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Gifted and talented students' intention to study and work in STEM fields: A multilevel structural equation modeling approach

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Abstract

This research analyzes the multilevel effects on the intention of gifted and talented students to pursue STEM studies and careers. Participants include 771 students and 43 teachers from a STEM-focused gifted and talented program. Nested data were collected using two questionnaires: one for students and one for teachers. The multilevel model consists of student-level and class-level factors. At the student-level, variables considered are student support, growth mindset, motivation in STEM, and intention to pursue STEM. At the class-level, variables include teacher support, teacher competencies in STEM for gifted and talented students, and classroom climate management for gifted and talented students in STEM. Findings reveal a good fit between the multilevel model and empirical data (CFI = 0.972, TLI = 0.960, RMSEA = 0.049). The causal model suggests that student motivation mediates the significant effect from growth mindset to intention. However, growth mindset has an insignificant direct effect on intention. Student support significantly affects intention but not motivation. At the class-level, teacher support significantly influences teacher competencies and classroom climate management. Teacher competencies significantly impact student motivation, while the effect of climate management on motivation is not significant. In summary, this research highlights the mediating role of motivation between growth mindset and intention. Student support influences intention, while teacher support affects competencies and classroom climate. Teacher competencies influence student motivation, but climate management's effect is not significant.

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Introduction

Gifted and talented students are often regarded as a nation's treasures, representing human capital with the potential to drive innovations that bolster economic growth. The definitions of "gifted" and "talented" students vary across national contexts and educational systems. In the academic discourse surrounding the definitions of "gifted" and "talented" students, three theories have prominently influenced many countries' perspectives: Gardner's Multiple Intelligence Theory (2003), Renzulli's Three-ring Conception of Giftedness (2016), and Gagné's Differentiated Model of Giftedness and Talent (2009). In Gardner's theory (Gardner, 2003), individuals can excel in specific intelligences, such as linguistic, logical-mathematical, or musical, among others, without being gifted in all areas. In Renzulli's model (Renzulli, 2016), high achievement does not equate to giftedness; a child must exhibit all three characteristics to be truly gifted. Gagné (2009) posits that natural giftedness, such as intellectual or musical, does not guarantee talent; external and internal factors help transform potential into expertise. The standard procedure for screening students for gifted and talented programs typically requires them to undertake assessments like the cognitive ability test, in addition to presenting evidence of their performance in their respective areas of giftedness (Sternberg, 2017). However, protocols may vary across different educational settings.

Developing gifted and talented students in Science, Technology, Engineering and Mathematics (STEM) fields is crucial for a country's overall development. Prior research has elucidated the significance of cultivating human capital in the realms of technology and innovation (Brockman & Roztocki, 2017; Kowal & Paliwoda-Paliwoda-Pękosz, 2017, Ludwig et al., 2016; Yang & Song, 2023). Nations with proficient human resources in mathematics, sciences, and technology have a higher likelihood of generating income through technological advancements, leading to economic growth. In Thailand, there is a longstanding focus on cultivating gifted and talented students in STEM fields. This includes specialized STEM schools, gifted programs in regular schools, and STEM skill development throughout the education system (Tsailexthim et al., 2015; Usanee, 2017).

Fostering the willingness of gifted and talented students to study and pursue careers in STEM is a significant developmental goal. It requires substantial investments in resources such as budget, equipment, and personnel. However, this investment is worthwhile if students with these skills continue to enhance their abilities through higher education and work opportunities. Researchers have emphasized the importance of variables at both the classroom and student levels in managing and promoting the educational development of gifted and talented students in STEM (e.g., Sternberg, 2017; Tirri, 2017).

At the classroom level, teachers with special competencies in managing, organizing learning processes, and providing emotional and social support play a crucial role. They create a positive learning environment that influences the development of talented students. At the student level, motivation to learn STEM, having a growth mindset, and receiving support are key variables in educational management for fostering intention to pursue STEM study and work.

This research presents the results of a multilevel factor analysis that examines the factors influencing student intention to pursue STEM fields. By understanding and addressing these factors, educational institutions and policymakers can better support the development of gifted and talented students in STEM, ultimately contributing to the country's progress and success.

