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Research Article

Exploring the Impact of Teaching Self-Efficacy on Instructional Behaviors and Student Motivation in High School Mathematics: A Structural Equation Modeling Approach

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About Article

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ABSTRACT

The effect of teaching self-efficacy more especially, efficacy for classroom management, instructional techniques, and student engagement on instructional behaviors and learning motivation in high school mathematics education is examined in this study. To investigate the connections between these characteristics, a total of 625 participants (42.9% male and 57.1% female) high school math students was gathered using a structural equation modeling technique. The results show that greater degrees of teaching self-efficacy greatly improve student autonomy support, cooperative learning strategies, instructional clarity, and instructional support and feedback. Additionally, it was discovered that these teaching practices had a favorable impact on students' perceived task value in mathematics as well as their intrinsic and extrinsic motivation. According to the findings, developing teaching self-efficacy is essential for raising student motivation and refining instructional strategies. This study offers insightful information to educators and policymakers, emphasizing the necessity of focused professional development initiatives that increase teachers' self-efficacy in these crucial areas in order to enhance mathematical learning results.

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1. INTRODUCTION

One of the most important factors impacting instructional behaviors and the efficacy of teaching and learning methodologies in mathematics education is teaching self-efficacy, which is defined as educators' beliefs in their ability to support student learning and engagement (Bandura, 1997; Tschannen-Moran *et al.*, 2001; Tschannen-Moran, 2001). Teachers with high levels of self-efficacy are better equipped to manage classrooms, use a range of instructional tactics, and actively include students in the learning process (Pajares, 1996). Teachers' approaches to teaching mathematics and their relationships with students are greatly influenced by key aspects of teaching self-efficacy, such as efficacy for instructional strategy, classroom management, and student engagement (Guskey & teaching, 2002; Kurt *et al.*, 2014). Establishing a supportive and inspiring learning environment requires effective teaching practices like encouraging student autonomy, offering instructional assistance and feedback, and encouraging cooperative learning (Johnson & Johnson, 2009; Ryan & Deci, 2000). These actions have a significant impact on students' intrinsic and extrinsic motivation for studying in addition to improving the caliber of mathematics education. While extrinsic motivation, which is fueled by outside rewards, can be strengthened by constructive criticism and acknowledging students' efforts, intrinsic motivation, which is defined by a sincere interest in mathematics, thrives when teachers design interesting and pertinent learning experiences (Collins, 2009; Schunk & Zimmerman, 2012). Furthermore, the idea of subjective task value students' assessments of the significance and applicability of their learning assignments emerges as a crucial element in determining motivation and involvement in mathematics (Wigfield & Eccles, 2002). Developing successful teaching and learning strategies in mathematics education requires an understanding of the interactions among instructional behaviors, learning motivation, and teaching self-efficacy. In order to improve the educational experience for both instructors and students in mathematics classrooms, this project intends to investigate these linkages and offer insights that can guide instructional design and teacher training.

This study aims to address this gap by explicitly investigating the impact of teaching self-efficacy on instructional behaviors and student motivation. The central research question guiding this inquiry is: How does teaching self-efficacy influence instructional behaviors, and what is the subsequent effect on student motivation in high school mathematics? By employing structural equation modeling, this research seeks to provide a nuanced understanding of these dynamics, ultimately contributing to the development of targeted interventions that enhance both teacher effectiveness and student engagement in mathematics.

In conclusion, the importance of teaching self-efficacy in influencing instructional behaviors and learning motivation in mathematics education is emphasized in this introduction. It highlights the significance of several aspects of self-efficacy, successful teaching strategies, and the impact of both internal and external motivation on student involvement. By looking at these interrelated components, the study hopes to offer insightful information for enhancing instructional strategies and creating a more productive learning environment in math classes.

2. LITERATURE REVIEW

2.1. Teaching self-efficacy

Self-efficacy, a fundamental element of Bandura's (1999) social cognitive theory, is the conviction that one can plan and carry out the actions necessary to accomplish particular objectives (Bandura, 1999). According to the teaching viewpoint, self-efficacy is "beliefs in person's capabilities to organize and execute the courses of action required to produce given attainments." Teaching self-efficacy, as used in the context of education, refers specifically to a teacher's belief in their capacity to successfully engage students, manage classrooms, and apply instructional practices. It has been discovered that teaching self-efficacy beliefs can predict people's effort, perseverance in the face of adversity, self-monitoring and motivational skills, accomplishments, and life decisions (Bandura & Wessels, 1997; Bandura, 1999). For this reason, studies have been focusing on how teaching self-efficacy affects learning motivation, learning techniques, and instructional behaviors in order to improve students in academic contexts (Usher & Kober, 2012). The concept of teaching self-efficacy is essential to comprehending how educators view their capacity to affect classroom dynamics and student learning. It is separated into three smaller structures:

(a) Efficacy for Instructional Strategies: This sub-construct describes a teacher's confidence in their capacity to apply different teaching techniques and strategies in an efficient manner in order to promote learning. It includes having the self-assurance to create lessons, apply a variety of teaching strategies, and modify teaching methods to accommodate various student needs. Teachers with high efficacy in this area are more likely to experiment with innovative practices and persist in the face of challenges (Tschannen-Moran & Woolfolk Hoy, 2002).

(b) Efficacy for Classroom Management: This component focuses on how confident a teacher is in their capacity to preserve a positive learning environment. It covers techniques for setting ground rules, controlling student conduct, and fostering a supportive learning environment. In order to effectively teach and learn, teachers who feel proficient in classroom management are better able to deal with disruptions, encourage polite relationships, and create a sense of safety and order (Tschannen-Moran *et al.*, 2001, 2007).

(c) Efficacy for Student Engagement: This sub-construct relates to a teacher's confidence in their capacity to actively include students in the educational process. It includes techniques for inspiring pupils, increasing involvement, and promoting a feeling of control over their education. Teachers who are highly effective at engaging their students are more likely to design engaging and interactive lessons that pique students' attention and encourage deeper comprehension (Tschannen-Moran & Woolfolk Hoy, 2002). These three teaching self-efficacy sub-constructs work together to influence student results and a teacher's overall effectiveness. Higher work satisfaction, perseverance in the classroom, and better student achievement are all linked to high levels of self-efficacy in these domains.

