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The Mediating Role of Motivational Learning Strategies in the Relationship Between Teacher Support and Mathematics Learning Engagement

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Abstract

Background

This study aimed to investigate the role of teacher support in predicting students' engagement in mathematics learning, with particular emphasis on the mediating role of motivational learning strategies.

Methods

This study employed a descriptive-correlational design using a structural equation modeling (SEM) approach. The target population comprised upper secondary school students in eastern Tehran during the 2025–2026 academic year. Participants were selected through a multistage cluster random sampling procedure. Initially, Educational Districts 8 and 14 of Tehran were randomly selected, followed by the random selection of eight schools and 24 classes from these districts. Of the 360 distributed questionnaires, 353 complete responses were retained for the final analysis after excluding incomplete questionnaires. Data were collected using the Mathematics Learning Engagement Questionnaire, the Teacher Support Questionnaire, and the Motivational Learning Strategies Questionnaire. Statistical analyses were conducted using SPSS version 26 and AMOS version 23.

Results

The structural model demonstrated that teacher support exerted a significant positive effect on both mathematics learning engagement (β = 0.343, $p = 0.002$) and motivational learning strategies (β = 0.711, $p < 0.001$). In addition, motivational learning strategies had a significant positive effect on mathematics learning engagement (β = 0.418, $p < 0.001$). Bootstrap analyses further revealed that motivational learning strategies significantly mediated the relationship between teacher support and mathematics learning engagement (β = 0.297, $p < 0.001$).

Conclusion

The findings suggest that teacher support enhances students' engagement in mathematics learning by strengthening their motivational learning strategies. These results underscore the importance of fostering supportive classroom environments and promoting students' motivational processes to improve academic engagement in mathematics.

Introduction

Mathematics occupies a unique position within the structure of formal education. It is simultaneously recognized as a gateway to higher education and careers in science, technology, engineering, and

mathematics (STEM)—a domain in which substantial differences in student performance are observed across countries—and as a subject in which declines in students' interest and engagement occur earlier and more sharply than in almost any other academic discipline (Fredricks et al., 2018). Large-scale international assessments have repeatedly revealed a concerning paradox: while mathematical competence has become increasingly essential for economic participation in knowledge-based societies, students' academic engagement and enjoyment of mathematics systematically decline throughout the secondary school years (Lo & Hew, 2021). This decline is not merely an affective phenomenon; rather, it has significant implications for students' academic trajectories, course selection, and long-term career aspirations (Robinson & Mueller, 2014). Consequently, identifying classroom mechanisms that strengthen or weaken students' academic engagement in mathematics has become one of the central concerns of educational psychology and mathematics education research (Olivier et al., 2021; Zhou et al., 2024; Fredricks et al., 2004).

The decline in academic engagement is of particular importance because mathematics is cumulative in nature. In other words, reduced engagement at one stage of education weakens the conceptual foundations required for subsequent learning and, consequently, creates inequalities that are difficult to compensate for except through extensive remedial instruction (Robinson & Mueller, 2014). To address this challenge, educational systems around the world have prioritized curriculum reform, the integration of technology, and instructional innovations (Lo & Hew, 2021). However, a growing body of research indicates that the relational and motivational context of the classroom, rather than curriculum content, is the primary determinant of whether students maintain or lose engagement in mathematics (Fredricks et al., 2018; Olivier et al., 2021; Zhou et al., 2024). This shift in perspective has renewed researchers' attention to the role of teachers as the most influential factor in fostering academic engagement while simultaneously highlighting the need for integrated theoretical models that not only demonstrate that teachers influence academic engagement but also explain the underlying mechanisms through which this influence occurs (Olivier et al., 2021; Zhou et al., 2024; Fredricks et al., 2004).

Contemporary literature on academic engagement generally agrees that academic engagement is a multidimensional and malleable construct consisting of three primary components: behavioral, emotional, and cognitive engagement (Fredricks et al., 2004; Prananto et al., 2025).

Behavioral engagement refers to students' active participation, sustained effort, and persistence in completing academic tasks. Emotional engagement encompasses the quality of students' affective experiences in the classroom, including interest, enjoyment, a sense of belonging, and the absence of anxiety or boredom. Cognitive engagement reflects the extent to which students employ learning strategies, self-regulation, and mental investment in the learning process (Fredricks et al., 2004).

Fredricks et al. (2004) argued that academic engagement can serve as an "antidote" to declining academic motivation because, unlike many relatively stable motivational constructs, academic engagement is sensitive to and shaped by characteristics of the learning environment and instructional practices (Fredricks et al., 2004). This perspective places the classroom, and consequently the teacher,

at the center of research on academic engagement (Prananto et al., 2025). Reeve (2013) further introduced the concept of *agentic engagement*, emphasizing that students are not passive recipients of instructional conditions; rather, through their active participation in classroom activities, they create an environment that enhances their own motivation and academic engagement. This perspective is consistent with recent findings highlighting students' active role in classroom interactions (Reeve, 2012; Cents-Boonstra et al., 2021).

In mathematics education, academic engagement has attracted considerable research attention because of its gradual decline throughout students' educational careers and its close association with mathematics-specific emotions, including mathematics anxiety (Watt et al., 2017). Research has shown that teachers' positive emotions and enthusiasm for teaching mathematics enhance students' motivation and engagement by creating a supportive classroom environment (Lazarides et al., 2018; Frommelt et al., 2021).

Extending these findings, Lazarides et al. (2018), in a longitudinal study conducted in secondary school mathematics classrooms, demonstrated that teacher enthusiasm, as perceived by students, increased their perceptions of teacher support for the three basic psychological needs of autonomy, competence, and relatedness. This support, in turn, enhanced students' mastery goal orientation and behavioral engagement. These findings indicate that teachers' interpersonal and instructional characteristics influence students' academic engagement through a set of motivational processes. Therefore, teacher support does not exert a solely direct effect on academic engagement; rather, this relationship is mediated through motivational mechanisms (Lazarides et al., 2018; Shao et al., 2025; Ryan & Deci, 2000).