Literature Review

According to the findings of prior research, factors that influence a student's decision to pursue a career in an area related to STEM can be divided into two categories: student factors and teacher factors. Student factors are: learning motivation, growth mindset, and support for gifted and talented students while teacher factors are teacher competencies and classroom climate management (Abe & Chikoko, 2020; Blotnick et al., 2018; Falco, 2017; Ketenci et al., 2020).

Intention to Study and Work in STEM Fields

The ultimate goal of gifted education in science, technology, and mathematics is to foster students' intention to study and pursue careers in STEM fields, emphasizing their self-driven interest in personal development within these domains. Student support structures, such as free access to education and academic and peer interactions, influence student decisions to continue studying and pursue careers in STEM (Sloan, 2020; Soldner et al., 2012). Sloan (2020) found that studying in specialized schools positively correlated with graduating in STEM education for female students. Soldner et al. (2012) demonstrated that support in academic and peer interactions directly affects student intention to study STEM. The intention to study and work in STEM is measured by two components: the intention to choose STEM for further studies and the intention to pursue a career in STEM (Lavigne et al., 2007; Potvin et al., 2020; Summers & Abd-EL-Khalick, 2018).

Learning Motivation, Growth Mindset, and Support for Gifted and Talented Students

Previous research has demonstrated the importance of study motivation in STEM education, as well as the role of student support structures in fostering motivation and academic success (Al-Dhamit & Kreishan, 2016; Esmaeili & Eydgahi, 2014; Lin et al., 2021. Additionally, growth mindset has been found to be linked to motivation and intention to study and work in STEM fields (Chen & Tutwiler, 2017; Cheng et al., 2017; Degol et al., 2018; Huang et al., 2019; Van Aalderen-Smeets et al., 2019). Finally, both family and school support play a crucial role in supporting gifted and talented students in their educational journey (Ecker-Lyster et al., 2021; Van Gerven, 2021). By examining these factors, we can gain insights into how to enhance STEM learning motivation and support for this unique group of students.

Learning motivation plays a significant role in STEM learning (Esmaeili & Eydgahi, 2014; Lin et al., 2021; Shin et al., 2017). According to Cavas (2011) and Tuan et al. (2005), in this study, learning motivation in STEM is measured by factors such as self-efficacy, value, goals, self-regulation, and the presence of a supportive environment. Shin et al. (2017) found a positive relationship between motivation to study careers in STEM and the decision to pursue STEM education in high school. This aligns with the findings of Esmaeili and Eydgahi (2014), where student motivations were positively correlated with STEM study intent. Additionally, Lin et al. (2021) identified intrinsic motivation as a significant influencer of career motivation in the field of artificial intelligence. Support structures, such as providing freedom of study, technology support, and family support, also contribute to student motivation. Hornstra et al. (2020) found that giving students freedom to study and addressing their individual needs increased motivation and satisfaction among gifted and talented students. Similarly, the use of technology to support learning and create engaging challenges can motivate students with unique abilities (Housand & Housand, 2012). Family support, excluding controlling behaviors, was found to have a positive impact on the motivation of gifted and talented students (Al-Dhamit & Kreishan, 2016).

Growth mindset, based on Dweck's Mindset Theory, refers to the belief that talent and intelligence can be developed and changed (Dweck, 2006; 2016). It positively influences attitudes, perspectives, and behaviors in learning and working. Individuals with a growth mindset believe in the malleability of their abilities and understand that effort, deliberate practice, and effective tactics can improve their competence. They embrace challenges and view failure as an opportunity for learning. Research has shown that growth mindset is related to motivation, STEM study and work intentions, and career choices. Studies by Chen and Pajares (2010), Chen and Tutwiler (2017), Cheng et al. (2017), Claro and Loeb (2019), Degol et al. (2018), Huang et al. (2019), and Van Aalderen-Smeets et al. (2019) consistently demonstrate the positive relationships between growth mindset and academic motivation, achievement, self-efficacy, and intentions to study and work in STEM fields.