One of the most important sources of teaching self-efficacy is thought to be mastery experiences. They speak of instructors' own experiences of success in their teaching methods, which support their confidence in their ability to instruct and run a classroom. Teachers' self-efficacy is increased when they successfully engage pupils, apply methods, and control classroom dynamics. On the other hand, a string of failures may cause them to lose faith in their own teaching abilities and results (Tschannen-Moran & Woolfolk Hoy, 2002). Because they offer verifiable proof of a teacher's efficacy and strengthen their abilities, mastery experiences are especially potent. Teachers develop resilience and a greater feeling of self-efficacy when they face and overcome obstacles in their work, which can enhance their ability to teach and improve student outcomes (Tschannen-Moran & Woolfolk Hoy, 2002).

According to Bandura (1977), vicarious experiences are the process of learning by watching others, especially when people are around peers or role models and observe their achievements and mistakes. In educational contexts, this type of learning is especially important because it allows students to gain self-efficacy the conviction that they can accomplish particular tasks by seeing their peers' overcome obstacles.

According to research, children are more likely to believe in their own potential when they witness individuals who are similar to them succeed through hard work and persistence (Schunk, 1989). For example, a student may feel more confident in their own abilities to solve similar problems if they witness a classmate grasp a challenging math idea. This phenomenon emphasizes how crucial it is to have a safe space for learning where students may exchange stories and gain knowledge from one another.

Furthermore, modeling in instructional strategies might improve vicarious experiences. Teachers can cultivate a culture of cooperation and support by purposefully showcasing peer success stories. Through the incorporation of vicarious learning opportunities into the curriculum, educators can greatly increase students' self-efficacy, which will improve their academic performance and ability to bounce back from setbacks (Bandura, 1997).

Since verbal persuasion entails the support and affirmation of mentors, peers, and teachers, it is essential to the growth of self-efficacy. As stated by (Bandura, 1997), verbal persuasion has the power to increase someone's self-confidence, which in turn affects their motivation and output. Teachers who express confidence in their students' abilities can boost their self-efficacy, which in turn encourages more involvement and perseverance in learning activities. According to research, students' opinions of their own talents can be greatly impacted by constructive criticism and positive reinforcement.

For instance, when teachers express confidence in a student's skills or provide affirming comments about their progress, students are more likely to internalize these messages and develop a stronger belief in their own capabilities (Schunk & Quarterly, 2003). This procedure is especially crucial in difficult areas where students could question their own skills. Improved academic results can result from verbal persuasion, which can help allay these fears and promote a growth mentality.

Additionally, verbal persuasion is frequently more powerful when it is personalized and particular. For instance, a teacher might say, "I believe you can solve this problem because you have successfully tackled similar ones before," as opposed to just saying, "You can do this." This specificity offers a clear path for future success in addition to reaffirming the student's prior accomplishments (Hattie & Timperley, 2007).

Teachers' confidence can be boosted by this type of persuasion, particularly when it comes from leaders or esteemed peers in the educational community. Teachers can overcome self-doubt and be inspired to take on new tasks or use creative teaching techniques by receiving positive reinforcement and encouragement. But it's crucial to remember that the reliability of the source and the situation in which the criticism is delivered frequently determine how successful verbal persuasion is. (Tschannen-Moran & Woolfolk Hoy, 2002) .

All things considered, teachers' self-efficacy beliefs are greatly influenced by verbal persuasion, which enhances their efficiency in the classroom and fosters professional development.

According to self-efficacy theory (Bandura, 1999), people's self-efficacy is influenced by their prior successes and failures (Williams & Rhodes, 2016). In this way, instructors' teaching self-efficacy is strengthened by successful teaching experiences while it is weakened by unsuccessful teaching experiences. In fact, the most significant source of teaching self-efficacy is mastery experiences (Da'as *et al.*, 2021), which is supported by several studies (Fackler *et al.*, 2021). It appears that SDT-based learning settings support teachers' growth in self-efficacy as educators. According to SDT, people are not driven to act until their basic needs for relatedness, competence, and autonomy are satisfied (Ryan, 2024), whereas, in self-efficacy theory, people do not perform actions unless they believe that they are capable to do so (Williams & Rhodes, 2016). However, how a social context fulfils people's needs is likely to foster their self-efficacy. For instance, positive feedback provided to satisfy the need for competence (Ryan & Deci, 2024) can also function as the verbal persuasion source of self-efficacy (Da'as *et al.*, 2021). In this respect, teachers can enhance their teaching self-efficacy when their teacher educators provide constructive feedback to support their need for competence (Pitkäniemi *et al.*, 2024);. Another relationship between the two motivational theories can be seen when teacher educators support teachers' need for relatedness through promoting cooperative learning. In so doing, teachers can engage in group work, peer discussion, peer teaching, and peer feedback, which results in the four sources of teaching self-efficacy (Sabanci *et al.*, 2023). However, little is known about how SDT-based instructional behaviors improve teachers' teaching self-efficacy (Bandura, 1999). Researchers have extensively examined the impact of teaching self-efficacy on instructional behaviors, student motivation, and academic performance (Usher & Kober, 2012).

Give a brief explanation of the relevance of these structures rather than just listing them. The ability of a teacher to modify classes to meet the needs of their pupils and ensure successful information transfer is reflected in the effectiveness of instructional tactics. Keeping the classroom in order and creating a positive learning atmosphere are essential components of effective classroom management. The goal of effective student engagement is to inspire and actively involve students in the educational process (Tschannen-Moran & Woolfolk Hoy, 2002) .

2.2. Instructional behaviors

Effective teaching serves as the foundation for proper instruction behaviors, which in turn support student learning actions. Instructional behaviors are instructional styles or physical education (Borich, 1974). Defines an effective physical education teacher as one who: accommodates each student's individual needs by choosing from a wide range of student-centered instructional approaches; maximizes practice opportunities; teaches in small groups; restricts competition; and makes use of the right kinds and quantities of equipment and space to encourage self-directed learning (Morris, 2019). Self-determination theory is one hypothesis that has been connected to students' motivation to learn (SDT) (Ryan, 2024), which holds that when people believe their basic psychological needs for autonomy (i.e., a sense of ownership in their actions or behaviors), competence (i.e., the feeling of mastery), and relatedness (i.e., a sense of belonging and connectedness) are met, they are inspired to take actions toward psychological growth (Ryan, 2024). The construct of instructional behavior encompasses various dimensions that significantly influence student learning and engagement. It can be divided into four key sub-constructs: instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning. Each of these sub-constructs plays a vital role in creating an effective learning environment.

Instructional Clarity: This sub-construct refers to the clarity with which teachers present information and concepts. Instructional clarity involves clear explanations, well-structured lessons, and the use of appropriate examples to facilitate understanding. Research indicates that when teachers provide clear and organized instruction, students are more likely to grasp complex concepts and achieve better academic outcomes (Hattie *et al.*, 2009).

