Parallel Mediation Effect of Autonomous Learning and Competence on the Correlation Between Teacher–Student Relationship and Mathematical Motivation

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Abstract

Declining motivation in mathematics among students remains an educational concern. This study examined the mediating effects of autonomous learning and competence on the relationship between the teacher–student relationship and mathematics motivation, using a predictive research design with mediation analysis and a survey of 187 junior high school students selected through stratified random sampling. Results showed that the autonomous learning variable did not mediate the relationship, while the competence variable did. These findings partially support Self-Determination Theory. Future research may explore other motivational variables that influence students' motivation in mathematics.

Keywords: Parallel mediation effect; autonomous learning; competence; teacher–student relationship; mathematical motivation

1. Introduction

1.1. The Problem and Its Scope

Students' declining motivation in mathematics has been a concern worldwide in mathematics education. A decline in student motivation is highlighted as a contributing factor to declining mathematics performance (Hatch, 2024). Studies have shown that personal motivation is a key factor influencing academic performance, alongside the educational environment (Ozhan & Kocadere, 2020; Prieto, 2020; Rojo-Robas et al., 2020).

A global student survey found that reduced motivation is among the factors influencing declining math scores across countries, alongside other factors affecting learning outcomes (Hatch, 2024). In China, many students experienced a decline in intrinsic motivation towards mathematics, which impacts their learning outcomes (Dong et al., 2023). Similarly, in Texas, the decline in motivation is evident, as students' motivation and persistence in mathematics are often influenced by their teachers' backgrounds and instructional practices, which can negatively impact their achievement and future Science, Technology, Engineering, and Mathematics (STEM) career plans (Ekmekci & Serrano, 2022).

In the Philippines, decreased motivation also weakens students' attitudes toward mathematics, playing a key role in shaping positive study habits and academic achievement (Camacho, 2022). Furthermore, a study in Cagayan found that declining motivation can affect learners' study habits and overall academic achievement (Campanilla, 2024). Taken together, these situations show that a decline in student motivation remains a critical problem affecting mathematics learning at global, national, and local levels.

The failure to address a decline in motivation in mathematics can have profound implications, including reduced engagement, weaker problem-solving skills, lower academic performance, and limited future opportunities. Although motivation in mathematics has been a focus of various studies, a significant gap remains. Prior work has emphasized its positive relationship with learning outcomes, problem-solving, and achievement (Howard et al., 2021; Baars et al., 2017; Ekmekci & Serrano, 2022). Few studies have examined the decline in motivation in relation to factors within the teacher-student relationship, autonomous learning, perceived competence, and mathematics motivation. Furthermore, evidence of a direct correlation among autonomous learning, perceived competence, and mathematics motivation remains limited, especially in the Philippines. Addressing this gap is essential, as it can provide valuable insights into how autonomous learning, competence, and the teacher-student relationship jointly shape students' motivation for mathematics.

1.2. Significance of the Study

This study is significant because it provides valuable insights into how teacher–student relationships influence mathematical motivation through the mediating effects of autonomous learning and competence, thereby greatly benefiting the stakeholders of Holy Cross College of Davao and other educational institutions in both the public and private sectors. The findings may help the Department of Education (DepEd) enhance curriculum development, instructional practices, teacher training, and intervention programs that strengthen students' motivation, confidence, and engagement in mathematics.

Furthermore, the study supports Sustainable Development Goal 4 (SDG 4): Quality Education by promoting inclusive, learner-centered, and effective educational practices that foster academic success and holistic development among learners. It also aligns with DepEd's core values: Maka-Diyos, Maka-tao, Makakalikasan, and Makabansa, encouraging positive teacher–student relationships, respect, empathy, responsibility, and the development of competent and self-directed learners. Moreover, the results are substantial for Holy Cross College of Davao, as they may serve as a basis for developing policies and academic support programs that improve students' mathematical motivation, emotional well-being, academic achievement, and overall institutional growth.

1.3. Statement of the Problem

This study aimed to determine the mediating roles of autonomous learning and competence in the relationship between the teacher-student relationship and mathematics motivation. Specifically, it pursued the following objectives:

1. To determine the levels of teacher-student relationships in terms of commitment, closeness, and complementarity; autonomous learning in terms of independent learning and study habits; competence in terms of cognitive, social, physical, and self-worth; and mathematical motivation in terms of intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety.
2. To determine the correlations between the teacher-student relationship and mathematics motivation, autonomous learning and mathematics motivation, and competence and mathematics motivation.
3. To determine the significance of the direct effect of the teacher-student relationship on mathematics motivation, controlling for autonomous learning.
4. To determine the significance of the indirect effect of the teacher-student relationship on mathematics motivation through autonomous learning.