Family and school support are crucial in promoting educational excellence among gifted and talented students (Van Gerven, 2021). Ecker-Lyster et al. (2021) highlight the role of parents in supporting educational management for excellence, including financial support, attention to education, and participation in school activities. Parental involvement and advocacy positively impact student progress and outcomes (Ecker-Lyster et al., 2021; Hansapiromchoke et al., 2015). School support entails creating a conducive learning environment that meets students' needs and provides assistance tailored to their requirements. Both family and school support contribute to fostering talent development in STEM.

Teacher Competencies and Classroom Climate Management

Teachers who are responsible for the education and development of gifted and talented students face various challenges in making progress for their students. The competence and abilities of these teachers have a significant impact on the learning environment and overall development of these students. Therefore, it is important to understand the key factors that influence the development of gifted and talented students, including the teacher competencies in organizing education, classroom climate management, and teacher support.

Research has shown that teachers need specific competencies to effectively educate gifted and talented students (Chan, 2011; Gomez-Arrizabalaga et al., 2016; Movieline, 2020; Tirri, 2017). These competencies include knowledge, attributes, and teaching skills for gifted and talented students. In the context of STEM education, teachers need to possess knowledge of educational management for gifted and talented students in STEM, necessary skills for teaching STEM subjects, and key characteristics that enable effective teaching for these students. Studies have found that the competence of teachers has a direct impact on student learning motivation (Schererer & Nilsen, 2016; Siegel et al., 2014). When students receive high-quality teaching, their interest in STEM subjects increases. Teachers with deep knowledge and wide-ranging abilities can better engage students and meet their individual needs, creating a more effective learning environment.

Creating a suitable learning environment is crucial for nurturing the education of gifted and talented students (Haidari et al., 2020; Türkman, 2020). Developing a learning environment for gifted and talented students in STEM involves establishing a classroom atmosphere that promotes learning in mathematics, science, and technology. This includes creating a sense of security, ensuring teacher approachability, and effectively managing the learning process. Previous studies (Akdağ & Koksal, 2022; Hansen, 1988; Kaya & Ataman, 2017; Supovitz & Turner, 2000) have demonstrated that trained teachers can create a better learning atmosphere for students. For example, professional development programs for teachers have been shown to improve classroom dynamics, reduce undesirable behavior, and enhance interactions between teachers and students. Teachers who participate in such programs tend to focus less on traditional lectures, prioritize student-centered approaches, and encourage advanced thinking processes. Additionally, the learning atmosphere fostered by teachers significantly impacts student learning motivation (Morrison et al., 2021). Supportive and attentive teachers who tailor their guidance to individual student interests while maintaining high standards and expectations create a learning environment that motivates students.

Teacher Support

Providing support for teachers is essential for developing gifted and talented students in STEM education (Hansapiromchoke et al., 2015; Jung et al., 2022; Van Gerven, 2021). This support includes knowledge exchange between teachers and students, fostering a conducive work environment, and enabling continuous professional development. Research has indicated that teacher support positively influences teacher competencies in educational management and the creation of a favorable learning environment (Hansen, 1988; Kaya & Ataman, 2017; Nedelson et al., 2012; Song & Zhou, 2021; Supovitz & Turner, 2000). Teacher training programs have been found to enhance teachers' abilities to teach, develop higher-order thinking skills, and improve self-awareness (Nedelson et al., 2012; Song & Zhou, 2021). The provision of support and resources allows teachers to effectively organize education for gifted and talented students (Hansen, 1988). For instance, training workshops have been shown to enhance teacher knowledge, teaching methods, and effectiveness in teaching STEM subjects. Teachers who undergo such training perceive themselves as more effective in their teaching, leading to improved outcomes for gifted and talented students.

In conclusion, the development of gifted and talented students in STEM education is influenced by various teacher factors. Teacher competencies in organizing education, classroom climate management, and the support they receive play crucial roles in creating an optimal learning environment. By continuously improving their knowledge, skills, and characteristics, teachers can effectively engage and motivate gifted and talented students. Additionally, creating a supportive classroom atmosphere and providing resources and professional development opportunities for teachers are essential for enhancing the education and development of these students.