Among the numerous factors proposed to explain individual differences in students' academic engagement, teacher support has consistently been identified as one of the strongest theoretical and empirical predictors (Ryan & Deci, 2000; Fu et al., 2023). Teacher support is generally conceptualized as a multidimensional construct comprising emotional support and warmth, instructional structure and guidance, responsiveness to students' needs, and autonomy-supportive behaviors (Deci & Ryan, 2000; Domen et al., 2019). Numerous classroom-based studies, beginning with the reciprocal effects model proposed by Skinner and Belmont (1993), have shown that teachers who are perceived by students as involved, well-structured, and autonomy-supportive foster higher levels of behavioral and emotional engagement among their students, and that these reciprocal effects continue throughout the academic year. More recent studies have extended these findings to subject-specific contexts, demonstrating that mathematics classrooms are particularly sensitive to the social–emotional climate created by the teacher (Fu et al., 2023; Flunger et al., 2021).

Despite this growing body of evidence, the precise psychological pathways through which teacher support leads to sustained student engagement in mathematics learning have not yet been fully elucidated. This gap constitutes the primary motivation for the present study. The theoretical basis for expecting indirect, rather than merely direct, effects of teacher support on academic engagement is

rooted primarily in **Self-Determination Theory (SDT)** (Ryan & Deci, 2000). According to this theory, human motivation flourishes when the social environment satisfies three fundamental psychological needs: autonomy, competence, and relatedness. Accordingly, teachers who support students' autonomy, provide appropriate instructional structure, and actively engage with their students create classroom conditions that satisfy these psychological needs and, consequently, enhance autonomous motivation and academic engagement (Deci & Ryan, 2000; Fu et al., 2023).

Importantly, research grounded in Self-Determination Theory has gradually distinguished between teachers' relatively stable interpersonal orientations toward students (e.g., being autonomy-supportive or controlling) and the specific motivational strategies that teachers employ in authentic classroom settings. These strategies include providing meaningful rationales for learning activities, offering opportunities for choice, using non-controlling language, and connecting instructional content to students' interests (Flunger et al., 2021; Assor et al., 2002). This distinction is important because it indicates that teacher support, by itself, is not the most proximal determinant of academic engagement. Rather, teacher support operates by enhancing the quality and frequency of the motivational strategies employed by teachers, which directly influence how students engage in learning. The study by Liu et al. (2019), conducted within the framework of Self-Determination Theory, provided robust empirical evidence for conceptualizing motivational strategies as an independent and measurable construct capable of functioning as a mediating variable, rather than merely serving as a substitute for the broader concept of teacher support.

This mediational rationale is further supported by findings from studies based on Self-Determination Theory. Previous research has shown that instruction designed to support students' psychological needs enhances their motivation and academic engagement by increasing the satisfaction of their basic psychological needs. These findings suggest that the pathway through which teachers' instructional behaviors influence students' academic engagement is rarely direct; instead, it is typically transmitted through intervening motivational processes (Ryan & Deci, 2000; Deci & Ryan, 2000). Similarly, perceived teacher support is not directly associated with academic effort alone; rather, this relationship is established through motivational and cognitive processes, including psychological need satisfaction, academic self-efficacy, and motivation (Zhou et al., 2022).

Both constructs can be regarded as outcomes of teachers' use of motivational strategies in structuring, guiding, and supporting learning activities (Yang et al., 2023; Liu et al., 2018). Collectively, this body of evidence suggests that any comprehensive explanation of how teacher support influences academic engagement in mathematics should also incorporate the motivational strategies employed by teachers, rather than conceptualizing teacher support as a unified construct without underlying mechanisms (Patrick et al., 2007; Zhou et al., 2022). Because motivational strategies, such as providing meaningful rationales for learning activities, strengthening students' sense of competence, and offering opportunities for choice, directly target students' perceptions of control and task value, they can be considered one of the mechanisms through which teachers' supportive instruction leads to more favorable emotional and motivational outcomes, even though achievement emotions and emotion

regulation were not included as mediating variables in the present study (Ruzek et al., 2016; Liu et al., 2018). Adopting this broader theoretical framework makes it possible to conceptualize motivational strategies not as an isolated variable, but rather as a construct embedded within a network of motivational, self-regulatory, and emotional processes operating in the classroom, explaining part of this network of relationships (Ryan & Deci, 2000; Deci & Ryan, 2000).

The present study seeks to address the aforementioned gaps by proposing and empirically testing a structural model in which teacher support is hypothesized to indirectly predict students' academic engagement in mathematics through the mediating role of motivational strategies. This approach contributes to the advancement of existing knowledge in several distinct ways. From a theoretical perspective, by empirically distinguishing a broad relational construct, namely teacher support, from a specific instructional mechanism, namely motivational strategies, this study extends Self-Determination Theory and academic engagement theory. Consequently, it provides a more precise examination of the underlying process assumptions in Self-Determination Theory-based models of classroom motivation (Ryan & Deci, 2000; Deci & Ryan, 2000; Liu et al., 2019). By explicitly modeling motivational strategies as a mediating variable rather than as an outcome of or substitute for teacher support, this study directly responds to calls in the research literature emphasizing the need to move beyond merely reporting correlations toward identifying the mechanisms that explain these relationships (Patrick et al., 2007; Zhou et al., 2022).