5. To determine the significance of the total effect of the teacher-student relationship on mathematics motivation.
6. To determine the significance of the direct effect of the teacher-student relationship on mathematics motivation, controlling for competence.
7. To determine the significance of the indirect effect of the teacher-student relationship on mathematics motivation through competence.

1.4. Hypotheses

H01: Teacher-student relationship, autonomous learning, competence, and mathematics motivation are not significantly correlated.

H02: The direct effect of the teacher-student relationship on mathematics motivation, controlling for autonomous learning, is not significant.

H03: The indirect effect of the teacher-student relationship on mathematics motivation, through autonomous learning, is not significant.

H04: The total effect of the teacher-student relationship on mathematics motivation is not significant.

H05: The direct effect of the teacher-student relationship on mathematics motivation, controlling for competence, is not significant.

H06: The indirect effect of the teacher-student relationship on mathematics motivation, through competence, is not significant.

1.5. Theoretical Framework

This study is based on the Self-Determination Theory by Deci and Ryan (1985). Self-Determination Theory posits that autonomy, competence, and relatedness are fundamental psychological needs driving motivation and personal growth (Deci & Ryan, 1985).

Authors such as Roca and Gagné (2008) provided empirical support for Self-Determination Theory (SDT), demonstrating its applicability in predicting continuance intention in e-learning contexts. Similarly, Reeves (2006) emphasized that teachers play a crucial role in satisfying students' psychological needs through the instructional practices they employ, thereby supporting the principles of Self Determination Theory (SDT).

1.6. Conceptual Framework

In this study, the variables used include the teacher–student relationship, comprising commitment, closeness, and complementarity (Jowett & Ntoumanis, 2004), which serve as predictors. The mediator variables are autonomous learning, as indicated by independent learning and study habits (Macaskill & Taylor, 2010), and competence as represented by cognitive, social, physical, and general self-worth indicators (Nagai et al., 2019). Finally, mathematics motivation is indicated by intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety (Fiorella et al., 2021), serving as the criterion variable reflecting students' motivational factors toward learning mathematics.

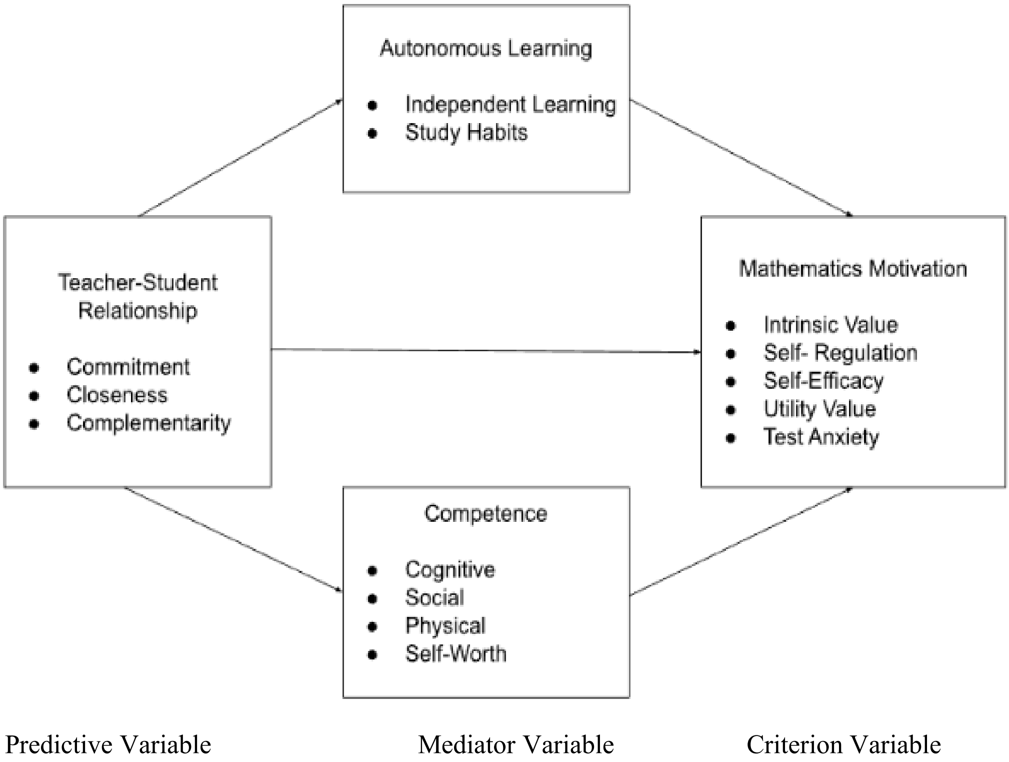

Figure 1. Conceptual Framework of the Study

2. Method

2.1. Research Design

This study employed a predictive research design. Predictive research uses historical and current data to forecast future outcomes, anticipate trends, predict behavior, and understand possible scenarios. Its advantages include providing proactive insights, identifying risks before they arise, and enhancing planning and decision-making, enabling more effective interventions and strategies (Pubrica, 2026). Additionally, predictive research is widely used across industries such as retail, healthcare, aviation, and business to improve success and outcomes by supporting better decision-making and operational efficiency (Coursera, 2024).

