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Teachers' Technology Use and Students' Academic Motivation in Mathematics Learning: The Mediating Role of Self-Efficacy

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ABSTRACT

Teachers' use of technology in mathematics instruction strengthens students' academic motivation and self-efficacy in mathematics learning. This study examined the extent of teachers' technology use, students' academic motivation, and the mediating role of self-efficacy in a private higher education institution in Ozamiz City. Using a quantitative, explanatory, correlational design with mediation analysis, data were collected from 197 college students via stratified and simple random sampling within each stratum. Data were collected using researcher-developed questionnaires and analyzed using means, standard deviations, Spearman's rank-order correlation, regression, and general linear mediation analysis. Results revealed that teachers' technology use was practiced to a very great extent, while students demonstrated high self-efficacy and very high academic motivation. Significant relationships were found among teachers' technology use, students' academic motivation, and self-efficacy. The application of mathematics across different contexts, instructional use of technology, and perseverance in mathematics tasks significantly predicted students' academic motivation. Moreover, students' self-efficacy partially mediated the relationship between teachers' technology use and academic motivation. Purposeful technology integration in mathematics instruction strengthens students' motivation and confidence. Mathematics teachers may continue integrating interactive digital tools in their lessons. At the same time, the Human Resource Department and the Information Technology Office may support this by providing training and access to appropriate technological resources.

Keywords: academic motivation, mathematics learning, mediation analysis, self-efficacy, technology integration

INTRODUCTION

Rationale of the Study

Education in the twenty-first century has been transformed by digital technologies that reshape how learners' access, process, and apply knowledge (Ali et al., 2023). In mathematics, once viewed as rigid and abstract, interactive tools, virtual simulations, and structured digital lessons have enhanced students' understanding, engagement, and achievement (St Omer et al., 2025). However, while technology is often credited with revolutionizing learning, its role in sustaining academic motivation remains contested, as access alone does not ensure increased motivation. Psychological factors, especially self-efficacy, play a big role in how well students do in school. Self-efficacy affects how students deal with problems, keep working hard, and stay confident (Aviory et al., 2025). In this context, the current study examines the relationship between teachers' technology use and students' academic motivation in mathematics, with students' self-efficacy as a mediating variable.

Technology is conceptualized not merely as tools or machines but as relational and systemic entities that combine knowledge, artifacts, practices, and human-actor networks to achieve practical goals (Hardwood & Eaves, 2022). Mathematics teachers have increasingly adopted tools such as digital resources, including video presentations, PowerPoint, interactive polling applications (such as Mentimeter), collaborative whiteboards, and quizzes in gamification modes (such as Kahoot!), which have been used to enhance engagement, feedback, and conceptual understanding. Studies have identified a significant effect of Kahoot! on mathematics and offered a way to reduce potentially harmful effects of excessive screen time (Pellas, 2024). Research on Mentimeter has also demonstrated that student interaction increased or remained active through quizzes and polls (Wulan & Sulisworo, 2024). Google Jamboard also allows students to work collaboratively in real time to solve problems, with students observing and contributing to the mathematical tasks visually.

Across fields, research continuously shows how the incorporation of digital technologies has changed teaching and learning. According to studies, learning management systems, interactive tools, cloud computing platforms, and video-based applications such as YouTube have become essential components of higher education, offering adaptable opportunities for collaboration and knowledge access (Gause et al., 2022).

However, how teachers incorporate digital technologies into their pedagogy determines how well they work in math classes. According to Viberg et al. (2023), children may receive fragmented education and struggle to balance tool-based and instructor-led instructions if there are no common practices or teacher expertise. According to Graham et al. (2021), math teachers in underdeveloped nations frequently use technology for routine rather than transformative purposes, thereby limiting the pedagogical potential of the tool. Technology has nevertheless been shown to increase learner engagement, provide active and constructive activities, and enhance educational outcomes when implemented effectively, despite challenges of infrastructure, training, and confidence (Wekerle et al., 2022).

Studies in East Asia and Africa highlight that technology in mathematics education is most effective when culturally aligned and supported by teachers. In East Asia, tools such as embodied AR and computer vision apps have helped students think more clearly about space, understand concepts more clearly, and become more interested in learning, especially when used with scaffolded instruction (Na & Sung, 2025). Similarly, African studies show that microlearning videos and adaptive practice platforms improve mathematics achievement and interest when integrated with local curricula and teacher facilitation. But these gains are tempered by ongoing equity issues, like limited access to devices, connectivity, and teacher training. Notably, findings across both regions indicate that motivation often mediates the link between technology use and achievement, underscoring the importance of psychological and contextual factors in realizing technology's learning benefits (Magbago et al., 2025).