From an educational perspective, positioning this model within the domain of mathematics education addresses the recognized yet insufficiently explained phenomenon of the gradual decline in academic engagement in mathematics throughout students' educational years and provides domain-specific evidence that complements the broader literature on academic engagement (Fredricks et al., 2004; Patrick et al., 2007). From a practical perspective, identifying motivational strategies as a proximal and modifiable mediating variable provides a feasible target for educational interventions. Unlike general and relatively stable personality or interpersonal characteristics, motivational strategies are teachable, observable, and can be strengthened through teacher professional development programs. Therefore, if their mediating role is empirically confirmed, these findings can be used to design instructional programs and teacher empowerment courses aimed at increasing students' academic engagement in mathematics classrooms (Liu et al., 2019; Longakit et al., 2025).

Furthermore, the use of Structural Equation Modeling (SEM) in the present study also addresses methodological limitations in previous research. Structural equation modeling enables the simultaneous estimation of the quality of the measurement model and structural relationships, formal testing of indirect effects, and differentiation of variance associated with distinct yet related constructs. These capabilities are essential for comparing competing explanations regarding how teacher support is associated with academic engagement (Hu & Bentler, 1999).

By applying this analytical approach within an integrated model that includes teacher support, motivational strategies, and mathematics academic engagement as three latent and psychometrically

distinct constructs, the present study is positioned to methodologically rigorously test a theoretically based mediation hypothesis—one that previous fragmented studies have not been able to fully explain.

Based on the theoretical foundations and empirical evidence presented, the present study was designed with the overall aim of explaining the mechanism underlying the relationship between teacher support and students' academic engagement in mathematics.

Specifically, this study pursues three interconnected objectives:

First, to examine the direct relationship between students' perceptions of teacher support and their level of engagement in mathematics.

Second, to examine the relationship between perceived teacher support and teachers' use of motivational strategies, as well as the relationship between motivational strategies and students' academic engagement.

Third, and most importantly, to test the hypothesis that motivational strategies mediate the relationship between teacher support and students' academic engagement in mathematics within an integrated structural model.

Based on these objectives, the present study seeks to answer the following research questions:

1. a) Does perceived teacher support significantly predict students' academic engagement in mathematics?
2. b) Does perceived teacher support significantly predict teachers' use of motivational strategies, and do motivational strategies significantly predict students' academic engagement?
3. c) Do motivational strategies mediate the relationship between teacher support and students' academic engagement in mathematics?

The proposed structural model, in which teacher support is considered an exogenous latent construct, motivational strategies are considered a mediating construct, and students' academic engagement in mathematics is considered an endogenous latent construct, will be tested using structural equation modeling methods, as described in the Method section.

Accordingly, by empirically testing this mediational pathway, the present study aims to provide a more precise, coherent, and practically valuable understanding of how teacher support is transformed into meaningful student engagement in mathematics classrooms. This understanding can contribute both to enriching motivational theories and to designing effective educational interventions for improving the quality of mathematics education.

Method

Population, Sample, and Sampling Procedure

The research method was correlational and was conducted using structural equation modeling (SEM). The statistical population of the study consisted of upper secondary school students from Educational Districts 8 and 14 in Tehran during the 2024–2025 academic year.

The sample size was determined based on the requirements of structural equation modeling (SEM) analysis. Considering the complexity of the proposed model, which included three latent constructs, 11 observed indicators, and direct and indirect paths, an adequate sample size was considered necessary for the stable estimation of model parameters. During the data collection phase, a total of 360 questionnaires were distributed and collected. After an initial examination of the data, seven questionnaires were excluded due to incomplete responses, missing data, or failure to meet the criteria for inclusion in the analysis. Ultimately, 353 valid questionnaires were entered into the final analysis. This sample size met the necessary statistical requirements according to methodological recommendations for conducting structural equation modeling, testing structural relationships, and examining mediation effects.

A multistage cluster random sampling method was employed in this study. Accordingly, two educational districts (Districts 8 and 14) were randomly selected from among the educational districts located in eastern Tehran. Subsequently, eight schools were randomly selected from these districts, and at the next stage, 24 classes were randomly selected from the selected schools. All participants were informed about the purpose, procedures, and voluntary nature of the study before participation. They were assured that participation was entirely voluntary and that they could withdraw from the study at any time without any negative consequences. Informed consent was obtained from all participants prior to data collection. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Semnan University. The ethical principles considered in this study included respect for participant welfare, informed consent, risk-benefit assessment, protection of privacy and confidentiality, and appropriate safeguards for participants. All collected data were used solely for research purposes, and the confidentiality and privacy of participants were maintained throughout the study.

Instruments

Mathematics Engagement Questionnaire

To assess students' engagement in mathematics, a questionnaire was used that was developed based on the theoretical framework of academic engagement proposed by Fredricks, Blumenfeld, and Paris (2004) and revised with a specific focus on mathematics. This instrument measures mathematics engagement as a multidimensional construct consisting of three components: behavioral, emotional, and cognitive engagement. The questionnaire includes 15 items that assess students' participation, attention, interest, positive emotions toward mathematics, and the use of cognitive and metacognitive strategies in mathematics learning.

Responses are rated on a five-point Likert scale ranging from 1 (very low) to 5 (very high). Items 2, 4, and 6 are reverse-scored. The total score ranges from 15 to 75, with higher scores indicating higher levels of students' engagement in mathematics. The content validity of the instrument was examined and confirmed through the opinions of experts in educational psychology and mathematics education. In the study by Fredricks et al. (2004), this construct demonstrated satisfactory reliability. In the present study, Cronbach's alpha coefficient for the overall mathematics engagement scale was 0.76, indicating acceptable reliability of the instrument.

Perceived Teacher Support Questionnaire

To measure perceived teacher support, the questionnaire developed by Skaalvik and Skaalvik (2013) was used. This instrument was designed to assess the extent to which students perceive support from their teachers and consists of 12 items across two dimensions: emotional support and instrumental support. Items 1 to 6 assess emotional support, while items 7 to 12 assess teachers' instrumental support.