2.2. Locale of the Study

The study was conducted in Babak District, Samal, Davao del Norte. It focused on three selected public high schools within the district. These schools are located within the area's barangays and follow the DepEd curriculum and policies in delivering secondary education. The setting is significant to this study as it provides a clear context of how teaching and learning are implemented during a crucial stage of students' cognitive, emotional, and academic development.

2.3. Sample and Sampling Technique

The respondents in this study comprised 187 Grade 9 and 10 junior high school students from the total population of 363 students. These respondents were selected based on the following inclusion criteria: students must be officially enrolled in Grades 9 to 10; must be present during the data collection period; and must be willing to participate in the study voluntarily. On the other hand, students who were absent during the survey administration or refused to participate were excluded from the study. Junior high school students were chosen as respondents because this grade level marks a critical stage in the development of mathematical learning, motivation, confidence, interest, and persistence, all of which are essential factors for future academic achievement.

The study utilized stratified proportional random sampling. According to Hayes (2025), stratified proportional random sampling ensures fair and equal representation of respondents across grade levels by dividing the population into strata and selecting participants in proportion to each stratum. This approach reduces sampling bias and increases the accuracy and representativeness of the data. Using a 5% margin of error and a 95% confidence level, a sample size of 187 respondents was determined.

2.4. Data Gathering Technique

The survey technique was employed to collect data in this study. This method involves systematically collecting information from respondents via structured questionnaires to describe the attitudes, perceptions, and behaviors of a target population. Moreover, survey research enables the rapid collection of information describing the characteristics of a large sample of individuals of interest (Ponto, 2015). By asking individuals questions, survey-based research enables researchers to generalize findings from a sample of respondents to a larger population (Goodfellow, 2023).

This study used four adapted research instruments, all converted to a four-point Likert scale for consistency. The teacher–student relationship questionnaire, adapted from Sophia Jowett and Nikolaos Ntoumanis (2004), contained 11 items assessing students' perceptions of commitment, closeness, and complementarity with their mathematics teacher, and obtained a Cronbach's alpha of 0.920. The autonomous learning questionnaire, adapted from Ann Macaskill and Elaine Taylor (2010), included 13 items measuring students' independent learning habits and responsibility for learning, with a Cronbach's alpha of 0.882. The competence questionnaire, adapted from Yuki Nagai et al. (2018), consisted of 38 items assessing cognitive, social, physical, and general self-worth. To maintain construct validity, all items were retained because these competence dimensions have been empirically linked to mathematics motivation and outcomes (Hoffman et al., 2021; Zhou et al., 2022; Rodríguez et al., 2021); the items were rephrased into a respondent-centered format, yielding a Cronbach's alpha of 0.780. Lastly, the mathematics motivation questionnaire, adapted from Logan Fiorella et al. (2021), comprised 19 items measuring intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety in mathematics, and showed a Cronbach's alpha of 0.894.

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2.5. Data Analysis Technique

In this study, descriptive, correlation, and mediation analyses were employed to examine the teacher-student relationship, autonomous learning, competence, and mathematics motivation.

Descriptive analysis is used to organize and summarize the data, with the mean and standard deviation providing insight into the variables' central tendencies and variability (Loeb et al., 2017). Correlation analysis assesses the prevalence and strength of relationships among variables, using the Pearson product-moment correlation to determine how changes in one variable correspond to changes in another (Curtis et al., 2016). Mediation analysis examines the independent effects of multiple mediators, using Estimate Beta to calculate direct, indirect, and total effects (Anderson et al., 2022), enabling evaluation of how teachers' self-efficacy influences effective teaching practices both directly and indirectly through classroom management and instructional competence.

This study presents a matrix that shows the scales and descriptive levels for each variable, providing a clear interpretation of the findings on mathematics teacher self-efficacy, instructional competence, classroom management, and effective teaching practices.