A Proposed Model of Intention to Study and Work in STEM

According to previous studies, intention to study and work in STEM fields of gifted and talented students were influenced by factors which were divided into the individual and classroom (or teacher) level. At the student level, learning motivation played a significant role to increase their intention (e.g., Esmaeili & Eydgahi, 2014; Lin et al., 2021). Growth mindset and support from family and school encourage students to persevere and continuously improve (e.g., Claro & Loeb, 2019; Ecker-Lyster et al., 2021, Jung et al., 2022). Moreover, student support and growth mindset have similar effects on the motivation of STEM students (e.g., Chen & Tutwiler, 2017; Van Gerven, 2021).

Furthermore, teachers who can effectively support their development need to be capable of providing education for these students and creating a motivating learning environment. Teacher support, including knowledge management, professional development, and adequate resources, plays a crucial role in enhancing teacher capabilities and creating the right atmosphere

(Hansapiromchoke et al., 2015; Jung et al., 2022; Van Gerven, 2021). Therefore, both teachers' abilities and learning environment influence student motivation and their decision to pursue STEM education and careers (Hansen, 1988). The proposed model of the study is presented in Figure 1.

Methodology

Participants

Samples were divided into 2 groups, gifted and talented students, and teachers who taught in gifted and talented programs in STEM fields. Stratified random sampling by grade levels (grade 5–6, grade 7–9, and grade 10–12) and school sectors (public, private or demonstration school) were applied in both groups. Finally, 771 students and 43 teachers from Thai schools were samples of the study.

Measurements

The nested data for multilevel analysis were collected using 2 online questionnaires, student questionnaire and teacher questionnaire. Both questionnaires were designed for multilevel analysis. A student's data can be linked to their teacher data. The questionnaire for gifted and talented students consisted of 60 items for 4 factors, (1) student support (S_SSP) (e.g. My parents have provided support for my pursuit of studies in STEM), (2) student growth mindset (S_GMT) (e.g. I have been seeking challenges in STEM learning), (3) student learning motivation to study and work in STEM fields (S_MOT) (I am confident in my ability to study in STEM fields), and (4) student intention to study and work in STEM fields (S_INT) (e.g. I intend to continue my studies in the STEM fields as I advance to higher levels). All items in student's questionnaire were designed by using 5-level rating scale with moderate to high reliability ($\alpha = 0.733–0.978$). 85 items of the 5-level rating scale questionnaire for teachers were used for 3 factors, (1) teacher support (T_TSP) (e.g., Colleagues have supported me to teach in the gifted and talented program) (2) teacher competency on STEM teaching for gifted and talented students (T_COM) (I possess the requisite knowledge to instruct within gifted and talented programs), and (3) classroom climate management for gifted and talented students in STEM (T_CRM) (e.g., I have taken into consideration the feelings and opinions of all my students in the class), with high reliability ($\alpha = 0.863–0.976$).