Academic motivation plays a vital role as a key factor influencing mathematics achievement and persistence. Motivation energizes students to work with difficult mathematics concepts, apply adaptive strategies, and persist through mathematical failure. Intrinsic motivation, identified regulation, and self-regulation have been associated with better aspects of mathematics performance. In contrast, motivation has been identified as an indicator of poor engagement and poor academic performance (Tran & Nguyen, 2021).

For example, in contexts where mathematics is a high-stakes subject, such as Sub-Saharan Africa, motivation helps mediate the connection between instructional quality and achievement (Arthur et al., 2022). Additionally, motivational constructs such as intrinsic value, utility value, and test anxiety are important factors in whether learners' value and enjoy learning mathematics (Čotić-Poturić et al., 2024). Recently, motivational stimulation in mathematics has been achieved through educational technologies, such as digital games, with positive results compared to traditional mathematics instruction (Fadda et al., 2022). While initiating engagement in learning can be facilitated by technology in this case, the motivation to use digital tools over time means using more than technology; it means fostering psychological resources to develop resilience and confidence in learning mathematics.

A central psychological construct that links technology use and academic motivation is self-efficacy. According to Bandura's social cognitive theory, self-efficacy is the belief that you can perform certain tasks well (Schunk & DiBenedetto, 2022). In mathematics education, self-efficacy has been found to directly predict persistence, learning engagement, and achievement (Kaufmann et al., 2022). It also serves as a link between teaching methods and academic results, especially in situations that need higher-order reasoning and problem-solving (Li et al., 2021).

High self-efficacy in mathematics correlates with advanced learning strategies, whereas low self-efficacy is associated with superficial strategies and the avoidance of challenges (Zakariya et al., 2022). Importantly, studies highlight that interventions that promote self-efficacy through visualization, cognitive activation, and mastery experiences significantly improve learners' motivation and performance (Kohen et al., 2022). Thus, in technology-supported environments, self-efficacy is not merely a personal trait but a mediator that determines whether digital tools translate into motivational and academic gains.

The growing use of digital tools in math class has changed how teachers teach and how students learn, but not all teachers use them as much as others do. For example, a teacher who is only using the technology for teaching purposes (such as presenting content to students or managing the class) versus a teacher who is using it to engage their students in student-centered learning. Even though digital tools are being used in math classes, most students still don't care about or are not interested in the subject. In field observations of students using mathematics technology, there are degrees of confidence and interest in learning mathematics when the use of technology is deemed meaningful. However, prior research has investigated teachers' utilization of educational technology, students' motivation in mathematics, and students' self-efficacy individually. Nonetheless, there is a significant gap in the literature regarding the relationship among teachers' educational technology use, students' self-efficacy, and students' academic motivation in mathematics, especially in developing educational contexts. Thus, this study aims to address these gaps by conducting an empirical gap, examining how teachers' technology use influences students' academic motivation in mathematics, and whether students' self-efficacy influences this relationship.

The purpose of this study is to investigate the relationship between teachers' technology use and students' academic motivation in mathematics learning, with a specific focus on the mediating role of students' self-efficacy. Conducted in the context of higher education, the study seeks to determine whether teachers' use of educational technologies directly influences students' academic motivation or whether such effects are primarily mediated through self-efficacy beliefs.

The present study is significant for advancing understanding of how teachers' technology use influences students' academic motivation in mathematics learning, with a focus on the mediating function of students' self-efficacy. Theoretically, the study contributes to the growing body of research on technology integration and motivational theories by elucidating the psychological mechanisms underlying the relationships among digital instructional practices, students' motivation, and learning outcomes. In practice, the findings of this study may serve as a significant reference for educators in higher education institutions on the effective integration of educational technologies that not only improve instructional delivery but also bolster students' self-efficacy and motivation in mathematics.

The results may inform school administrators, curriculum developers, and policymakers in formulating evidence-based programs and professional development initiatives that promote technology-enhanced, motivation-driven mathematics instruction.

THEORETICAL FRAMEWORK

This study was anchored in the Technology Acceptance Model, Social Cognitive Theory, and Self-Determination Theory, which explain how teachers’ technology use and students’ self-efficacy influence students’ academic motivation in mathematics learning.