Scale	Level	Teacher-Student Relationship	Autonomous Learning	Competence	Mathematics Motivation
1.00 – 1.75	Low	Very Weak	Very Weak	Very Poor	Very Poor
1.76 – 2.50	Moderate	Weak	Weak	Poor	Poor
2.51 – 3.25	High	Strong	Strong	Good	Good
3.26 – 4.00	Very high	Very Strong	Very Strong	Very Good	Very Good

Standard Deviation Value Ranges and Interpretation

Range	*Description*	*Interpretation*
SD ≤ 0.50	High Consistent Responses	Strong and Uniform Perception
SD = 0.51 – 1.00	Moderate Consistent Responses	Acceptable Consistency
SD = 1.01 – 1.50	Low Consistent Responses	Differing Views or Experiences
SD > 1.50	Very Low Consistent Responses	High Variability and Lack of Consensus

In this study, the significance of the correlation was tested at a 0.05 confidence level. The following standard measure for interpreting the r-value was used:

Computed r	**Descriptive Interpretation**
+/- 1.00	Perfect correlation
Between +/- 0.75 – +/- 0.99	High correlation
Between +/- 0.51 – +/- 0.74	Moderately high correlation
Between +/- 0.31 – +/- 0.50	Moderately low correlation
Between +/- 0.01 – +/- 0.30	Low correlation
0.00	No correlation

The standard measure for the interpretation of the strength of the mediation is as follows:

Proportion Mediated	**Interpretation**
< 0.20	Weak Mediation
0.20 – 0.50	Moderate Mediation
> 0.50	Strong Mediation

2.6. Ethical Considerations

Before administering the research instruments, ethical clearance was obtained from the ethics board of the Graduate School Program of Holy Cross of Davao College, which is the Society of Moral Integrity and Legal Ethics (SMILE). Then, the Graduate School granted formal approval and endorsement, and obtained permission from the Schools Division Office of Babak District, Samal, Davao del Norte, as well as the heads of the participating schools. Before data collection, students in participating schools were clearly informed that their participation in the study was voluntary and that they could exercise their free will in deciding whether to participate in the survey, in line with Lavrakas (2008).

Prior to the distribution of questionnaires, students were thoroughly briefed on the study's purpose, procedures, and their rights, in accordance with the principle of informed consent (Bhandari, 2021). Additionally, in line with Resnik (2020), the researcher emphasized the importance of confidentiality and academic integrity to protect students' private information. Students' identities will remain anonymous, as the researcher cannot trace data to individual participants by removing direct identifiers (Coffelt, 2017). The conduct of this study on students' motivation in mathematics strictly adhered to the ethical standards set by the school administration and relevant governmental regulations, and its findings will be shared with the school to support initiatives that enhance students' motivation and performance in mathematics.

3. Results

Included in this chapter are the results of the descriptive, correlation, and the mediation analyses. Also, the summary of findings is presented.

3.1. Descriptive Results

Table 1 presents the descriptive statistics of the variables involved in the study, namely, teacher–student relationship, autonomous learning, competence, and mathematics motivation, including their respective indicators. It also shows the number of respondents, the mean, the standard deviation, and the descriptive level for each variable.

Table 1. Descriptive Table (n= 187)

Predictor Variables	n	Standard Deviation	Mean	Descriptive Level
Teacher-Student Relationship	**187**	**0.530**	**3.031**	***High***
Commitment	187	0.624	2.965	*High*
Closeness	187	0.623	3.157	*High*
Complementarity	187	0.560	2.969	*High*
Autonomous Learning	**187**	**0.455**	**2.933**	***High***

Independent Learning	187	0.526	2.947	*High*
Study Habits	187	0.451	2.822	*High*
Competence	**187**	**0.241**	**2.623**	***High***
Cognitive	187	0.331	2.664	*High*
Social	187	0.379	2.615	*High*
Physical	187	0.407	2.505	*High*
General Self-Worth	187	0.407	2.719	*High*
Mathematics Motivation	**187**	**0.412**	**2.873**	***High***
Intrinsic Value	187	0.574	2.936	*High*
Self Regulation	187	0.527	2.890	*High*
Self Efficacy	187	0.560	2.755	*High*
Utility Value	187	0.496	2.977	*High*
Test Anxiety	187	0.567	2.809	*High*

The table reveals that the teacher–student relationship variable obtained a mean of 3.031, described as high. This result indicates that the teacher–student relationship is generally strong. All its indicators are also interpreted as high. A standard deviation of 0.530 is considered moderately consistent, indicating acceptable response consistency. Moreover, the autonomous learning variable obtained a mean of 2.933, described as high. This outcome suggests that autonomous learning is strong. All its indicators are described as high. The standard deviation of 0.455 is described as highly consistent, indicating strong and uniform perception. In addition, the competence variable yielded a mean of 2.623, described as high. This data point implies that respondents' competence is generally strong. All indicators are likewise described as high. The standard deviation of 0.241 indicates highly consistent responses, reflecting strong and uniform perception. Moreover, the mathematics motivation variable obtained a mean of 2.873, described as high. This result indicates that respondents' motivation for mathematics is strong. All indicators are interpreted as high. The standard deviation of 0.412 indicates highly consistent responses, suggesting a strong, uniform perception.