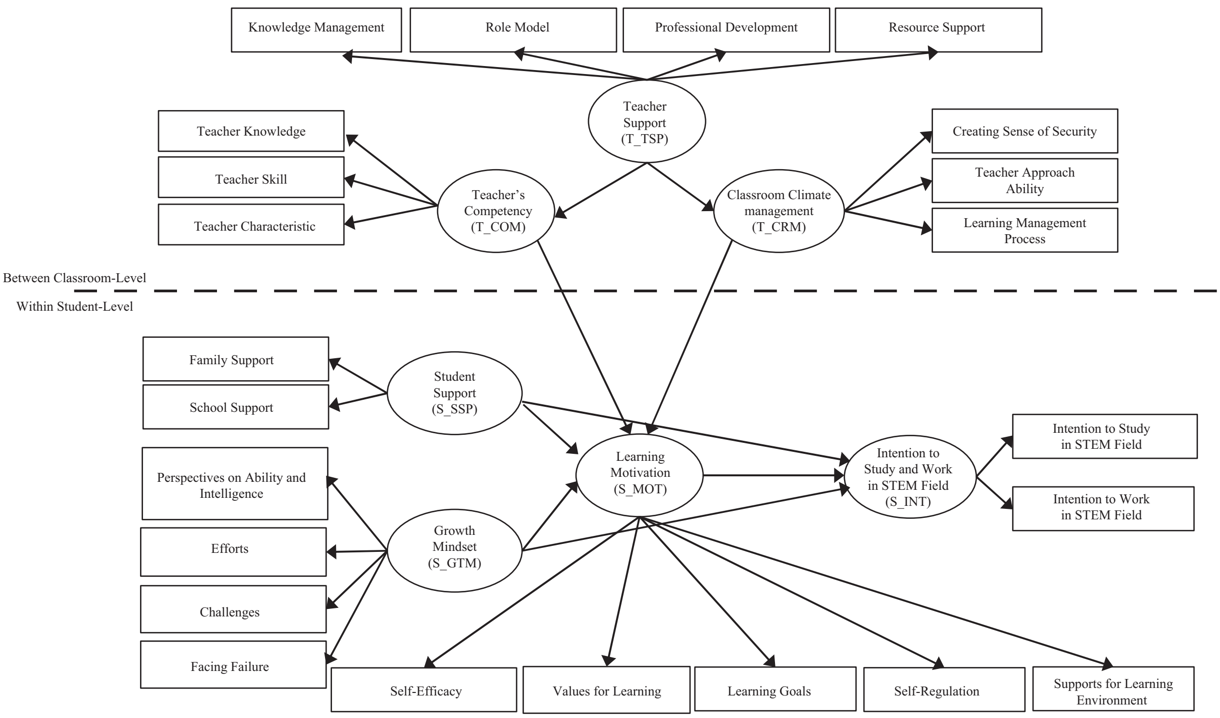

Figure 1 Model of multilevel structural equations of intent to choose to study and work in STEM (proposed model)

Data Collection

Target schools were identified through a random sampling process. To facilitate data collection, a set of tickets for logging in to appropriate online questionnaire was prepared. One set of tickets consisted of a ticket for a teacher and some tickets for students belonging to a particular teacher. Each ticket provided a username and password for a participant to log in at the homepage of the questionnaire website. These usernames were registered to link together between the students and teachers, which allowed us to pair answers of students with those of their teacher.

The number of set of tickets for a school depended on the number of its participants. A pack of ticket set was mailed to a designated teacher who agreed to be a collector of the school. Upon receiving the tickets, the collector distributed them to the selected participants. Participants had the freedom to answer their questionnaires using their smartphones or any computer in the school. Prior to accessing the questionnaire website, participants were provided with a guideline webpage to introduce them to the questionnaire.

Data Analysis

To compare students who were in the same classroom who would be same influenced by factors of their teacher. However, these effects should be different in each class. Therefore, to answer the research questions, data were analyzed using a multilevel structural equation model (MSEM) to predict the values in the proposed model using MPLUS version 8.8.

Results

Students' and teachers' background

When considering the students' background, findings have demonstrated that public school students had higher mean scores than those from other school sectors in almost all factors except growth mindset. However, as illustrated in Table 1, only mean scores of student support are significantly different at .05 level, among different school groups. Based on the data presented in Table 2, the mean sores for motivation and growth mindset in grade 1–6 students are significantly higher than those of other grade levels. In contrast, grade 10–12 students exhibit the highest mean scores in intentions to study and work in STEM fields.

The results, as depicted in Table 3, indicate that the mean scores of all teacher-related factors from one school sector are marginally higher than those from another sector; however, the difference is not statistically significant at the .05 level. This suggests that teachers from different school sectors do not exhibit significant differences in competencies, classroom climate management, and support.

Table 1 Mean comparison of intention, motivation, student support, and growth mindset between students who studied in different school sectors

Factors	Group	*N*	*M*	*SD*	*SE*	*SW*	*U*	*p*
Intention	Public school	489	3.72	0.99	0.05	.949***	65,225.50	.210
	Others	282	3.63	1.01	0.06			
	Total	771	3.69	1.00	0.04			
Motivation	Public school	489	3.53	0.74	0.03	.990***	65,293.00	.220
	Others	282	3.49	0.69	0.04			
	Total	771	3.52	0.72	0.03			
Student support	Public school	489	3.88	0.85	0.04	.962***	59,795.50*	.002
	Others	282	3.73	0.76	0.05			
	Total	771	3.83	0.82	0.03			
Growth mindset	Public school	489	3.96	0.77	0.04	.949***	68,912.50	.990
	Others	282	3.98	0.73	0.04			
	Total	771	3.97	0.75	0.03			

Note: Shapiro-Wilk (*SW*) was applied for normality test. Mann-Whitney U test (*U*) were applied for mean comparison between non-normality data. $^*p < .05$, $^{***}p < .001$.