The Technology Acceptance Model developed by Fred Davis explains how users accept and use technology based on two main factors: perceived usefulness and perceived ease of use. Perceived usefulness refers to the belief that technology improves performance, while perceived ease of use refers to the belief that technology is simple and effort-free to use. In this study, TAM provides a strong framework for understanding why teachers integrate technology into mathematics instruction. Teachers who perceive technology as useful and easy to use are more likely to apply it effectively in teaching, which may increase students’ engagement and academic motivation. The model also recognizes the role of external variables such as self-efficacy, supporting the study’s focus on self-efficacy as a mediating factor between teachers’ technology use and students’ academic motivation. Research has consistently supported TAM in educational settings. Studies by Celayir et al. (2025) found that perceived usefulness and perceived ease of use significantly influence students’ and teachers’ intentions to adopt digital learning technologies.

The Social Cognitive Theory by Albert Bandura emphasizes the interaction between personal factors, behavior, and the environment in shaping learning outcomes. A key concept of SCT is self-efficacy, which refers to an individual's belief in their capability to accomplish tasks successfully. In this study, teachers' technology use serves as an environmental factor that can influence students' confidence, engagement, and motivation in mathematics learning. Through interactive and technology-rich instruction, students may develop stronger self-efficacy, leading to greater effort, persistence, and academic motivation. SCT also explains that students learn through observation, modeling, and reinforcement, suggesting that exposure to effective technology integration can positively shape students' attitudes toward mathematics. Supporting this theory, Mekheimer (2025) reported that technological self-efficacy and intrinsic motivation strongly predicted students' use of digital learning strategies and overall satisfaction. Similarly, Woreta et al. (2025) found that self-efficacy and outcome expectations indirectly influenced student engagement, while Honicke et al. (2023) emphasized the reciprocal relationship between self-efficacy and academic performance.

The Self-Determination Theory developed by Edward Deci and Richard Ryan explains that motivation is strengthened when the psychological needs for autonomy, competence, and relatedness are fulfilled. In mathematics learning, teachers' effective use of technology can support autonomy by allowing students to learn independently, competence by providing immediate feedback and interactive activities, and relatedness through collaborative digital learning experiences. These conditions help students feel more capable and confident, thereby enhancing their self-efficacy and academic motivation. SDT is therefore relevant to the study because it explains how technology-integrated instruction can foster students' intrinsic and extrinsic motivation in mathematics learning. Supporting evidence was provided by Shank et al. (2024), who found that an SDT-based online Algebra 2-unit improved students' competence, relatedness, and motivation to learn mathematics. Likewise, Chiu et al. (2024) reported that technology-mediated interactions supported students' autonomy and relatedness needs, while Wang et al. (2024) concluded through meta-analysis that need-supportive learning environments effectively enhance intrinsic and autonomous motivation across educational settings.

CONCEPTUAL FRAMEWORK

This paper considered teachers' technology use as the independent variable, students' academic motivation as the dependent variable, and self-efficacy as the mediating variable.

Teachers' Technology Use. Teachers' technology use refers to the intentional, knowledge-driven use of technological devices, platforms, and resources in their teaching practice. This includes the use of devices such as computers, tablets, and interactive whiteboards, as well as software such as learning management systems, presentation tools, and educational applications, to support teaching and learning. Through these technologies, teachers can facilitate learning objectives, manage classroom interactions, provide feedback, and personalize instruction (Raave et al., 2024). In today's digitally driven educational environment, technology use has become a key component of effective teaching. Research shows that teachers' knowledge and competence significantly influence the successful integration of technology in the classroom (Maulet et al., 2024), while the evolving educational landscape has shifted teachers' roles from traditional facilitators to innovators who foster interactive and student-centered learning experiences (Safitri et al., 2024).