Instructional Support and Feedback: This dimension emphasizes the importance of providing timely and constructive feedback to students. Effective feedback helps students understand their progress, identify areas for improvement, and reinforces their learning. According to Hattie and Timperley (2007), feedback is one of the most powerful influences on student achievement, as it guides learners in their efforts and fosters a growth mindset.

Instructional Support for Student Autonomy: This sub-construct focuses on promoting student independence and self-regulation in the learning process. When teachers support student autonomy, they encourage learners to take ownership of their education, set personal goals, and engage in self-directed learning. Research suggests that fostering autonomy can enhance motivation and lead to deeper learning experiences (Ryan & Deci, 2000).

Instructional Support for Cooperative Learning: This dimension highlights the importance of collaborative learning experiences. Instructional support for cooperative learning involves structuring group activities that promote teamwork, communication, and shared problem-solving. Studies have shown that cooperative learning can enhance student engagement, improve social skills, and lead to higher academic achievement (Johnson & Johnson, 2009).

2.3. Learning motivation

A complex concept, learning motivation has a big impact on students' involvement, perseverance, and academic success. The two main types of motivation intrinsic and extrinsic have a significant impact on how students feel and act when completing assignments. Our knowledge of learning motivation is further enhanced by the idea of subjective task value, which refers to how students judge the significance and applicability of a task. The desire to participate in an activity because it brings about feelings of fulfillment and delight is known as intrinsic motivation. According to (Deci & Ryan, 1985), higher levels of creativity, more in-depth learning, and more perseverance in the face of difficulties are all linked to intrinsic motivation. Students that are intrinsically motivated are more likely to pursue opportunities for inquiry and mastery as well as self-directed learning (Ryan & Deci, 2000). Fostering intrinsic motivation has been linked to better academic results, according to research, since students who find personal significance in their education are more inclined to devote time and effort to their studies (Meece & Agger, 2018; Schunk, 2008; You *et al.*, 2016).

Conversely, extrinsic motivation entails doing something in order to obtain benefits from outside sources or stay away from unfavorable outcomes. Although extrinsic incentive can successfully encourage students to finish assignments, it can occasionally erode intrinsic motivation, especially when rewards are seen as dominating (Deci *et al.*, 1999a; Deci *et al.*, 1999b). However, extrinsic rewards can improve motivation and performance when they are in line with students' individual objectives and interests (Eisenberger & Cameron, 1996). For instance, providing recognition or praise for effort can reinforce students' engagement without diminishing their intrinsic interest in the subject matter.

A crucial element of motivation is subjective task value, which is the learner's assessment of a work's significance, usefulness, and interest. According to (Eccles & Wigfield, 2002), subjective task value influences students' choices, effort, and persistence in learning activities. When students perceive a task as valuable and relevant to their goals, they are more likely to engage deeply and persist through challenges. This idea emphasizes the significance of contextual elements in motivation since teachers can raise students' subjective task value by relating course materials to their interests and real-world applications (Pintrich, 2003).

In conclusion, the literature underscores the critical interconnections between teaching self-efficacy, instructional behaviors, and learning motivation, particularly within the context of high school mathematics education. Research consistently demonstrates that teachers with high self-efficacy are more likely to employ effective instructional strategies, manage classrooms effectively, and engage students actively (Bandura, 1997; Tschannen-Moran *et al.*, 2001). These instructional behaviors not only enhance the learning environment but also significantly contribute to fostering student motivation, both intrinsic and extrinsic (Schunk & Zimmerman, 2012).

Moreover, the reciprocal nature of this relationship suggests that as students become more motivated, their engagement can further bolster teachers' self-efficacy, creating a positive feedback loop that benefits the educational experience (Pajares, 1996; Schunk & Zimmerman, 2012). The importance of providing instructional support, feedback, and opportunities for student autonomy and cooperative learning is also highlighted as essential components that enhance motivation and learning outcomes (Johnson & Johnson, 2009; Ryan & Deci, 2000).

The combination of these results highlights the necessity of focused professional development that actively fosters student motivation in addition to improving instructors' self-efficacy and instructional strategies. To better understand the principles behind successful teaching and learning in mathematics education, future research should keep examining these dynamics, especially in varied educational environments.

2.4. Present study and research questions

In the context of teaching mathematics in high school, the current study is to investigate the reciprocal links among teaching self-efficacy, instructional practices, and learning motivation. This study aims to give a thorough grasp of how these characteristics interact and influence one another, eventually affecting student learning outcomes, by using structural equation modeling (SEM). Understanding these relationships is crucial for creating effective teaching tactics and raising student engagement in mathematics, given the crucial roles that teachers and students play in the educational process.

The following research questions have been developed to direct this study:

i. How do the instructional behaviors, self-efficacy, and learning motivation of high school math teachers relate to each other?

By answering these research questions, the study hopes to add to the body of knowledge already available on educational psychology and offer perspectives that can guide professional development and teacher training initiatives, ultimately improving the standard of mathematics instruction in high schools.

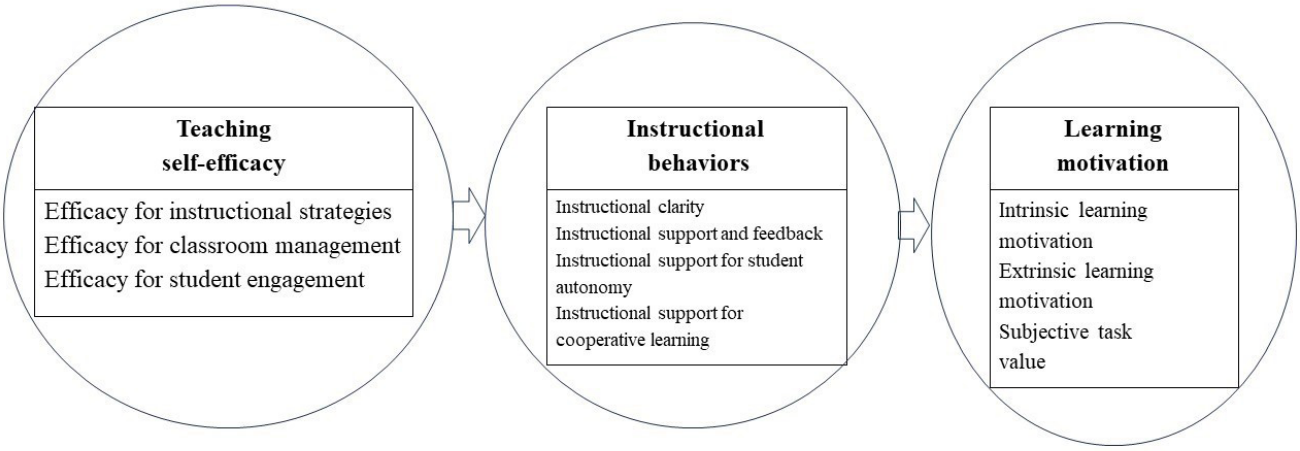

Figure 1. Conceptual model for the connection between learning motivation, instructional actions, and teaching self-efficacy