Table 2 Mean comparison of factors of students who studied in different grade levels

Factors	Grade	*N*	*M*	*SD*	*SE*	*W*	Mean difference (Grade)		
							1–6	7–9	10–12
Intention	1–6	195	3.708	0.992	0.071	6.656***	(—)	0.179	-0.122
	7–9	285	3.529	1.04	0.062			(—)	-0.300***
	10–12	291	3.830	0.932	0.055				(—)
Motivation	1–6	195	3.769	0.751	0.054	15.467***	(—)	0.356***	0.324***
	7–9	285	3.414	0.731	0.043			(—)	-0.032
	10–12	291	3.446	0.654	0.038				(—)
Student support	1–6	195	3.993	0.789	0.056	7.044***	(—)	0.278***	0.165
	7–9	285	3.715	0.811	0.048			(—)	-0.113
	10–12	291	3.828	0.828	0.049				(—)
Growth mindset	1–6	195	4.127	0.707	0.051	8.064***	(—)	0.276***	0.158*
	7–9	285	3.851	0.787	0.047			(—)	-0.118
	10–12	291	3.969	0.734	0.043				(—)

Note: Welch's test (*W*) was applied for all of variables with heterogeneity of variances.
* $p < .05$, *** $p < .001$.

Table 3 Mean comparison of competency, classroom climate, and teacher support between teachers who studied in different school sectors

Factors	Group	*N*	*M*	*SD*	*SE*	*SW*	*U*	*p*
Competency	Public school	25	4.08	0.72	0.15	.898***	221.50	.941
	Others	18	4.18	0.43	0.10			
	Total	43	4.12	0.61	0.09			
Classroom climate management	Public school	25	3.86	0.86	0.17	.935*	218.00	.873
	Others	18	3.96	0.60	0.14			
	Total	43	3.90	0.75	0.12			
Teacher support	Public school	25	3.83	0.86	0.17	.933*	207.50	.675
	Others	18	4.03	0.60	0.14			
	Total	43	3.92	0.76	0.12			

Note: Shapiro-Wilk (*SW*) was applied for normality test. Mann-Whitney U test (*U*) was applied for mean comparison between non-normality data.
*$p <. 05$. ***$p < .001$.

Multilevel Model of Student Intention to study and work in STEM Fields

Results from 2-level model analysis of student intention to study and work in STEM fields are described in 2 parts: within student-level and between classroom-level. The final model has been fitted with the empirical data (CFI = 0.972, TLI = 0.960, RMSEA = 0.049, $SRMR_{wth} = 0.020$; $SRMR_{btw} = 1.775$). Considering within student-level results, student support (S_SSP) has a low direct effect on student intention to study and work in STEM fields (S_INT) with statistical significance at .05 level ($B = 0.264$, $p = .025$); however, it has a direct effect on student learning motivation to study and work in STEM fields (S_MOT) with statistical insignificance at .05 level ($B = 0.069$, $p = .555$).

Student learning motivation (S_MOT) acts as a mediator between student growth mindset (S_GTM) and student intention to study and work in STEM fields. Student growth mindset has a direct effect on student intention with statistical insignificance at .05 level ($B = -0.066$, $p = .615$); however, it has a significant moderate direct effect on student learning motivation at .05 level ($B = 0.698$, $p < .001$) while student learning motivation has a significant moderate direct effect on student intention ($B = 0.602$, $p < .001$). Moreover, the result indicates an indirect effect from student growth mindset to student intention through student learning motivation ($B = 0.420$, $p < .001$) with statistical significance at .05 level.