Instructional Use of Technology. Mathematics teachers' effective use of technology in the classroom largely depends on their Technological Pedagogical Content Knowledge (TPACK), which enables them to integrate digital tools in meaningful, pedagogically sound ways (Dockendorff & Zaccarelli, 2024). Teachers with strong TPACK are more likely to utilize dynamic applications such as GeoGebra to enhance students' conceptual understanding. However, the successful implementation of technology is often hindered by limited access to resources, insufficient training, and inadequate infrastructure (Bueno et al., 2021). Despite these barriers, research highlights that when technology is effectively integrated into pedagogy, it can significantly improve students' engagement, promote inquiry-based learning, and enhance achievement in mathematics (Boadu & Boating, 2024). Furthermore, the integration of digital tools supports the development of interactive and student-centered learning environments (Zhu et al., 2021), while technology-supported instruction has become increasingly essential in both online and blended learning contexts, particularly in reshaping teaching practices and strengthening teacher–student interaction during and beyond the pandemic (Sum & Oancea, 2022).

Engagement and motivation through technology. Engagement and motivation through technology refer to the extent to which digital tools and learning environments promote students' active participation (behavioral), interest and enthusiasm (emotional), and deep thinking (cognitive), ultimately sustaining their motivation to learn. Technology supports these dimensions by offering interactive, adaptive, and immersive experiences such as gamified platforms, real-time feedback, collaborative tools, and augmented features. Empirical studies show that gamified learning environments significantly enhance students' emotional and behavioral engagement (Hellín et al., 2023), while educational technologies more broadly foster active learning, communication, and higher-order thinking skills (Godsk & Møller, 2024). Additionally, interactive technologies have been found to improve students' motivation and knowledge retention, particularly in online learning contexts (Guaña-Moya et al., 2024). Recent research further confirms that technological innovations increase motivation and academic achievement by creating engaging and adaptive learning experiences (Mustamin et al., 2025).

Assessment and feedback through technology. Assessment and feedback through technology involve the use of digital tools and platforms to evaluate student learning while providing immediate, individualized, and actionable feedback that supports learning development. Educators use technologies such as online quizzes, formative assessments, peer-review systems, and progress-tracking software to monitor student performance and deliver real-time feedback. These tools also enable adaptive feedback systems that respond to students' individual learning needs and performance patterns. Research indicates that digital feedback has a medium-to-strong positive effect on student learning outcomes, particularly when it is detailed and explanatory (Cai et al., 2023). Similarly, digital assessment tools support formative feedback that enhances students' self-regulation and learning achievement (Gikandi, 2021), while learning analytics platforms help teachers monitor progress and adjust instruction based on real-time data (Ifenthaler & Yau, 2022). Moreover, online formative assessment practices have been shown to strengthen student engagement and understanding by fostering continuous feedback between teachers and learners (Broadbent, 2024).

Accessibility and support through technology. Accessibility and support through technology refer to the provision of digital tools, systems, and institutional practices that ensure equitable learning opportunities for all students, particularly those with diverse needs. This includes assistive technologies such as screen readers, magnifiers, and speech-to-text tools, as well as universally designed learning materials, reliable internet access, appropriate devices, and institutional support such as training and inclusive policies. Recent literature indicates that while higher education institutions are increasingly evaluated for their efforts to create inclusive online learning environments, many still face challenges in fully implementing accessibility standards (Lomellini et al., 2025). Empirical studies further show that assistive and adaptive technologies significantly improve students with disabilities' and diverse learners' access to learning resources (Kumar & Pal, 2025). In addition, learning management systems and mobile-based platforms enhance academic support by enabling flexible, anytime access to instructional content (Verma & Mathur, 2026). Furthermore, integrating Universal Design for Learning (UDL) with digital technologies enhances accessibility by providing multiple means of engagement, representation, and expression for learners (Wang & Sanchez, 2025).

Students' Academic Motivation. Students' academic motivation refers to the psychological processes that initiate, direct, sustain, and regulate students' engagement in learning activities toward achieving desired outcomes. It encompasses intrinsic motivation (driven by interest and personal growth), extrinsic motivation (influenced by external rewards or demands), and amotivation (lack of intention to act). Academic motivation is dynamic and shaped by students' beliefs, such as self-efficacy, goals, and values, as well as by contextual factors, such as teacher support and classroom climate. It is reflected in outcomes such as persistence, performance, and well-being. It is widely recognized as a strong predictor of academic achievement across learning contexts (Lo et al., 2022). Furthermore, supportive teaching strategies and technology-enhanced learning environments help sustain students' motivation and engagement (Habib et al., 2025), while higher levels of academic motivation are associated with improved self-regulation, deeper cognitive processing, and better academic outcomes (Wang et al., 2024).

