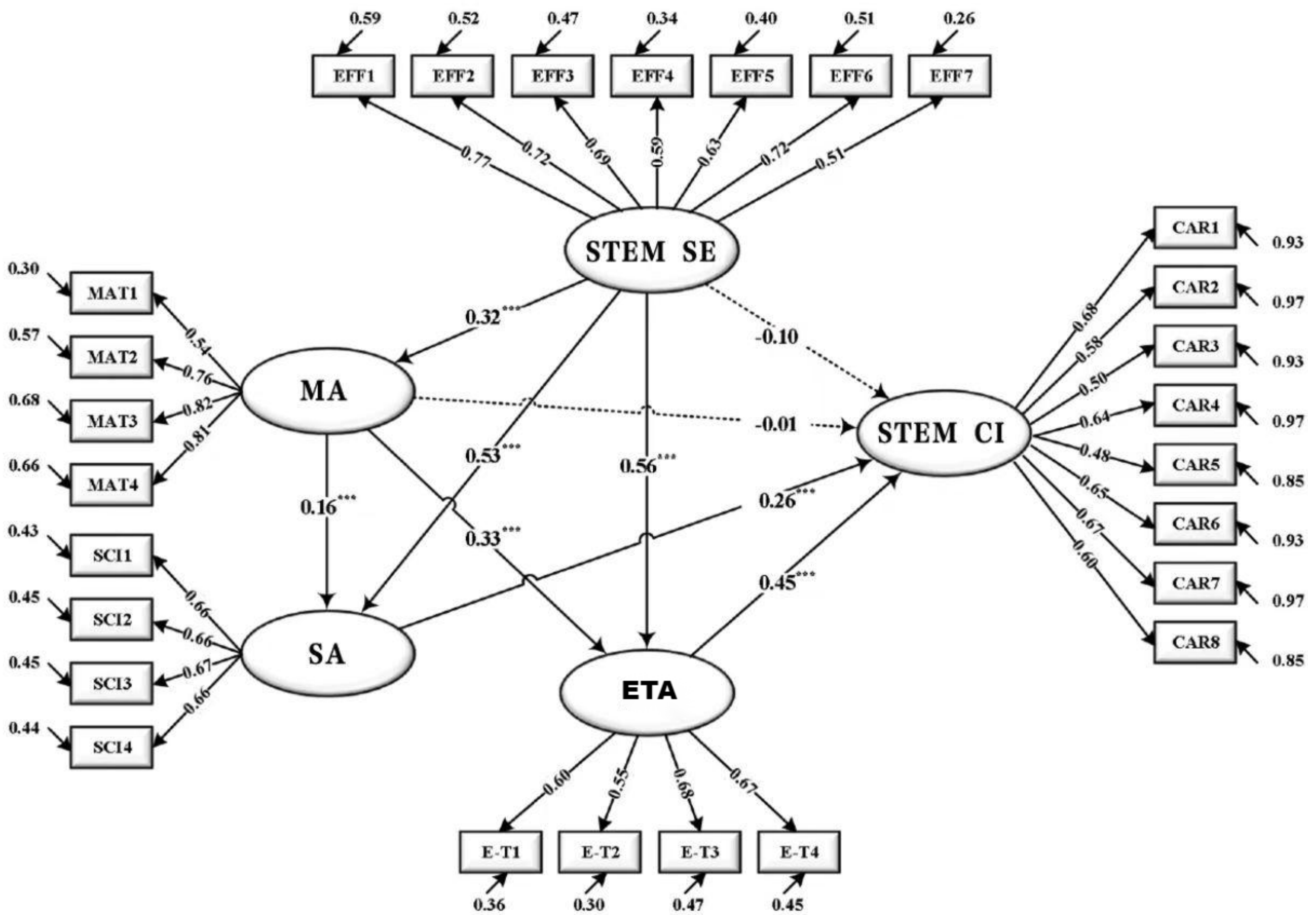

Fig. 1. Results of structural equation model analysis.

6.1 Gender differences in STEM career interest

Gender, as one of the key demographic factors, is often a focal point in studies exploring influences on students' STEM career interest. However, existing research presents conflicting findings. Some studies have reported no significant correlation between gender and middle school students' attitudes toward STEM learning in Grades 6 through 8 (Karakaya & Avgin, 2016). In contrast, other studies using STEM-related scales and semi-structured interviews with 22 middle school students found that only one-quarter of the female participants expressed interest in pursuing a STEM career, indicating a clear gender disparity (Sarı et al., 2018). Additional research has shown that male students tend to exhibit higher levels of interest in STEM careers compared to their female counterparts (Unfried et al., 2014).