When considering the results from classroom-level, teacher support (T_TSP) has a statistically significant direct effect on classroom climate management for gifted and talented students in STEM (T_CRM) and teacher competency on STEM teaching for gifted and talented students (T_COM) at .05 level ($B = 0.883$, $p < .001$ and $B = 0.900$, $p < .001$ respectively). In addition, teacher competency has a statistically significant direct effect on student motivation ($B = 0.356$, $p < .025$), whilst classroom climate management of teachers has a statistically insignificant direct effect on student motivation ($B = -.224$, $p = .209$). The results are shown as Table 4 and Figure 2.

Table 4 The 2-level model of student intention to study and work in STEM fields

Path	*b*	*SE*	*B*	*p*
Within student-level				
1. S_SSP → S_MOT	0.056	.095	.069	.555
2. S_SSP → S_INT	0.367	.164	.264	.025
3. S_GTM → S_MOT	0.551	.081	.698	<.001
4. S_GTM → S_INT	-0.088	.176	-.066	.615
5. S_MOT → S_INT	1.021	.145	.602	<.001
6. S_SSP → S_MOT → S_INT	0.057	.095	.041	.547
7. S_GTM → S_MOT → S_INT	0.563	.116	.420	<.001
Between classroom-level				
1. T_TSP → T_COM	0.824	.083	.900	<.001
2. T_TSP → T_CRM	0.999	.089	.883	<.001
3. T_COM → S_MOT	0.323	.144	.356	.025
4. T_CRM → S_MOT	-0.241	.192	-.224	.209
5. T_TSP → T_COM → S_MOT	0.322	.146	.320	.027
6. T_TSP → T_CRM → S_MOT	-0.199	.159	-.198	.210
7. T_COM → S_MOT → S_INT	0.330	.144	.214	<.001
8. T_CRM → S_MOT → S_INT	-0.246	.169	-.135	.201
9. T_TSP → T_COM → S_MOT → S_INT	0.329	.146	.193	.025
10. T_TSP → T_CRM → S_MOT → S_INT	-0.203	.152	-.119	.208
Total effects				
Within student-level				
1. S_SSP → S_INT	0.424	(—)	.305	(—)
2. S_GTM → S_INT	0.475	(—)	.354	(—)
3. S_MOT à S_INT	1.021	(—)	.602	(—)
Between classroom-level				
1. T_COM → S_INT	0.330	(—)	0.214	(—)
2. T_CRM → S_INT	-0.246	(—)	-0.135	(—)
3. T_TSP → S_INT	0.126	(—)	0.073	(—)