Responses to the items are rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total questionnaire score is calculated by summing the scores of the 12 items, with total scores ranging from 12 to 60; higher scores indicate greater perceived teacher support among students. Previous studies have shown that this instrument has appropriate construct validity and satisfactory reliability. In the present study, Cronbach's alpha coefficient for the overall perceived teacher support scale was calculated as 0.85, indicating desirable internal consistency of the instrument.

Motivated Strategies for Learning Questionnaire (MSLQ)

To assess students' motivational strategies and learning strategies, the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich, Smith, Garcia, and McKeachie (1991) was used. This instrument is an 81-item self-report scale designed to evaluate motivational beliefs, cognitive strategies, metacognitive strategies, and resource management strategies in the learning process.

The MSLQ consists of two main sections: motivational strategies and learning strategies. The motivational strategies section includes three components: value, expectancy, and affective components. The value component includes three subscales: intrinsic goal orientation, extrinsic goal orientation, and task value. The expectancy component includes control beliefs for learning and academic self-efficacy. The affective component assesses test anxiety. The learning strategies section includes two main components: cognitive and metacognitive strategies, and resource management strategies. Cognitive and metacognitive strategies include rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation. Resource management strategies include time and study environment management, effort regulation, peer learning, and help-seeking.

Responses to the items are rated on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me). The score for each subscale is calculated based on the mean of its related items, with

higher scores indicating greater use of the corresponding motivational and learning strategies. In the original version, none of the items are reverse-scored.

Pintrich et al. (1991) reported satisfactory construct validity and reliability for this instrument. In the original study, Cronbach's alpha coefficients for different subscales ranged from 0.52 to 0.93, indicating acceptable internal consistency of the instrument. In the present study, the reliability of the questionnaire was examined using Cronbach's alpha coefficient, and the Cronbach's alpha value for the overall scale was 0.92.

Results

The number of participating students who responded to the questionnaire items was 360. After data screening, seven missing data cases were identified and excluded from the analysis. Therefore, the final analyses were conducted on 353 participants. Accordingly, the response rate of the study was 98.1%. Among the final participants, 168 students (47.6%) were female and 185 students (52.4%) were male. The descriptive statistics of the study variables are presented in Table 1.

Table 1
Descriptive Statistics of the Study Variables

variablles	N	Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
Total Mathematics engagement	353	49.21	8.485	26	75	.384	.435
Behavioral	353	12.45	2.501	7	20	.734	.799
Affective	353	20.52	4.211	10	30	.307	− .125
Cognitive	353	16.24	3.921	5	25	.078	.302
Total Teacher support	353	44.20	8.021	20	60	− .071	− .211
Emotional support	353	22.31	4.212	11	30	− .191	− .328
Instrumental support	353	21.89	4.722	8	30	− .115	− .520
Total Motivational strategies for learning	353	128.41	32.329	58	217	.841	.543
Intrinsic goal orientation	353	16.22	4.973	6	28	.564	− .010
Extrinsic goal orientation	353	16.52	5.035	6	28	.506	− .276
Task value	353	26.28	6.812	9	42	.536	.005
Control of learning beliefs	353	16.75	4.822	4	28	.497	.063
Self-efficacy	353	33.05	9.336	13	56	.731	.179
Test anxiety	353	19.59	5.657	5	35	.656	.502

As shown in Table 1, univariate normality was assessed using the values of skewness and kurtosis, which should fall within the range of − 2 to + 2 (Kline, 2023). To examine the independence of errors, the Durbin–Watson test was conducted. The results showed that the Durbin–Watson statistic was 1.32, which falls between 1.5 and 2.5, indicating the independence of errors.

To assess multicollinearity, tolerance and variance inflation factor (VIF) coefficients were used. The results indicated that none of the tolerance values were below the acceptable threshold of 0.10, and none of the variance inflation factor values exceeded the acceptable threshold of 10. The correlation matrix of the study variables is presented in Table 2.

Table 2
Correlation matrix of the study variables

Research Variables	1	2	3
1.Total Mathematics engagement	1	–	–
2. Total Teacher support	**0.485****	1	–
3. Total Motivational strategies for learning	**0.561****	**0.594****	1

** P < 0.05

The results presented in Table 2 indicate that there are significant positive correlations among all study variables. Mathematics learning engagement was positively correlated with teacher support (r = 0.485, $p < 0.05$) and motivational strategies (r = 0.561, $p < 0.05$). Moreover, teacher support and motivational strategies also demonstrated a significant positive correlation (r = 0.594, $p < 0.05$).

The direct coefficients for the revised model are presented in Table 3.

Table 3
Standardized and Direct Coefficients in the Research Model

Direct Paths	Beta	Lower Bound	Upper Bound	Significance
Teacher support→ Mathematics engagement	0.343	0.130	0.532	0.002
Teacher support→ Motivational strategies	0.711	0.618	0.790	0.0005
Motivational strategies→ Mathematics engagement	0.418	0.224	0.616	0.0005

The results presented in Table 3 indicate that all direct paths in the research model are significant. Teacher support has a significant positive effect on mathematics learning engagement ($\beta = 0.343$, $p < 0.002$) and also demonstrates a strong effect on motivational strategies ($\beta = 0.711$, $p < 0.0005$). In addition, motivational strategies are a significant positive predictor of mathematics learning engagement ($\beta = 0.418$, $p < 0.0005$). These findings confirm the role of teacher support and motivational strategies in increasing students' engagement in mathematics learning.

Subsequently, the bootstrap method was used to examine the indirect relationship in the proposed model. The results of the bootstrap procedure for testing the mediating or indirect paths are presented in Table 4.