3. METHODOLOGY

3.1. Participants

A sample of 625 high school math students from 8 schools in Kampong Cham Province, Cambodia participated in the study. A stratified random sample technique was used to choose participants in order to guarantee a varied representation of students in terms of factors like age (16–20), gender, and gender. A Process Questionnaire, which was created to evaluate many facets of teaching self-efficacy, instructional practices, and learning motivation, was used to gather data. In addition to measures of instructional clarity, support and feedback, support for student autonomy, cooperative learning, intrinsic, extrinsic, and task value, the questionnaire also asked about the effectiveness of instructional tactics, classroom management, and student engagement.

Structural Equation Modeling (SEM) was then used to examine the connections between learning motivation, instructional behaviors, and teaching self-efficacy.

3.2. Measurements

A wide range of metrics were used in the study to evaluate different aspects of efficacy pertaining to teaching methods and student motivation. These metrics were created to represent the complex relationship between student participation in the learning process and the efficacy of instruction.

Efficacy for Instructional Strategy: This measure evaluated teachers' confidence in their ability to implement effective instructional strategies that enhance student learning. It was based on the work of (Tschannen-Moran *et al.*, 2001), who developed a framework for measuring teachers' self-efficacy in various domains, including instructional practices.

Efficacy for Classroom Management: Teachers' confidence in their capacity to properly control classroom conduct was the main focus of this survey. It contained resources for creating a supportive learning environment and upholding student discipline, based on the findings of (Evertson & Weinstein, 2013a, 2013b), which emphasizes the importance of classroom management in promoting student learning.

Efficacy for Student Engagement: Teachers' opinions on their ability to actively include students in the learning process were evaluated using this measure. It was based on the research of (Fredricks *et al.*, 2011; Fredricks *et al.*, 2004; Sharan & Tan, 2008), who identified engagement as a critical factor in student achievement and motivation.

Instructional Clarity: This assessment looked at how well lessons were structured and how well explanations were used in the delivery of teaching. It was founded on the ideas presented by (Hattie & Gan, 2011; Witter & Hattie, 2024), which stress how crucial good communication is to improving learning outcomes and student comprehension.

Instructional Support and Feedback: This metric evaluated the degree to which educators offer students helpful criticism and assistance. It continued to (Hattie & Timperley, 2007; Lipsch-Wijnen & Dirkx, 2022), studies that demonstrate how feedback significantly affects students' learning and performance.

Instructional Support for Student Autonomy: This metric assessed how well teachers support students' learning autonomy and self-control. It was disclosed by (Ryan & Deci, 2024; Ryan *et al.*, 2008). According to the self-determination theory, fostering autonomy increases engagement and intrinsic motivation.

Instructional Support for Cooperative Learning: This measure focused on the extent to which teachers facilitate collaborative learning experiences among students. It was based on (Johnson & Johnson, 2008) work on cooperative learning, which emphasizes the benefits of teamwork and collaboration in educational settings.

Intrinsic Learning Motivation: This measure assessed students' intrinsic motivation to learn, capturing their interest in and enjoyment of the learning process. It was based on the framework developed by (Ryan & Deci, 2024), which identifies intrinsic motivation as a key driver of engagement and academic success.

Extrinsic Learning Motivation: This assessment looked at students' extrinsic motivation, concentrating on their desire to learn in order to receive benefits from outside sources or to stay out of trouble. It was influenced by studies on motivation conducted by (Deci & Ryan, 1985), which explores the dynamics between intrinsic and extrinsic factors.

Subjective Task Value: Students' opinions of the significance and applicability of the assignments they complete were assessed using this metric. It was predicated on (Eccles & Wigfield, 2002) model of success motivation, which highlights how students' decisions and perseverance in learning activities are influenced by their subjective task value.

Through the use of these several metrics, the study sought to establish a thorough grasp of how instructional efficacy and student motivation interact, ultimately assisting in the creation of efficient teaching strategies that improve learning outcomes for students.

3.3. Measurement tools

The Study Process Questionnaire is one of the often utilized instruments (SPQ) (Biggs *et al.*, 2001; Biggs, 1978) , the Learning Process Questionnaire (LPQ) (Biggs *et al.*, 2001; Biggs, 1978). The researchers first modified the original English scales, and two multilingual Cambodian researchers subsequently translated them into Khmer. We converted the scales back into English using the translated version. Prior to gathering data, we contrasted the scales' Khmer and English versions to see whether each item.

36 grade 12 students completed the Khmer version of the scales, which had 63 items. The validity and reliability of each item were assessed through a pilot test, and each student was interviewed in person to obtain feedback after completing all the surveys. Second, 625 grade 12 students from several high schools in Kampong Cham province (Private, Public School, Urban, and Non-urban) completed 63 items on the Khmer version of the scales. Public school = (7) Urban (4=347), non-urban (3=242), private school (1=36).

Factor analysis and concept validity (convergent and divergent/ discriminant validity) will be used to verify the validity of the data collected. The third step is to consult with validity, followed by structural equation modeling (SEM) and internal consistency reliability (Cronbach's Alphas, construct/composite reliability). Response bias may result from the self-report method we utilized in this study to gauge subjective opinions about the items in each modified scale. Each item on each measure was rated by students using a 5-point Likert scale, with 1 denoting "strongly disagree" and 5 denoting "strongly agree."

Confirmatory factor analysis (CFA) was used to ensure that the subconstructs were appropriate for the Cambodian teacher setting and to verify the construct validity of the model. We looked for multicollinearity and a normal distribution prior to the CFA. The skewness and kurtosis of each item were used to determine the data's normal distribution (Cohen *et al.*, 2018), (Hair *et al.*, 2024). The most commonly used values for skewness and kurtosis are −1 to +1 and −1.96 to +1.96, respectively (Hair *et al.*, 2024). In this study, the skewnesses and kurtoses of all the items used ranged between -0.01 and + 0.03 and between -0.03 and +0.03, respectively.