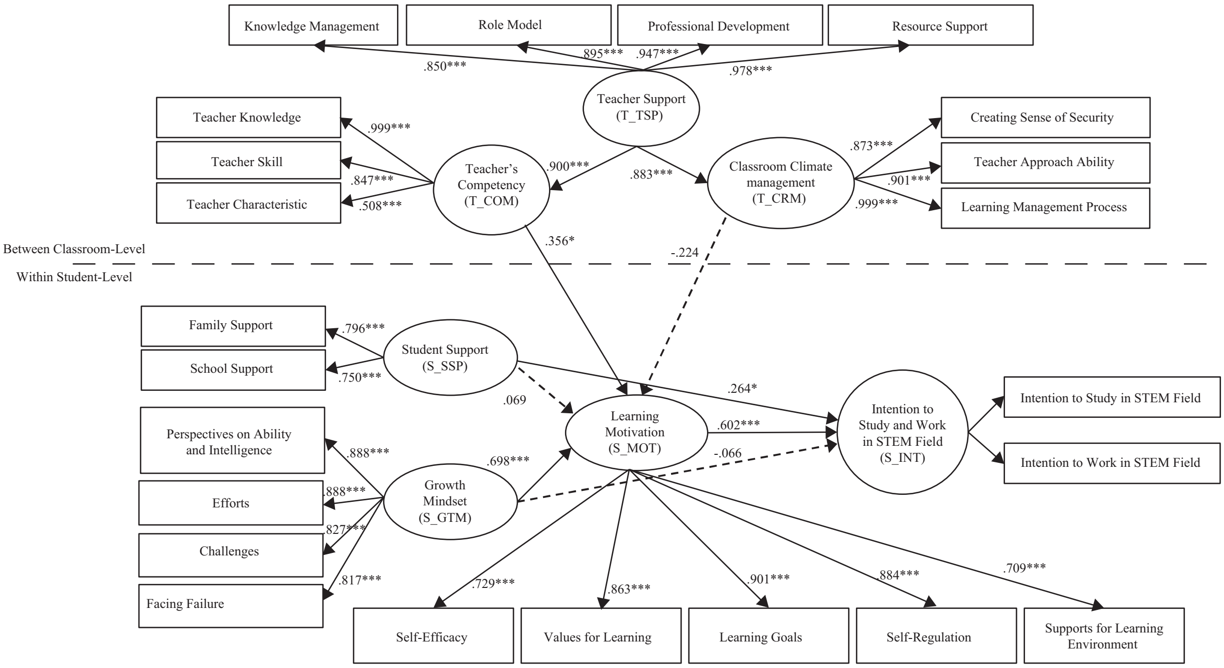

Figure 2 The 2-level model of student intention to study and work in STEM fields
Note: Statistically insignificant effects were presented in a dotted line.
$*p < .05$, $***p < .001$.

Discussion

The results of this study highlight the interconnections between classroom variables, student motivation, and support from family and institutions. These factors collectively influence student intention to pursue STEM education and careers. Teacher support and professional development emerged as crucial factors in fostering a positive classroom environment, aligning with previous studies (Kaya & Ataman, 2017; Nedelson et al., 2012; Song & Zhou, 2021). Enhancing teacher competencies can contribute to creating a conducive learning environment.

Factors such as family and institutional support, along with student motivation in STEM, play significant roles in influencing student intentions to pursue further education and employment in STEM fields. Student learning motivation has a stronger influence on intention compared to support from family and institutions. Previous research supports the positive correlation between student learning motivation and their intention to pursue STEM education (Esmaeili & Eydgahi, 2014; Lin et al., 2021; Shen et al., 2017). However, this study has found no notable impact of student support on their motivation for STEM learning. This finding contrasts with earlier research, which focused on different aspects of student support and varied contexts.

Growth mindset indirectly influences student intentions to pursue STEM education and careers through its impact on learning motivation. Students with growth mindsets tend to be more motivated, leading to a desire for further education and employment in STEM fields. Earlier studies have also supported the relationship between growth mindset and student intentions through self-efficacy (Huang et al., 2019; Van Aalderen-Smeets et al., 2019).

Teacher competencies in STEM teaching have a direct influence on student motivation for STEM learning. Teachers who possess knowledge, skills, and positive attitudes toward STEM education are more effective in stimulating student motivation. However, the study has found minimal to no impact of the learning environment on student motivation, contradicting previous research (Morrison et al., 2021). It is important to consider the diverse contexts of inclusive gifted and talented programs in each school in producing varied learning outcomes. Future research should explore the specific role of the school environment in shaping student motivation and climate.

Conclusion and Recommendation

This study highlights the importance of teacher support and professional development, along with student motivation and support from family and institutions, in shaping student intentions to pursue STEM education and careers. The findings suggest a need to focus on enhancing teacher competencies and creating a supportive learning environment to promote student motivation and foster interest in STEM fields.

According to research findings, having a growth mindset significantly influences student inclination to pursue careers and studies in STEM fields, with learning motivation acting as a mediator. To practically foster this mindset, schools should host regular growth mindset workshops and integrate real-life STEM challenges through project-based learning. Additionally, teachers should emphasize the value of the learning process over mere outcomes and facilitate peer-to-peer learning sessions. By implementing these strategies, schools can more effectively nurture students' passion for STEM disciplines. Furthermore, this study highlights the importance of teacher support in enhancing student learning motivation, and this can be achieved through the development of teacher competencies. To translate this into actionable measures, schools should initiate and invest in continuous professional development workshops for teachers, focusing on STEM pedagogy and best practices. Moreover, schools could facilitate mentorship programs where seasoned STEM educators guide their peers, sharing strategies and tools that have proven effective in enhancing student engagement and motivation.

Conflict of Interest

The authors declare that there is no conflict of interest.

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