Table 4
Bootstrap Results for the Indirect Effects

Indirect Paths	Beta	Lower Bound	Upper Bound	Significance
Teacher support→ Motivational strategies → Mathematics engagement	**0.297**	**0.161**	**0.464**	**0.0005**
Total Effect				
Teacher support→ Motivational strategies → Mathematics engagement	**0.640**	**0.506**	**0.753**	**0.0005**

The results presented in Table 4 showed that the indirect effect of teacher support on mathematics learning engagement through motivational strategies was positive and significant (β = 0.297, *p* = 0.0005). Furthermore, the total effect of this pathway was also significant (β = 0.640, *p* = 0.0005). Since the bootstrap confidence interval did not include zero, the mediating role of motivational strategies in the relationship between teacher support and mathematics learning engagement was confirmed. In addition, the results of the Sobel test confirmed this mediating effect (Sobel Z = 3.98, *p* < 0.001). Therefore, teacher support, in addition to its direct effect, can enhance students' engagement in mathematics learning through increasing the use of motivational strategies.

The model fit indices are presented in Table 5.

Table 5
Model Fit Indices of the Research Model

Type of Index	Fit Indices	Obtained Value	Acceptable Value
Absolute Fit Indices	**Normed Chi-square (CMIN)**	**120.021**	**–**
	Degrees of Freedom	**41**	**–**
	CMIN/DF	**2.97**	**< 3**
	Significance	**0.0005**	**–**
Relative Fit Indices	**Root Mean Square Error of Approximation (RMSEA)**	**0.07**	**≤ 0.08**
	Comparative Fit Index (CFI)	**0.96**	**> 0.90**
	Parsimony Comparative Fit Index (PCFI)	**0.72**	**> 0.60**
	Parsimony Normed Fit Index (PNFI)	**0.71**	**> 0.60**
	Incremental Fit Index (IFI)	**0.96**	**> 0.90**
	Normed Fit Index (NFI)	**0.95**	**> 0.90**

To test the proposed model in the present study, the Structural Equation Modeling (SEM) method was applied. The fit indices presented in Table 5 were used to evaluate the model fit. Based on the results of the final research model, as can be observed, most of the indices are desirable.

Furthermore, if the value obtained for the Root Mean Square Error of Approximation (RMSEA) index is less than 0.08, it indicates an acceptable model fit (Schermelleh-Engel et al., 2003). In the present study, the significance value for the approximation fit index was 0.0005, and the Root Mean Square Error of Approximation was 0.07, which, according to Kline's model (2023), indicates an acceptable model fit. Figure 2 presents the modified research model.

Figure 1 presents the final structural equation model of the study after model fitting. The results indicate that teacher support, in addition to its direct effect on mathematics academic engagement, also influences this variable indirectly through motivational strategies, indicating the partial mediating role of motivational strategies in the research model.

Discussion and Conclusion

The present study was conducted with the aim of developing and empirically testing a structural model to explain students' engagement in mathematics learning based on the simultaneous roles of teacher support and motivational learning strategies. Drawing on contemporary perspectives in educational psychology, particularly Self-Determination Theory, Social Cognitive Theory, and self-regulated learning approaches, this study examined whether teacher support directly enhances students' engagement in mathematics learning and whether this relationship operates indirectly through motivational learning strategies. Overall, the findings provided strong evidence supporting the proposed model. The results indicated that teacher support was significantly associated with mathematics engagement, teacher support was a strong predictor of motivational learning strategies, and motivational strategies played a significant role in increasing students' engagement in mathematics learning. Furthermore, mediation analysis revealed that motivational strategies represent one of the important psychological mechanisms through which teacher support influences students' engagement in mathematics.

One of the main findings of the study was the positive and significant relationship between teacher support and mathematics academic engagement ($\beta = 0.343$, $p = 0.002$). This finding indicates that students who perceive their mathematics teacher as more supportive are more likely to demonstrate higher levels of behavioral, emotional, cognitive, and participatory engagement in mathematics activities. Moreover, the observed correlation between teacher support and mathematics engagement ($r = 0.485$) suggests that positive teacher–student relationships and the quality of classroom interactions constitute an important foundation for students' active participation in the mathematics learning process. This finding is consistent with the view that academic engagement is not merely a stable individual characteristic but rather develops through continuous interactions between learners' personal characteristics and the educational environment.

This finding is consistent with the results of studies by Léon et al. (2017), Shih (2008), Opdenakker (2021), and Yang et al. (2024). Léon et al. (2017) demonstrated that teaching quality and teacher supportive behaviors significantly predict students' behavioral engagement in mathematics classrooms. Similarly, Shih (2008) reported that higher perceptions of teacher autonomy support are associated with increased behavioral and emotional engagement of students in learning activities. In the longitudinal study by Opdenakker (2021), it was also found that teacher supportive behaviors, including autonomy support, structure provision, and engagement, play an important role in enhancing students' academic engagement. Furthermore, Yang et al. (2024) showed that teacher emotional support and competence support directly and significantly increase students' engagement in mathematics.

From a theoretical perspective, the positive effect of teacher support can be explained based on Self-Determination Theory. According to this theory, students demonstrate the highest levels of intrinsic motivation and active participation when their three basic psychological needs—autonomy, competence, and relatedness—are satisfied within the learning environment (Ryan & Deci, 2000; Deci & Ryan, 2000). Supportive teachers can facilitate the satisfaction of these needs by providing opportunities for choice, offering constructive feedback, respecting students' perspectives, encouraging independent thinking, and creating a safe emotional climate (Ahn et al., 2021). When students experience the mathematics classroom as a supportive and non-threatening environment, they are more likely to perceive mathematics activities as valuable, attainable, and meaningful; consequently, they demonstrate greater effort, higher persistence, and deeper engagement in learning (Ryan & Deci, 2000).