The multicollinearity occurs when the intercorrelation between variables or items is higher than 0.83 (Kline, 2024).The Shapiro-Wilk test and Kolmogorov Smirnov test, but for sample smaller then 300; Sig.> .05= normal distribution and Z score are -3 and +3= no outliers (Kline, 2024). The multicollinearity occurs when the intercorrelation between variables or items is higher than 0.90 (Kline, 2024). The intercorrelations in the present study ranged between 0.08 and 0.71, which eliminates multicollinearity problems. According to (Hair *et al.*, 2024), construct validity is ensured by assessing convergent and discriminant validities. In so doing, the average variance extracted (AVE), maximum shared variance (MSV), and average shared variance (ASV) were calculated and compared. The AVE should be greater than the MSV and the ASV to ensure acceptable discriminant validity, which indicates that the construct is different from other constructs, and 0.50 or higher to suggest adequate convergent validity, which indicates that a set of measured items share a high proportion of variance in the same construct (Hair *et al.*, 2024). The subconstructs in this study had AVEs larger than 0.50, and each subconstruct's AVE was higher than its MSV and ASV. Additionally, 36 items with factor loadings less than 0.50 were eliminated for desired internal consistency, and cross-loadings were prohibited to guarantee dimensionality (Hair Jr *et al.*, 2019). The construct reliabilities of the subconstructs ranged from 0.83 to 0.90, surpassing the recommended threshold of 0.70, while the standardized loadings for the items used ranged from 0.56 to 0.86, beyond the recommended threshold of 0.50 (Hair Jr *et al.*, 2019). Demonstrating how the 10 subconstructs might fit the context of teacher and student education in Cambodia.

Table 1. Pearson's correlations and descriptive statistics for latent variables (N = 625)

	EIS	ECM	ESE	IC	ISF	ISSA	ISCL	ILM	ELM	TV
EIS	—									
ECM	0.233***	—								
ESE	-0.028	0.021	—							
IC	0.286***	0.348***	-0.062	—						
ISF	0.322***	0.283***	-0.061	0.488***	—					
ISSA	0.381***	0.267***	-0.069	0.400***	0.553***	—				
ISCL	-0.031	0.004	0.388***	-0.045	-0.083*	-0.068	—			
ILM	0.368***	0.207***	0.008	0.237***	0.336***	0.395***	-0.047	—		
ELM	0.315***	0.125**	-0.029	0.220***	0.289***	0.355***	-0.011	0.473***	—	
TV	0.101*	0.173***	-0.000	0.265***	0.188***	0.182***	-0.034	0.287***	0.249***	—

Noted that EIS stands for instructional techniques, ECM for classroom management, and ESE for student engagement. IC = Clarity of instruction, IM stands for intrinsic motivation, EM for extrinsic motivation, STV for task value, SF for support and feedback, AS for autonomy support, and SCL for support for cooperative learning.
*Note. * p < .05, ** p < .01, *** p < .001*

3.4. Teaching self-efficacy

Teaching self-efficacy metrics were modified from (Skaalvik & Skaalvik, 2016; Tschannen-Moran *et al.*, 1998) (Appendix A). We tapped teachers' teaching self-efficacy through their perceived efficacy for instructional strategies (5 items, e.g., "my math teacher uses a satisfying teaching method", SD = 0.491, α = 0.703), perceived efficacy for classroom management (5 items, e.g., "My math teacher can control my annoying behavior with other students.", SD = 0.498 α = 0.718), and perceived efficacy for student engagement (5 items, e.g., "My math teacher helps me and other students understand the value of learning", SD = 0.561, α = 0.748). The construct reliabilities for efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement were SD = 0.491, α = 0.703, SD = 0.498, α = 0.718, SD = 0.561, α = 0.748, respectively.

3.5. Instructional behaviors

Our instructional behavior metrics were modified from several studies (Cabrera *et al.*, 2001; Feldman, 1986; Heng & Practice, 2014; Lam *et al.*, 2007; Marsh *et al.*, 2006; Marsh *et al.*, 2012; Norton *et al.*, 2005; Tani *et al.*, 2021) (Appendix B). We assessed instructional behaviors through teachers' perceptions of teacher educators' instructional clarity (5 items, e.g. "My math teacher explained the purpose of the lesson clearly", SD = 0.529, α = 0.694) (Norton *et al.*, 2002); instructional support and feedback (5 items, e.g. "My math teacher advises me when I have a problem with lesson content or homework.", SD = 0.627, α = 0.679) (Heng, 2014), instructional support for student autonomy (5 items, e.g. "mathematics teacher accept student suggestions when designing assignments", SD = 0.739, α = 0.673) (Lam & Aman, 2007), and instructional support for cooperative learning (5 items, e.g. "My math teacher discusses ideas with me and the other students in the group.", SD = 0.504, α = 0.742) (Tani *et al.*, 2021). The construct reliabilities for instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning were SD = 0.529, α = 0.694, SD = 0.627, α = 0.679, SD = 0.739, α = 0.673, SD = 0.504, α = 0.742, respectively.

3.6. Learning motivation

Learning motivation measures were modified from earlier research (García & Pintrich, 1991; Hilpert *et al.*, 2012; Hilpert *et al.*, 2013), (see Appendix C). Mathematic students' learning motivation was measured through their perceived intrinsic learning motivation (5 items, e.g. "In this education course, I prefer course content from which I can learn new things", SD = 0.612, α = 0.689) (Pintrich, 1991), perceived extrinsic learning motivation (5 items, e.g. "In this education course, if I can, I want to get better grades than most of my classmates", SD = 0.731, α = 0.701) (Pintrich, 1991), and perceived subjective task value (5 items, e.g. "I will be able to use what I learn in this education course in my future teaching career", SD = 0.521, α = 0.721) (Hilpert *et al.*, 2012). The construct reliability values for intrinsic learning motivation, extrinsic learning motivation, and subjective task value were SD = 0.612, α = 0.689, 0.86, 0.87, SD = 0.731, α = 0.701, SD = 0.521, α = 0.721, respectively.

3.7. Data analysis

To investigate the connection between elements of teaching instructional behaviors and teaching self-efficacy, structural equation modeling was used.

We evaluated the direct path coefficients connecting the three sub-constructs of teaching self-efficacy, instructional practices, and learning motivation in order to answer our study objectives.