All major variables, such as teacher–student relationship, autonomous learning, competence, and mathematics motivation, are interpreted as high, indicating that respondents generally exhibit strong perceptions and behaviors across these domains. These findings suggest that students tend to experience supportive relationships with teachers, demonstrate autonomous learning, perceive themselves as competent, and maintain strong motivation toward mathematics, with responses showing acceptable to strong consistency across variables.

3.2. Correlation Results

Table 2 is a correlation table. It presents the determinant and criterion variables. It shows the r-value, p-value, decision on the null hypothesis, and the corresponding interpretation.

Table 2. Correlation Table (n=187)

Variables	**Mathematics Motivation**			
	r-value	**p-value**	**Decision on *Ho***	**Interpretation**
Teacher-Student Relationship	.664	.000	Reject *Ho*	Moderately high positive significant correlation
Autonomous Learning	.653	.000	Reject Ho	Moderately high positive significant correlation
Competence	.406	.000	Reject Ho	Moderately low significant correlation

Level of Significance: 0.05,
Decision Rule: Reject H_0 if $p < 0.05$

Specifically, the table shows that the correlation between the teacher–student relationship and the mathematics motivation variables yielded a p-value of 0.000, which is lower than the 0.05 level of significance; hence, the null hypothesis was rejected. This indicates that the correlation is statistically significant. The corresponding r-value of 0.664 reflects a moderately high positive correlation between teacher–student relationship and mathematics motivation. This finding implies that as the quality of teacher–student relationships improves, students' motivation in mathematics also increases. Similarly, the correlation between autonomous learning and mathematics motivation variables yielded a p-value of 0.000, which is also lower than the 0.05 level of significance; hence, the null hypothesis was rejected. This indicates that the correlation is statistically significant. The corresponding r-value of 0.653 shows a moderately high positive correlation between autonomous learning and mathematics motivation. This implies that students who demonstrate higher levels of autonomous learning tend to have higher motivation in mathematics. Lastly, the correlation between competence and mathematics motivation variables obtained a p-value of 0.000, which is lower than the 0.05 level of significance; thus, the null hypothesis was rejected. This indicates that the correlation is statistically significant. The corresponding r-value of 0.406 reflects a moderately low correlation between competence and mathematics motivation. This means that higher competence is associated with higher mathematics motivation, although the relationship is weaker than that with the other variables.

The findings show that both teacher–student relationships and autonomous learning are more strongly positively associated with mathematics motivation than competence. This indicates that relational and self-directed learning factors play a greater role in enhancing students' motivation in mathematics.

3.3. Mediation Results

Table 3 is a mediation table. It contains the path/effect, the estimate (Beta), the standard error, the Z-value, the p-value, the decision on H_0, and the corresponding interpretation.

Table 3. Mediation Table (n= 187)

Type	Path/Effect	Estimate (β)	SE	Z	P	Decision on H_0	Interpretation
Indirect	TSR➔ AL ➔ MM	0.0934	0.1005	0.722	0.470	Accept H_0	Not Significant
	TSR ➔ C ➔ MM	0.0639	0.0183	2.710	0.007	Reject H_0	Significant
Direct	TSR➔ AL	0.9165	0.0251	31.329	0.001	Reject H_0	Significant
	AL➔ MM	0.1019	0.1277	0.722	0.470	Accept H_0	Not Significant
	TSR ➔ C	0.3206	0.0315	4.628	0.001	Reject H_0	Significant
	C ➔ MM	0.1992	0.1018	3.343	0.001	Reject H_0	Significant
	TSR ➔ MM	0.5072	0.1044	3.777	0.001	Reject H_0	Significant
Total	TSR ➔ MM	0.6645	0.0426	12.127	0.001	Reject H_0	Significant

LEGEND: TSR = teacher–student relationship; AL = autonomous learning; C = competence; MM = mathematics motivation

Level of Significance: 0.05

Decision Rule: Reject H_0 if $p < 0.05$

Proportion Mediated: M1 = indirect effect / total effect =0.1406 or 14.06% , M2 = indirect effect / total effect = 0.0961 or 9.61%

The table specifically shows that the direct effect of the teacher-student relationship on the mathematics motivation variable, controlling for autonomous learning, yielded an estimated Beta of 0.9165 and a corresponding p-value of 0.001, which is below the 0.05 level of significance. Hence, the null hypothesis was rejected. This finding indicates that the teacher-student relationship on mathematics motivation, controlling for autonomous learning, is significant. Consequently, students with stronger, more positive relationships with their teachers are more likely to develop greater motivation in mathematics.