However, the results of the present study suggest a significant gender difference in STEM career interest, with female students showing higher interest than male students—a finding that diverges from much of the existing literature. In this study, the proportion of male and female participants was relatively balanced, yet female students demonstrated a more positive inclination toward STEM careers. These differences may be attributed to contextual variations such as country, ethnicity, research setting, or methodological design. Given that this study administered surveys randomly to students in a township middle school, it is reasonable to speculate that certain local educational factors—particularly within that school's STEM education program—may have positively influenced female students' interest in STEM learning.

6.2 Grade-level differences in STEM career interest

In existing research on the influence of demographic characteristics on STEM attitudes and interests, some scholars have found that the classroom environment does not significantly affect students' interest in STEM. Moreover, other studies have similarly indicated no significant differences across grade levels (Yerdelen et al., 2016). However, contrasting findings also exist. For instance, Mahoney (2009) reported significant differences in STEM learning attitudes between ninth-grade and tenth-grade students.

In the present study, students' STEM career interest showed significant variation across grade levels. The data revealed an upward trend in interest from Grades 3 to 4, a decline beginning in Grade 4, and a renewed increase starting in Grade 6 and continuing into Grade 7. The fluctuation from Grades 7 to 8 was minimal. Post hoc multiple comparisons showed that sixth-grade students exhibited significantly lower

Table 4. Bootstrap test of mediating effects.

Pathway	Indirect Effect	Boot SE	95% Bias-Corrected CI	
			Boot Lower Bound	Boot Upper Bound
Self-Efficacy → Math Attitude → Career Interest	-0.004	0.013	-0.031	0.021
Self-Efficacy → Science Attitude → Career Interest	0.107**	0.029	0.059	0.173
Self-Efficacy → Eng./Tech Attitude → Career Interest	0.193**	0.045	0.118	0.295
Math Attitude → Science Attitude → Career Interest	0.028**	0.012	0.008	0.056
Math Attitude → Eng./Tech Attitude → Career Interest	0.101**	0.026	0.060	0.166
Self-Efficacy → Math Attitude → Science Attitude → Career Interest	0.010**	0.004	0.003	0.021
Self-Efficacy → Math Attitude → Eng./Tech Attitude → Career Interest	0.036***	0.010	0.020	0.063

Notes:*$p<0.05$; **$p<0.01$; ***$p<0.001$

levels of STEM career interest than students in other grades, while differences among the remaining grades were not statistically significant. These findings suggest that sixth grade may represent a critical turning point in students' STEM interest development and should therefore be a key focus for early career guidance and intervention efforts.

6.3 Relationships among variables

6.3.1 STEM self-efficacy and STEM attitudes

The analysis shows that STEM self-efficacy is significantly and positively correlated with students' attitudes toward science, mathematics, and engineering/technology—collectively referred to as STEM attitudes. This indicates that students' perceptions of their own abilities influence their attitudes toward STEM subjects. Enhancing students' self-efficacy also promotes the development of more positive STEM attitudes. This finding aligns with previous research, which has identified self-efficacy as a key determinant of individuals' acceptance and engagement with information technology. Individuals with high self-efficacy demonstrate more positive attitudes when facing challenges or striving to achieve goals compared to those with lower self-efficacy (Rahman et al., 2016).

Research in the domain of mathematics learning also indicates that self-efficacy not only significantly influences academic performance but plays a particularly crucial role in supporting students with lower achievement levels (He & Qi, 2018). Therefore, in the implementation of STEM curricula, boosting students' confidence in their ability to succeed in STEM subjects may serve as a powerful strategy for enhancing their long-term interest in STEM careers.

6.3.2 STEM attitudes and STEM career interest

Among the three dimensions of STEM attitudes, science attitude and engineering/technology attitude had significant positive effects on students' STEM career interest. Math attitude, however, did not show a direct effect. Nonetheless, further analysis revealed that math attitude significantly influenced both science and engineering/technology attitudes, suggesting that it contributes to career interest indirectly through these two domains.

This finding is consistent with previous research indicating that although students recognize the importance of mathematics and engineering knowledge for future careers, they are generally more willing to learn science and technology than math (Wang et al., 2020). This suggests that students form distinct but related attitudes toward each component of the STEM framework.

The lack of a direct correlation between math attitude and STEM career interest may be linked to the nature of mathematics instruction in test-oriented education systems. As students progress through the grades, the difficulty and complexity of math content increase, often leading to learning difficulties. Under pressure from teachers and parents, students may adopt serious attitudes toward learning math, yet fail to develop genuine interest in the subject.