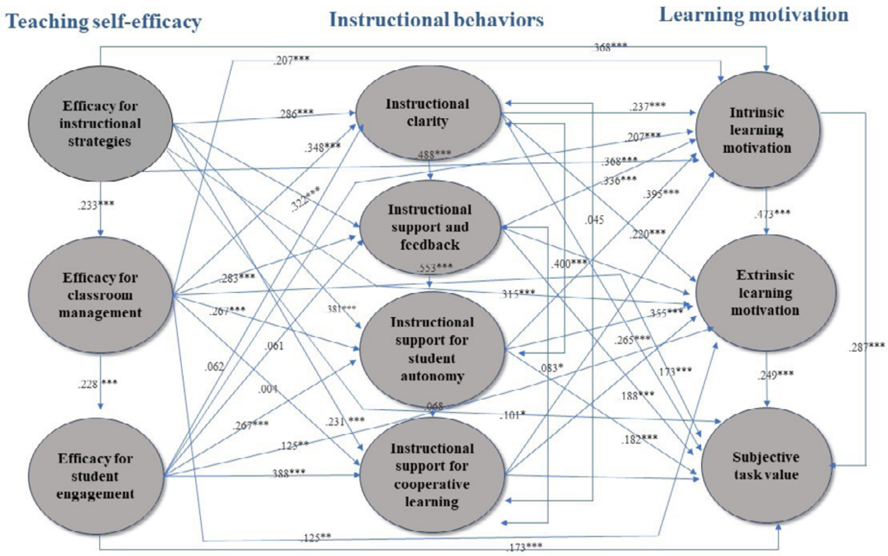

Figure 2. TSE is for teaching self-efficacy, where EIS, ECM, and ESE stand for instructional techniques, classroom management, and student engagement, respectively. Behaviors of instruction (IC = Clarity of instruction). ISSA stands for instructional support for student autonomy, ISCL for cooperative learning, IC for instructional clarity, and ISF for instructional support and feedback. Learning motivation (STV = Subjective task value, ELM = Extrinsic learning motivation, and ILM = Intrinsic learning motivation).

4. RESULTS AND DISCUSSION

Table 1 Pearson's correlations between latent variables and descriptive statistics (N = 625). Perceptions of intrinsic motivation, extrinsic motivation, and task value were positively connected with perceptions of the effectiveness of instructional strategies, classroom management, student engagement, instructional clarity, support and feedback, autonomy support, and support for cooperative learning. Perceived intrinsic and extrinsic motivation were positively connected with task value perception. Figure 1 Provide the conceptual framework for the connection between learning motivation, instructional behaviors, and teaching self-efficacy. Figure 2 The effect of teaching self-efficacy on instructional behaviors (IC = Instructional clarity) (EIS = efficacy for instructional methods, ECM = efficacy for classroom management, and ESE = efficacy for student engagement). Learning motivation (ILM = intrinsic learning motivation, ELM = extrinsic learning motivation, STV = subjective task value) and instructional clarity (IC = instructional clarity, ISF = instructional support and feedback, ISSA = instructional support for student autonomy, ISCL = instructional support for cooperative learning). The overall fit of the final model was excellent, Exact Fit RMSEA 90% CI: χ^2=1627, df=998, p<.001. Fit Measures: CFI=0.947, TLI=0.943, SRMR=0.0382, RMSEA=0.0272, Lower=0.0249, Upper=0.0295, AIC=57167, BIC=57953. The model accounted for a large portion of the variance in the outcomes (R2 = 0.146 and 0.195 for efficacy for instructional strategies, efficacy for classroom management, efficacy for student engagement, R2 = 0.250, 0.56, and 0.231 for affective intrinsic motivation, extrinsic motivation and task value, respectively. Table 2 direct, indirect, and total associations the perception of support and feedback was positively associated with students' R2 = 0.250, 0.56, and 0.231 for affective, intrinsic motivation, extrinsic, task value (ß = 0.027). The perception that teachers' behaviors promote cooperative learning was associated positively with students' intrinsic motivation (ß= 0.73), extrinsic motivation (ß= 0.73) and task value (ß= 0.73). While support for cooperative learning was the most significant determinant of learning motivation, support and feedback were the strongest predictors of intrinsic motivation among the measures of teaching self-efficacy, efficacy for classroom management, efficacy for student engagement, and instructional behaviors.

These findings provide compelling evidence that enhancing teachers' self-efficacy can lead to improved instructional practices, which in turn significantly boost student motivation in high school mathematics. This research not only contributes to the theoretical understanding of these dynamics but also has practical implications for teacher training and professional development programs aimed at fostering self-efficacy among educators.

Table 2. Direct, indirect, and total associations for Figure 2.

				Standardized coefficient (β)				
Type	**Effect**	**Estimate**	**SE**	**Lower**	**Upper**	**β**	**z**	**p**
Indirect	Efficacy for classroom management ⟹ Instructional clarity ⟹ Efficacy for instructional strategies	0.03354	0.01535	0.00345	0.06363	0.03400	2.1847	0.0289
	Efficacy for classroom management ⟹ Instructional support feedback ⟹ Efficacy for instructional strategies	0.02898	0.01362	0.00228	0.05568	0.02938	2.1276	0.0334
	Efficacy for classroom management ⟹ Instructional support student autonomy ⟹ Efficacy for instructional strategies	0.06821	0.01528	0.03827	0.09816	0.06915	4.4646	8.02e0-6
	Efficacy for classroom management ⟹ Instructional support cooperative learning ⟹ Efficacy for instructional strategies	4.22e-6	1.51e-4	-2.92e−4	3.00e-4	4.28e-6	0.0279	0.9777
	Efficacy for student engagement ⟹ Instructional clarity ⟹ Efficacy for instructional strategies	-0.00592	0.00413	-0.01402	0.00218	-0.00677	-1.4325	0.1520
	Efficacy for student engagement ⟹ Instructional support feedback ⟹ Efficacy for instructional strategies	-0.00601	0.00439	-0.01462	0.00260	-0.00688	-1.3683	0.1712
	Efficacy for student engagement ⟹ Instructional support student autonomy ⟹ Efficacy for instructional strategies	-0.01692	0.00914	-0.03483	9.99e-4	-0.01935	-1.8507	0.0642
Component	Efficacy for student engagement ⟹ Instructional support cooperative learning ⟹ Efficacy for instructional strategies	-3.88e−4	0.01335	-0.02655	0.02578	-4.44e−4	-0.0291	0.9768
	Efficacy for classroom management ⟹ Instructional clarity	0.37132	0.03978	0.29335	0.44928	0.34918	9.3342	0.0000
	Instructional clarity ⟹ Efficacy for instructional strategies	0.09033	0.04020	0.01154	0.16911	0.09738	2.2471	0.0246
	Efficacy for classroom management ⟹ Instructional support feedback	0.35824	0.04826	0.26367	0.45282	0.28421	7.4239	1.14e-13
	Instructional support feedback ⟹ Efficacy for instructional strategies	0.08090	0.03643	0.00950	0.15231	0.10339	2.2207	0.0264
	Efficacy for classroom management ⟹ Instructional support student autonomy	0.39842	0.05711	0.28648	0.51036	0.26818	6.9758	3.04e-12
	Instructional support student autonomy ⟹ Efficacy for instructional strategies	0.17121	0.02946	0.11346	0.22896	0.25787	5.8106	6.23e0-9
	Efficacy for classroom management ⟹ Instructional support cooperative learning	-0.00379	0.03733	-0.07695	0.06936	-0.00375	-0.1016	0.9191
	Instructional support cooperative learning ⟹ Efficacy for instructional strategies	-0.00111	0.03832	-0.07622	0.07399	-0.00114	-0.0291	0.9768
	Efficacy for student engagement ⟹ Instructional clarity	-0.06554	0.03525	-0.13464	0.00355	-0.06955	-1.8593	0.0630
	Efficacy for student engagement ⟹ Instructional support feedback	-0.07429	0.04276	-0.15810	0.00952	-0.06651	-1.7372	0.0823
	Efficacy for student engagement ⟹ Instructional support student autonomy	-0.09882	0.05061	-0.19802	3.85e-4	-0.07506	-1.9523	0.0509