Moreover, the indirect effect of the teacher-student relationship on the mathematics motivation variable, through autonomous learning, yielded an estimated Beta of 0.0934 and a corresponding p-value of 0.470, both greater than the 0.05 level of significance. Hence, the null hypothesis was accepted. This outcome indicates that the indirect effect of the teacher-student relationship on mathematics motivation, through autonomous learning, is not significant. Thus, this implies that although positive teacher-student relationships may contribute to students' autonomous learning, autonomous learning alone does not significantly account for how teacher-student relationships influence students' motivation in mathematics.

The total effect of the teacher-student relationship on the mathematics motivation variable obtained an estimated Beta of 0.6645 with a corresponding p-value of 0.001, which is below the 0.05 level of significance. Thus, the null hypothesis was rejected. This data point indicates that the total effect of the teacher-student relationship on mathematics motivation is significant. Hence, this suggests that the teacher-student relationship plays an important role in enhancing students' motivation in mathematics, particularly through support, encouragement, and positive interactions that foster students' interest, engagement, and confidence in learning mathematics.

In addition, the direct effect of the teacher-student relationship on the mathematics motivation variable, controlling for competence, yielded an estimated Beta of 0.3206, with a corresponding p-value of 0.001, which is below the 0.05 level of significance. Hence, the null hypothesis was rejected. This result indicates that the teacher-student relationship has a significant direct effect on competence. For this reason, students who experience positive, supportive relationships with their teachers are more likely to develop greater confidence, as encouraging interactions with teachers help foster students' self-belief, participation, and confidence in their academic abilities.

Furthermore, the indirect effect of the teacher-student relationship on the mathematics motivation variable, through competence, obtained an estimated Beta of 0.0639, with a p-value of 0.007, which is less than the 0.05 level of significance. Therefore, the null hypothesis was rejected, indicating that this indirect effect is significant. This result implies that competence is an important mechanism by which the teacher-student relationship influences mathematics motivation.

The findings indicate that autonomous learning and competence both serve as weak mediators in the relationship between the teacher-student relationship and mathematics motivation, with autonomous learning contributing more strongly than competence. When combined, these mediating variables demonstrate a moderate overall effect, suggesting that the model has a meaningful capacity to explain how teacher-student relationships influence students' motivation for mathematics through the development of autonomy and competence.

3.4. Summary of Findings

Based on the statistical results, it was specifically found that:

1. Teacher–student relationship, autonomous learning, and competence show significant positive correlations with mathematics motivation.
2. The direct effect of the teacher–student relationship on mathematics motivation, controlling for autonomous learning, is significant.
3. The indirect effect of the teacher–student relationship on mathematics motivation, through autonomous learning, is not significant.
4. The total effect of the teacher–student relationship on mathematics motivation is significant.
5. The direct effect of the teacher–student relationship on mathematics motivation, controlling for competence, is significant.
6. The indirect effect of the teacher–student relationship on mathematics motivation, through competence, is significant.

4. Discussions

Discussed in this chapter are the findings of the study. Also, the conclusion and recommendations are presented.

4.1. Teacher-Student Relationship and Mathematics Motivation Correlation

The current finding of this study reveals that there is a significant positive correlation between teacher–student relationships and mathematics motivation, which agrees with the study of Hettinger et al. (2023), asserting that students' perception of teacher emotional support positively predicted mathematics interest, indicating that the teacher–student relationship directly relates to math motivation. Similarly, teacher feedback–feedforward reinforces the teacher–student relationship by encouraging students to set Personal Best (PB) goals, thereby increasing their motivation and contributing to higher achievement in mathematics (Burns et al., 2024). These findings suggest that fostering strong teacher–student relationships and effective feedback practices should be central strategies in mathematics education to enhance student motivation.

Conversely, the current finding differs from Choi and Han (2023), who found that perceived math teacher support was linked to lower math achievement only in medium-SES schools and did not moderate the relationship between student motivation and achievement.