Another important finding of the study was the strong effect of teacher support on motivational learning strategies ($\beta = 0.711$, $p = 0.0005$). This strong relationship indicates that teachers play a determining role in shaping students' motivational and self-regulatory processes. In other words, teacher support is not merely an external factor associated with the classroom environment; rather, it functions as an important psychological resource that influences how students perceive learning, academic goals, competence beliefs, and the ways in which they respond to learning challenges.

This finding is consistent with the results of studies by Chen (2026), Yu and Singh (2018), Feng et al. (2019), and Sakiz et al. (2012). Chen (2026) demonstrated that teacher support not only directly enhances students' self-regulated learning abilities but also promotes the use of learning strategies and self-regulation through strengthening mathematics self-efficacy. Similarly, Yu and Singh (2018) reported that teacher support, by enhancing students' self-efficacy and motivation, facilitates the use of effective learning strategies and ultimately academic achievement in mathematics. Feng et al. (2019) also showed that teacher support strengthens students' effort in completing mathematics tasks through increasing autonomous motivation. Furthermore, Sakiz et al. (2012) indicated that students' perceptions of teachers' emotional support enhance their self-efficacy, enjoyment of learning, and academic effort in mathematics classrooms, all of which are considered fundamental components of motivational strategies.

From a theoretical perspective, this finding can be explained based on self-regulated learning theory and social cognitive theory. According to self-regulated learning theory, learners are active individuals who set their learning goals and employ cognitive, metacognitive, and motivational strategies to achieve these goals (Zimmerman, 2000). Within this framework, the classroom environment, particularly teachers' supportive behaviors, is considered one of the most important sources for the development of self-regulation. Moreover, according to social cognitive theory, teacher support strengthens students' motivation to use effective learning strategies through enhancing self-efficacy beliefs, task value, and expectations of success (Pintrich & De Groot, 1990). When teachers demonstrate confidence in students' abilities, acknowledge their efforts, and provide opportunities for active participation in the learning process, students are more likely to develop higher academic self-efficacy, learning-oriented goals, and greater perceived value of mathematics. These motivational beliefs encourage students to employ effective learning strategies, such as planning, monitoring learning progress, seeking help when necessary, and maintaining effort when encountering difficulties in mathematics (Chen, 2026; Yu & Singh, 2018). Therefore, teacher support can function as a driving factor that transforms positive classroom experiences into internal motivational regulation processes and provides the foundation for the sustained use of motivational strategies.

The findings also indicated that motivational learning strategies were significant predictors of mathematics academic engagement ($\beta = 0.418$, $p = 0.0005$). This result suggests that students' academic engagement in mathematics learning is strongly influenced by their motivational resources and their ability to manage the learning process. The correlation coefficient between motivational strategies and mathematics academic engagement ($r = 0.561$) was the strongest relationship among the study variables, indicating that motivational processes are among the most important components shaping students' participation in mathematics learning.

This finding is consistent with the results of studies by Morano et al. (2021), Singh et al. (2002), Valenzuela-Peñuñuri et al. (2024), and Zakka et al. (2025). Morano et al. (2021) demonstrated that motivation and the use of motivational strategies are among the most important factors enhancing students' engagement in mathematics classrooms, and that the use of appropriate motivational strategies facilitates active participation and effective learning. Similarly, Singh et al. (2002) reported that motivational factors and academic engagement are important predictors of achievement in mathematics and science, and that students with higher levels of motivation demonstrate greater academic engagement. Furthermore, Valenzuela-Peñuñuri et al. (2024) showed that academic motivation strengthens students' emotional engagement in mathematics learning through increasing self-efficacy. The findings of the systematic review by Zakka et al. (2025) also indicated that intrinsic motivation and motivational strategies are among the most important factors contributing to enhanced academic engagement and effective mathematics learning.

From a theoretical perspective, this finding can be explained based on self-regulated learning theory and social cognitive theory. According to self-regulated learning theory, students are active individuals who guide their learning processes by setting goals, monitoring progress, and regulating their cognition,

emotions, and motivation (Zimmerman, 2000). Within this framework, motivational strategies play a fundamental role in maintaining effort, regulating emotions, and sustaining learning activities. Moreover, according to social cognitive theory, motivational beliefs such as self-efficacy, task value, and expectations of success determine the extent to which students employ self-regulatory strategies and actively participate in learning activities (Pintrich & De Groot, 1990). Students who possess effective motivational strategies are more likely to set clear learning goals, regulate their effort, demonstrate persistence in the face of difficulties, and perceive academic challenges as opportunities for growth rather than indicators of inability. This issue is particularly important in mathematics because learning mathematics often requires continuous effort, abstract thinking, problem-solving, and engagement with complex concepts. Therefore, students who are capable of regulating their motivation can better maintain concentration, participate in problem-solving activities, and withstand cognitive challenges (Morano et al., 2021; Zimmerman, 2000).

One of the most important findings of the present study was the confirmation of the mediating role of motivational strategies in the relationship between teacher support and academic engagement in mathematics. The results showed that the indirect effect of teacher support on academic engagement through motivational strategies was significant (β = 0.297, p = 0.0005; 95% confidence interval: 0.161 to 0.464). This finding indicates that the effect of teacher support is not limited merely to positive interactions, encouragement, or the creation of warm and supportive relationships; rather, a substantial part of this effect is exerted through strengthening students' motivational processes. In other words, by providing a supportive environment, teachers enhance students' sense of competence, self-efficacy, task value, and beliefs regarding their ability to succeed, and these motivational changes encourage students to use motivational strategies more frequently and ultimately participate more actively in mathematics learning activities.