	Efficacy for student engagement ⇒ Instructional support cooperative learning	0.34839	0.03308	0.28356	0.41322	0.38834	10.5327	0.0000
Direct	Efficacy for classroom management ⇒ Efficacy for instructional strategies	0.09941	0.03865	0.02365	0.17517	0.10078	2.5719	0.0101
	Efficacy for student engagement ⇒ Efficacy for instructional strategies	5.27e-4	0.03439	-0.06687	0.06792	6.03e-4	0.0153	0.9878
Total	Efficacy for classroom management ⇒ Efficacy for instructional strategies	0.23015	0.03839	0.15491	0.30539	0.23333	5.9951	2.03e0-9
	Efficacy for student engagement ⇒ Efficacy for instructional strategies	-0.02871	0.03402	-0.09539	0.03797	-0.03284	-0.8439	0.3987

$^{*}p < .05$; $^{**}p < .01$.

4.1. Discussion

The results of this study shed light on the complex and mutually reinforcing interactions that exist between learning motivation, instructional practices, and teaching self-efficacy in high school mathematics education. According to the findings, teachers who have higher levels of self-efficacy are more likely to use teaching strategies that work, which in turn increases student motivation. This is consistent with previous research that highlights how crucial teacher perceptions are in determining classroom dynamics and student results (Klassen & Chiu, 2010; Tschannen-Moran *et al.*, 2001).

The study shows a link between students' motivation and teachers' self-efficacy, indicating that teachers' self-efficacy may rise in tandem with students' motivation. This win-win situation emphasizes how crucial it is to provide a nurturing learning atmosphere where teachers and students may flourish. There are important ramifications for educational practice; professional development programs ought to give teachers tools to increase student motivation and their own sense of self-efficacy at the same time (Bandura, 1997; Tschannen-Moran *et al.*, 2001; Tschannen-Moran, 2001)

In conclusion, this study contributes to our understanding of the complex relationships that exist between teaching self-efficacy, instructional methods, and learning motivation. By recognizing and addressing these connections, educators and policymakers can develop targeted interventions that enhance high school math instruction's instructional efficacy and student learning outcomes.

4.2. Limitations and suggestions for practice

First, the study's dependence on self-reported measures for teaching self-efficacy and instructional activities may introduce response bias. Due to social desirability bias or ignorance, teachers may overestimate their own skills or the efficacy of their teaching strategies (Podsakoff *et al.*, 2003). Future studies could triangulate results and offer a more thorough understanding of these dimensions by including different data sources, such as student feedback or classroom observations, to increase the validity of the findings (Creswell & Plano Clark, 2011; Yin, 2018). Researchers can learn more about the dynamics of teaching self-efficacy and instructional techniques by employing a mixed-methods approach.

Second, the ability to deduce causal links between the variables is limited by the cross-sectional nature of the study. While structural equation modeling can be used to analyze complicated relationships, causation cannot be proven (Kline, 2015). Longitudinal studies are advised in order to pinpoint plausible causal pathways and better understand how these correlations evolve over time (Shadish *et al.*, 2002).

Furthermore, the study's sample might not be representative of all high school math teachers and pupils because it might only include those from particular demographic or geographic groups. Future research should aim for a more varied sample in order to improve the findings' generalizability across different educational environments (Creswell & Plano Clark, 2011). Researchers can gain a deeper understanding of the dynamics of learning motivation, instructional methods, and teaching self-efficacy in various contexts by involving a wider range of participants.

Finally, this study focuses on high school mathematics education, even if the dynamics of teaching self-efficacy, instructional techniques, and learning motivation may vary between disciplines and educational levels. Future research might look at these relationships in a range of educational settings, including as elementary and middle schools, as well as in other subjects like language arts or science. According to research, comprehending these dynamics across various academic disciplines and levels can offer important insights into successful teaching strategies and student involvement (Wang *et al.*, 2019; Eccles & Wigfield, 2002). Teachers can create more thorough solutions that address the particular needs of students in different disciplines by investigating these links in a variety of contexts.

Improving Teacher Self-Efficacy: Increasing teachers' self-efficacy in teaching mathematics should be a top priority for professional development programs. Teachers might feel more secure in their skills by attending workshops that offer ideas for classroom management, effective teaching practices, and student engagement (Darling-Hammond *et al.*, 2017; Tschannen-Moran & Woolfolk Hoy, 2001). According to research, teachers are more likely to use successful teaching techniques that enhance student learning outcomes when they receive focused training and assistance (Guskey, 2002; Hattie, 2009). We may establish a more productive and encouraging learning environment for children by making investments in the professional development of instructors.

Putting Effective Teaching Strategies into Practice: Teachers of mathematics should use research-based teaching techniques that foster comprehension and clarity. Different learning styles can be supported and instructional clarity greatly improved by employing strategies including technology integration, visual aids, and problem-solving process modeling (Hattie, 2009; Marzano, 2007). According to research, children can better grasp the procedures involved in solving mathematical problems by modeling problem-solving processes, and visual aids can assist give abstract concepts a more tangible form (Miller & McGowan, 2015). Furthermore, incorporating technology into the classroom can offer dynamic and captivating educational opportunities that accommodate different learning styles (Baker *et al*., 2016). Teachers can establish a more productive and inclusive learning environment for all students by implementing these tactics.