4.2. Autonomous Learning and Mathematics Motivation Correlation

The result that autonomous learning has a significant positive correlation with mathematics motivation reinforces the prior study by Rahayu and Fauzan (2023), indicating that both motivation and independence of learning significantly affect mathematics outcomes across classes. Likewise, another study found that motivation for mathematics positively influences online learning engagement through self-efficacy and self-monitoring, underscoring the importance of autonomous learning strategies (Alemayehu & Chen, 2021). Together, these findings suggest that enhancing student autonomy can meaningfully improve motivation and achievement in mathematics.

However, the present finding contradicts Hmouri (2024), who reported no statistically significant correlation among Moroccan university students between motivation, autonomous out-of-class learning activities, and academic achievement, although students reported that these activities could still support learning outcomes.

4.3. Competence and Mathematics Motivation Correlation

The current finding aligns with Radišić et al. (2024), who concluded that perceived competence was more strongly related to math identity, thereby supporting the importance of perceived competence when evaluating potential success in specific tasks or activities. In addition, perceived competence strongly affects mathematics motivation, with higher competence associated with greater motivation, better performance, and lower anxiety (Rodríguez et al., 2023). These findings imply that fostering students' sense of competence is essential for sustaining motivation and achievement in mathematics.

On the other hand, the current finding disagrees with Granello et al. (2025), who asserted that competence beliefs alone do not fully influence math outcomes, as self-regulation strategies and instructional teaching were found to be more effective.

4.4. Teacher-Student Relationship and Mathematics Motivation as Mediated by Autonomous Learning

The finding of this study, asserting that autonomous learning does not mediate the correlation between teacher–student relationship and mathematics motivation, upholds the study of Alemayehu and Chen (2021), underscoring, in the context of online learning environments, that learning self-efficacy and self-monitoring partially mediated the relationship between motivation and learning engagement. It implies that self-efficacy and self-monitoring account for only part of how motivation leads to engagement. At the same time, other unmeasured factors and a direct effect of motivation also influence engagement in online learning. Additionally, this may reflect that self-regulated learning accounts for only part of the relationship. In contrast, the teacher–student relationship influences mathematics motivation mainly through a direct pathway rather than autonomous learning.

In contrast, the present finding contradicts Montero (2025), who stressed that study habits, as an indicator of autonomous learning in this study, were the only direct predictor of academic achievement, with psychological and instructional factors mediating the effect.

4.5. Teacher-Student Relationship and Mathematics Motivation as Mediated by Competence

The result of this study that teacher-student relationship and mathematics motivation is mediated by competence, affirms the study of Huang et al. (2022), stressing that strengthening positive teacher–student relationships is important for improving student engagement, particularly among students with low self-worth, highlighting self-worth as a key indicator of students' competence, where supportive teacher interactions can help compensate for lower self-evaluations and enhance engagement in learning. Furthermore, self-competence is a significant mediator of mathematics achievement, as higher math anxiety reduces students' sense of competence (Valenzuela et al., 2024). Consequently, self-competence plays an important role in influencing both students' motivation and mathematics achievement.

Conversely, the current finding contradicts Gan (2024), who reported that competence does not mediate the relationship between teacher–student relationships and mathematics motivation, suggesting that other factors, such as self-efficacy and intrinsic value, are more influential.

4.6. Conclusions

Based on the findings, the autonomous learning variable did not significantly mediate the relationship between the teacher–student relationship and mathematics motivation, whereas the competence variable did. Hence, these findings partially support the Self-Determination Theory, which posits that autonomy, competence, and relatedness are fundamental psychological needs that drive motivation and personal growth.

4.7. Recommendations

Based on the conclusions, the following are recommended:

1. Future researchers may explore other potential mediators to understand better the mechanisms linking teacher–student relationships to mathematics motivation. Mixed-method or qualitative approaches could also provide deeper insights.
2. Teacher professionals may prioritize strategies that enhance students' motivation, including fostering self-efficacy, setting goals, and engaging in meaningful mathematics tasks.

3. School administrators may focus on strengthening teacher–student relationships through feedback, scaffolding, and mastery experiences rather than relying solely on promoting autonomous learning or competence.

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Appendix A. Research instruments

A.1. Teacher-Student Relationship

Directions: For each of the contents below, please indicate the extent of your agreement or disagreement by placing a check (/) in the appropriate boxes.

4- Strongly Agree 3- Agree

2- Disagree 1 – Strongly Disagree

Commitment				
Statements	1	2	3	4
1. I am close to my maths teacher.				
2. I am committed to my maths teacher.				
3. I can improve my maths with my maths teacher				
Closeness				
Statements	1	2	3	4
4. I like my maths teacher.				
5. I trust my maths teacher				
6. I respect my maths teacher				
7. I appreciate my maths teacher's hard work in order to improve my maths.				