This finding is consistent with the results of studies by Yang et al. (2024), Chen (2026), Yu and Singh (2018), and Ahn et al. (2021). Yang et al. (2024) demonstrated that teacher support plays an important role in improving mathematics learning through increasing students' engagement, and that motivation represents one of the key mechanisms underlying this relationship. Similarly, Chen (2026) reported that teacher support indirectly enhances students' learning abilities through strengthening self-efficacy and self-regulated learning strategies. Yu and Singh (2018) also showed that the effect of teacher support on mathematics-related academic outcomes is largely explained through increases in students' motivation and self-efficacy. Furthermore, Ahn et al. (2021) indicated that teachers' supportive behaviors enhance students' autonomous motivation through satisfying their psychological needs, thereby leading to more active participation in learning activities.

From a theoretical perspective, this finding can be explained within the framework of Self-Determination Theory and social cognitive models of motivation. According to Self-Determination Theory, when teachers support students' basic psychological needs, including autonomy, competence, and relatedness, students' intrinsic motivation and quality of self-regulation increase (Ryan & Deci, 2000; Deci & Ryan, 2000). Under such conditions, students not only participate in classroom activities with greater

interest but also employ more effective motivational strategies, such as maintaining effort, self-encouragement, goal setting, and emotion regulation, to overcome learning difficulties. On the other hand, within the framework of social cognitive theory, supportive teacher behaviors serve as one of the most important environmental sources that strengthen self-efficacy beliefs and expectations of success, and these beliefs facilitate the use of motivational strategies (Pintrich & De Groot, 1990; Zimmerman, 2000). Therefore, motivational strategies can be considered a linking mechanism through which environmental factors, such as teacher support, are transmitted into learning outcomes, including academic engagement.

In fact, the findings of the present study clarify that the relationship between teacher support and academic engagement is not a simple and direct relationship; rather, this relationship is explained through changes in students' cognitive–motivational processes. When students perceive that their teacher cares about their progress, provides constructive feedback, supports them during difficulties, and creates opportunities for experiencing success, they develop more positive attitudes toward mathematics learning. This positive orientation encourages students to demonstrate greater persistence when facing learning challenges, pursue learning goals more seriously, and employ motivational strategies to maintain effort and sustain their engagement. Consequently, their cognitive, emotional, and behavioral participation in the learning process increases, which is consistent with the predictions of Self-Determination Theory and social cognitive theory regarding the role of environmental resources in shaping motivation and academic engagement (Ryan & Deci, 2000; Pintrich & De Groot, 1990).

These findings make an important contribution to the literature on mathematics education because they demonstrate that enhancing students' academic engagement is not limited to improving teaching methods or transferring mathematical knowledge; rather, it requires serious attention to the quality of human relationships in the classroom and the motivational climate created by teachers. Students' lack of interest or limited participation in mathematics should not be attributed solely to insufficient ability or aptitude; instead, motivational experiences and the quality of educational interactions play a fundamental role in determining their level of engagement.

From an applied perspective, the findings of this study provide important implications for mathematics teachers, teacher education programs, and educational policymakers. Teachers should move toward instructional approaches that strengthen students' feelings of autonomy, competence, and relatedness. Providing opportunities for choice, offering constructive feedback, acknowledging students' efforts, avoiding controlling classroom environments, and demonstrating confidence in students' mathematical abilities can enhance their motivational processes. Therefore, teacher training programs should emphasize not only mathematical knowledge and instructional skills but also communication skills and the ability to create motivational learning environments.

Despite the importance of the present findings, several limitations should be considered. First, the cross-sectional nature of the study limits the possibility of making definitive causal inferences regarding the relationships among the variables. Although the proposed model is supported by an appropriate

theoretical foundation, future longitudinal studies could examine changes in teacher support, motivational strategies, and mathematics engagement over time. Second, the use of self-report measures may be associated with response bias; therefore, future research is recommended to employ multi-source approaches, including classroom observations, teacher reports, and behavioral indicators of participation. Third, because educational experiences are influenced by cultural and social factors, replicating this model across different societies and educational systems may enhance the generalizability of the findings.

Future studies may also incorporate additional variables into the model, such as mathematics anxiety, growth mindset, academic emotions, perceptions of the classroom climate, and parental support. Examining differences in these relationships across various age groups, levels of academic achievement, and educational contexts may also provide a more comprehensive understanding of the processes underlying the development of mathematics engagement.

Conclusion

Overall, the findings of the present study indicate that teacher support is a fundamental contextual factor in strengthening students' engagement in mathematics learning, and motivational learning strategies represent one of the most important psychological mechanisms explaining this relationship. Students demonstrate deeper and more sustained engagement in mathematics learning when they are placed in a supportive environment—an environment that, in addition to fostering positive teacher–student relationships, promotes motivation, self-regulation, and beliefs regarding their ability to learn. Therefore, creating supportive and motivation-oriented mathematics classrooms not only improves teacher–student relationships but also provides an essential pathway for enhancing students' interest, persistence, and active participation in mathematics learning.

Declarations

Ethics Approval

This study was approved by the Ethics Committee of Semnan University, Semnan, Iran. The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant ethical guidelines.

Consent to participate

Written informed consent was obtained from all participating students prior to data collection. For participants under 16 years of age, written informed consent was additionally obtained from their parents or legal guardians. Prior to data collection, consent forms containing information about the study were provided to the parents or legal guardians, who were given sufficient opportunity to review

the study information and provide written consent for their child's participation or decline participation. All signed parental or legal guardian consent forms were collected prior to the commencement of data collection. No parent or legal guardian declined consent for their child's participation. The study was conducted in accordance with the approval of the relevant university ethics committee and the appropriate educational authorities.

Consent to publish

Not applicable.

Conflict of Interest

The authors declare no conflict of interest.

Author 2 (Corresponding Author)

Supervised the overall research process and was responsible for finalizing the manuscript and revisions.