Giving Constructive Feedback: Promoting student development and learning in mathematics classes requires establishing a feedback culture. Teachers should give students timely, targeted feedback to help them with their learning. According to research, students' motivation and performance can be greatly increased by receiving feedback that emphasizes effort and development (Hattie & Timperley, 2007). Teachers can assist students in viewing problems as chances for improvement by promoting a growth mindset, which holds that students' talents can be developed through commitment and hard work (Dweck, 2006). This method fosters resilience and a positive attitude toward learning in addition to academic success.

Encouraging Student Autonomy: teachers ought to give pupils the chance to take charge of their own mathematical education. Project-based learning, giving students options for problem-solving exercises, and promoting self-evaluation can all help achieve this. According to research, students are more likely to be intrinsically motivated and exhibit higher levels of engagement and persistence in their learning when they feel a feeling of autonomy (Deci & Ryan, 2000; Patall *et al*., 2008). Giving students alternatives in their education encourages accountability and a commitment to their academic path.

Promoting Cooperative Learning: Using cooperative learning techniques in math classes can improve student participation and encourage teamwork. Students can develop a supportive learning community and learn from one another through group projects, peer tutoring, and cooperative problem-solving exercises (Johnson & Johnson, 2009; Slavin, 2014). In addition to encouraging social connection, these techniques support students' growth in communication and critical thinking abilities, two things that are crucial for success in mathematics.

Making the Connection Between Mathematics and Practical Uses: Math teachers should make an effort to relate mathematical ideas to students' interests and real-world circumstances in order to increase the subjective task value. By making mathematics more interesting and relevant to students' daily lives, this relevance can boost both intrinsic and extrinsic motivation (Lave & Wenger, 1991; Boaler, 2016). According to research, pupils are more likely to value and interact with mathematics when they observe its real-world applications (NCTM, 2000).

Building a Positive Learning Environment: It's critical to establish a classroom culture that views mistakes as a necessary part of learning and promotes taking risks. Teachers can encourage pupils to have a growth mindset, which recognizes that perseverance and hard work increase mathematics skills (Dweck, 2006). Research shows that students' confidence and motivation to tackle difficult mathematical ideas can be increased in a supportive learning environment (Blackwell *et al*., 2007).

By using these suggestions, educators can create a more effective and motivating arithmetic learning environment. In addition to increasing teacher self-efficacy, this strategy encourages student achievement and engagement, which eventually improves mathematics education results (Hattie, 2009; Darling-Hammond *et al*., 2017). According to research, students are more likely to participate actively and reach greater knowledge levels when teachers use effective instructional tactics and foster a supportive learning environment in the classroom (Marzano, 2007; Zepeda, 2012). Teachers can have a big impact on their own professional development and their students' academic achievement by making these activities a priority.

5. CONCLUSION

To sum up, research on learning motivation, instructional strategies, and teaching self-efficacy shows a complex and mutually reinforcing relationship that is critical to raising the educational outcomes of high school mathematics. According to research, teachers who have high levels of self-efficacy in instructional tactics, classroom management, and student engagement are more likely to use successful teaching methods that create a supportive learning environment (Tschannen-Moran & Woolfolk Hoy, 2001; Bandura, 1997). Additionally, teachers who are confident in their skills are better able to inspire pupils, which raises student achievement and engagement (Schunk, 1991; Klassen & Chiu, 2010). These findings demonstrate how important it is to increase instructors' self-efficacy in order to improve their instructional methods and raise math proficiency. In particular, students' intrinsic and extrinsic motivation for learning is greatly increased when teachers are able to assist and provide feedback on their learning, encourage student autonomy, and facilitate cooperative learning (Deci & Ryan, 2000; Ryan & Deci, 2000). According to research, teachers are more likely to establish an engaging learning environment that promotes student motivation and participation when they are confident in their teaching methods (Tschannen-Moran & Woolfolk Hoy, 2001; Zepeda, 2012). This emphasizes the necessity of professional development initiatives that boost educators' self-efficacy in order to improve math learning outcomes for students.

The study also highlights how intrinsic learning motivation which is defined as a sincere interest in the subject matter is significantly impacted by teachers' ability to engage students and give insightful feedback (Deci & Ryan, 2000). On the other hand, extrinsic motivation which is fueled by praise and rewards from outside sources can also be improved by good teaching techniques (Ryan & Deci, 2000). Since students are more likely to be motivated and involved when they believe that their learning activities are pertinent to their lives and goals, the idea of subjective task value becomes critical in this situation (Eccles & Wigfield, 2002). In order to improve total student engagement, this emphasizes the significance of instructional tactics that not only promote intrinsic motivation but also emphasize the usefulness of learning tasks.

It is plausible that when students' motivation increases, their increased engagement will increase teachers' self-efficacy, creating a positive feedback loop that enhances both teaching and learning. This is because these interactions are reciprocal. Increased student involvement has been shown to improve instructors' self-efficacy by raising their judgments of their own efficacy (Tschannen-Moran & Woolfolk Hoy, 2001). This emphasizes how important it is for professional development programs to focus on enhancing teachers' self-efficacy and teaching skills while also fostering student enthusiasm and engagement (Darling-Hammond *et al.*, 2017; Guskey, 2002). These initiatives have the potential to improve educational outcomes by establishing a nurturing atmosphere that encourages the development of both teachers and students.

Overall, the findings are in favor of a thorough approach to teacher preparation and instructional strategies that recognizes the connection between instructional behaviors, self-efficacy, and student motivation. According to research, students' motivation has a big impact on their engagement and math performance (Pintrich & Schunk, 2002). Furthermore, teaching practices that create a positive learning atmosphere can boost students' self-efficacy, which influences their academic achievement (Bandura, 1997; Schunk, 1991). Future research should keep looking at these dynamics in a range of educational settings in order to further enhance strategies that promote effective teaching and learning in mathematics education (Wang *et al.*, 2019; Hattie, 2009).

In summary, enhancing teaching self-efficacy is a multifaceted endeavor that requires the concerted efforts of teachers, principals, and policymakers. By implementing these tailored recommendations, stakeholders can create a more supportive educational environment that fosters effective teaching and motivates students in high school mathematics, ultimately leading to improved educational outcomes.

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