Complementarity				
Statements	1	2	3	4
8. When I am taught by my maths teacher, I am relaxed and comfortable.				
9. When I am taught by my maths teacher, I respond to his/ her efforts.				
10. When I am taught by my maths teacher, I am ready to do my best.				
11. When I am taught by my maths teacher, I have a friendly character.				

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A.2. Autonomous Learning

Directions: For each of the contents below, please indicate the extent of your agreement or disagreement by placing a check (/) in the appropriate boxes.
4- Strongly Agree 3- Agree
2- Disagree 1 – Strongly Disagree

Independent Learning				
Statements	1	2	3	4
1. I enjoy new learning experiences.				
2. Even when tasks are difficult, I try to stick with them.				
3. I enjoy finding information about new topics on my own.				
4. I am open to new ways of doing familiar things.				
5. I take responsibility for my learning experiences.				
6. I enjoy being set a challenge.				
7. I tend to be motivated to work by assessment deadlines.				
Study Habits				
Statements	1	2	3	4
8. I frequently find excuses for not getting down to work.				
9. I plan my time for study effectively				
10. I am good at meeting deadlines				
11. My time management is good.				
12. I am happy working on my own.				
13. I imagine myself working through challenging math problems successfully.				

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A.3. Competence

Directions: For each of the contents below, please indicate the extent of your agreement or disagreement by placing a check (/) in the appropriate boxes.
4- Strongly Agree 3- Agree
2- Disagree 1 – Strongly Disagree

Cognitive				
Statements	1	2	3	4

1. I am among the best at studying.				
2. I am poor at studying. (R)				
3. I am one of the cleverest students in my class.I find math courses essential because it provides problem-solving skills that are applicable across various subjects.				
4. My grades are bad. (R)				
5. I finish my homework quickly.				
6. I understand school lessons well.				
7. I am often unable to answer questions in class. (R)				
8. I attempt challenging problems even if they are difficult.				
9. I get good scores in exams.				
10. I express my opinions in class.				
Social				
Statements	1	2	3	4
1. I have many friends.				
2. I am popular in my class.				
3. I am often teased by my friends. (R).				
4. Nobody worries when I am absent. (R)				
5. I find it easy to make friends.				
6. My friends invite me to play or join activities.				
7. I am the center of interaction in my class.				
8. I am liked by my friends.				
9. People do not pay much attention to me. (R)				
10. People will feel sad if I transfer to another school.				
Physical				
Statements	1	2	3	4
1. I am good at sports.				
2. I am confident when trying new sports.				
3. I am often chosen to join sports meets.				
4. I prefer watching rather than participating in sports. (R)				
5. I am interested in trying new sports.				
6. I dislike P.E. classes. (R)				
7. I am poor at sports. (R)				
8. I do not like losing to my friends in sports.				
9. I am among the best at sports.				
10. I prefer not to be seen by others when I do sports. (R)				
General Self-Worth				
Statements	1	2	3	4
1. I have self-confidence.				
2. I can do things better than others.				
3. I have many things to be proud of.				
4. Things do not go well no matter what I do. (R)				
5. I am satisfied with the way I am now.				
6. I believe I will surely become a great person.				

7. I am not a useful person. (R)				
8. I have confidence in my own opinions.				

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A.4. Mathematics Motivation

Directions: For each of the contents below, please indicate the extent of your agreement or disagreement by placing a check (/) in the appropriate boxes.

4- Strongly Agree 3- Agree
2- Disagree 1 – Strongly Disagree

Intrinsic value				
Statements	1	2	3	4
1. I enjoy learning math				
2. I find learning math interesting.				
3. I like math that challenges me.				
Self-regulation				
Statements	1	2	3	4
4. I put enough effort into learning math.				
5. If I am having trouble learning the math, I try to figure out why				
6. I use strategies that ensure I learn math well.				
7. I prepare well for math tests and quizzes				
Self-efficacy				
Statements	1	2	3	4
8. I am confident I will do well on math assignments and projects.				
9. I am confident I will do well on math tests.				
10. I believe I can master the knowledge and skills in the math course.				
11. I believe I can earn a grade of "A" in the math course.				
Utility Value				
Statements	1	2	3	4
12. I think about how the math I learn will be helpful to me.				
13. I think about how I will use the math I learn.				
14. I think about how learning math can help me get a good job.				
15. I think about how learning math can help my career.				
Test anxiety				
Statements	1	2	3	4
16. I become anxious when it is time to take a math test.				
17. I am nervous about how I will do on the math tests.				
18. I worry about failing math tests.				
19. I am concerned that the other students are better at math.				

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