6.3.3 STEM self-efficacy and STEM career interest

Academic self-efficacy and interest are both essential motivators for student learning. Although the present study found no significant direct effect of STEM self-efficacy on STEM career interest, self-efficacy significantly and positively influenced students' attitudes toward mathematics, science, and engineering/technology. These attitudes, in turn, served as mediators in the relationship between self-efficacy and career interest.

Given the interrelations among the three STEM attitude domains, self-efficacy was also found to indirectly influence STEM career interest through a chain mediation pathway: STEM self-efficacy enhanced math attitude, which subsequently influenced science and engineering/technology attitudes, ultimately shaping career interest. Bandura argued that the stronger a student's self-efficacy in a particular field, the stronger their interest in that domain. Other researchers have likewise posited a causal link between self-efficacy and career interest development (Guo & Jiang, 2003).

The present study supports this theoretical framework by showing that the impact of STEM self-efficacy on career interest is fully mediated by students' attitudes toward STEM subjects. This offers a new perspective on how self-efficacy and career interest are connected. In practice, educators can begin by building students' confidence in their ability to complete STEM-related tasks, thereby improving attitudes and ultimately enhancing career interest.

6.4 Summary of findings

In summary, this study identified gender, grade level, STEM self-efficacy, and STEM attitudes as key factors influencing the career interests of primary and middle school students. STEM self-efficacy had a direct positive effect on STEM attitudes, and through these attitudes, it indirectly influenced students' career interest. The findings suggest that students who rate their self-efficacy in STEM courses more highly tend to exhibit more positive learning attitudes and higher levels of STEM career interest.

Since career interest in STEM is a strong predictor of future career choices, efforts to cultivate talent in STEM fields must focus on fostering career interest during the early years of education. This study aimed to explore the mechanisms influencing STEM career interest among primary and secondary students and to provide theoretical guidance for the effective implementation of STEM curricula and the development of student engagement and motivation.

7. Implications and recommendations

This study offers valuable insights for educators, administrators, and policy-makers seeking to foster STEM career interest among primary and middle school students. Based on the empirical findings and theoretical underpinnings, the following recommendations are proposed:

7.1 Strengthen career-oriented STEM guidance in schools

Schools should play an active role in shaping students' awareness and understanding of STEM career pathways. Teachers need to be equipped not only with foundational STEM knowledge but also with the ability to inspire curiosity and guide students through career exploration. Targeted professional development programs should emphasize both pedagogical strategies and current developments in STEM industries.

Schools are encouraged to organize structured career exploration activities—such as STEM career days, expert panels, and university outreach events—to introduce students to real-world applications of STEM disciplines. Personalized counseling that takes into account students' backgrounds, interests, and family contexts can help bridge the gap between academic learning and vocational aspirations. Early access to information about STEM-related higher education opportunities and career trajectories is essential for shaping long-term interest.

7.2 Foster self-efficacy to build career interest

Although this study found no significant direct relationship between self-efficacy and career interest, the results underscore the crucial indirect influence of self-efficacy via STEM attitudes. Therefore, improving students' confidence in their STEM abilities should be a core component of instruction. Teachers can cultivate self-efficacy by providing mastery experiences, modeling effective problem-solving strategies, offering constructive feedback, and promoting a growth mindset.

Reducing performance anxiety and academic pressure—especially in mathematics—can help sustain engagement across grade levels. Creating emotionally supportive classrooms, designing appropriately challenging assignments, and celebrating small wins may enhance both academic confidence and vocational interest over time.

7.3 Promote active, experiential STEM learning

To transform attitudes and spark interest, students should engage in authentic, hands-on STEM activities. Schools should expand access to project-based learning, engineering design challenges, robotics clubs, and interdisciplinary STEM labs. These programs should connect classroom learning to real-world problems and emphasize inquiry, creativity, and collaboration.

Local governments and educational authorities can support this by building a national repository of effective STEM programs and facilitating partnerships among schools, universities, industry, and community organizations. Industry mentorships, field visits, and participation in STEM-related competitions can provide meaningful exposure that reinforces students' career aspirations.

7.4 Focus on critical developmental periods

The study's results identified Grade 6 as a turning point in STEM career interest. Interventions should be carefully timed to sustain students' motivation and prevent declines during this sensitive period. Educators should monitor attitude shifts and adapt instructional approaches to re-engage students who may begin to lose interest due to academic challenges or misaligned expectations.

Special attention should also be paid to gender-responsive strategies, as girls in this study demonstrated higher levels of STEM interest—contrary to much existing literature. Schools can leverage this momentum by ensuring that learning environments remain inclusive and supportive of all learners, especially during key transitional years.

Conflict of interest

The authors declare no conflict of interest.

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