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Author Contribution

Fatemeh Khodapanah: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.Mohammadali Mohammadi Far: Supervision, Methodology, Validation, Writing – review & editing.Both authors: Read and approved the final manuscript

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Data Availability

The raw data collected from students are not publicly available due to ethical and confidentiality considerations. However, the data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Figures

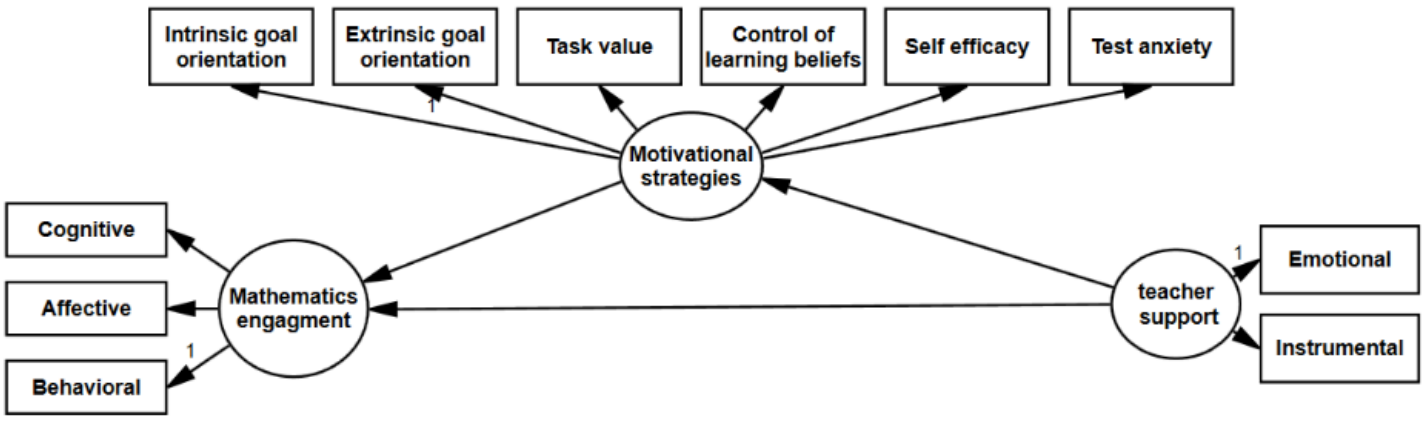


Figure 1

The preliminary conceptual model of the study

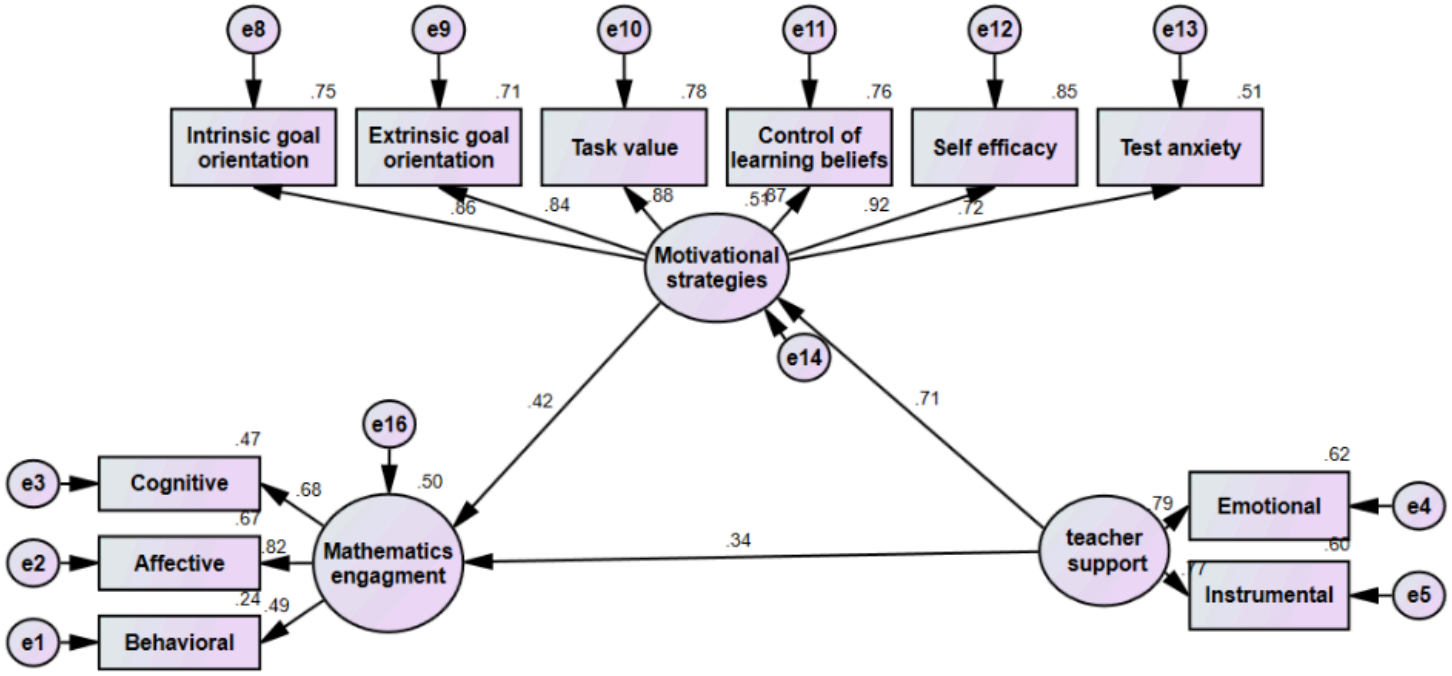


Figure 2

The final structural model of the study