Intrinsic motivation. Intrinsic motivation in mathematics refers to engaging in learning activities because they are interesting, enjoyable, and inherently rewarding. It fosters exploratory behavior, deep cognitive engagement, and persistence in solving complex mathematical problems, while also contributing to sustained interest and higher-quality learning in mathematics and STEM fields. Technology can support intrinsic motivation when it promotes interactive learning, visualizations that stimulate curiosity, and meaningful problem-solving experiences; however, poorly designed or misaligned technological tools may fail to enhance motivation. Recent studies highlight intrinsic motivation as an essential component of students' motivational profiles in mathematics (Hossein-Mohand, 2023). Empirical evidence further shows that intrinsic motivation, driven by interest and personal satisfaction, is strongly linked to deeper cognitive engagement and improved academic performance (Alharfi & Alamer, 2026). In addition, autonomy-supportive learning environments significantly enhance intrinsic motivation, leading to greater participation and achievement (Soe et al., 2025), while instructional practices that emphasize curiosity, relevance, and mastery-oriented goals further strengthen students' intrinsic motivation (Smith II, 2024).

Extrinsic motivation. Extrinsic motivation in mathematics refers to students' engagement in learning driven by external factors, such as grades, rewards, approval, or perceived future utility. While it can effectively encourage participation in the short term, its impact on deeper learning depends on whether it is structured in a controlling or autonomy-supportive way. Research distinguishes between controlling extrinsic motivation and more adaptive forms, such as identified regulation, in which students value mathematics for its usefulness and relevance; in this sense, well-designed educational technologies can help clarify purpose and support the internalization of motivation (Mula et al., 2024). External incentives such as grades and performance feedback remain strong influences on students' engagement and achievement, particularly in structured classroom settings (Gabriel et al., 2025). Moreover, thoughtfully designed instructional environments can transform extrinsic motivators into more self-determined forms of motivation, thereby enhancing persistence and academic outcomes (Bandara & Hettiwaththage, 2025). However, recent evidence also suggests that while extrinsic rewards may boost short-term engagement, their long-term effectiveness is maximized only when integrated with autonomy-supportive teaching practices (Al Shuaili, 2025).

Task value and relevance. Task value and relevance refer to students' evaluations of mathematics tasks as meaningful, useful, interesting, and worth the effort, according to expectancy-value theory. These perceptions strongly influence motivation, leading to greater effort, persistence, and willingness to pursue more challenging mathematics courses. Research shows that when learning tasks are contextualized in real-life or professional settings, students' perceived task value increases, leading to higher engagement and greater effort in problem-solving (Rach & Schukajlow, 2024). Similarly, task value is a key motivational construct that significantly predicts students' engagement and academic achievement by shaping their willingness to invest effort in learning activities (Yurt, 2025). Studies grounded in expectancy-value theory further confirm that when students perceive academic tasks as aligned with their personal goals or future careers, their motivation and performance improve (Eccles & Wigfield, 2023). In addition, instructional strategies that emphasize real-world applications of content have been shown to enhance perceived task value and sustain students' engagement in learning (Stutzman, 2026).

Persistence and effort. Persistence and effort refer to the behavioral and volitional dimensions of motivation, specifically the extent to which students continue working on mathematics tasks despite difficulty and the amount of energy they invest in learning. These factors are strong predictors of mathematics achievement and often serve as a bridge between motivational beliefs and academic performance. However, research notes that students may experience early declines in motivation or "motivation shock," which can negatively affect persistence unless appropriate instructional support is provided (Benden & Lauermann, 2022). Studies show that students with higher persistence are more likely to achieve better academic outcomes and overcome learning challenges effectively (Kausar & Haroon, 2025). In addition, effort regulation is strongly shaped by motivational beliefs such as self-efficacy and task value (Bembenutty et al., 2024), while supportive and technology-enhanced learning environments have been found to strengthen students' persistence by making tasks more engaging, interactive, and manageable (Greenspon, 2023).

Students' Self-Efficacy. Self-efficacy was first mentioned as a concept by Bandura (1977; 1986) and refers to individuals' beliefs in their capabilities to organize and execute the courses of action required to achieve a given level of performance, the belief in "how well one can execute courses of action required to manage prospective situations" (Lopez-Garrido, 2023). When applied in educational contexts, this construct is often called academic self-efficacy. It simply refers to students' beliefs in their ability to complete educational tasks and fulfill educational performance goals .Research indicates that self-efficacy, as a construct, makes a strong prediction of students' engagement, persistence, motivation, and achievement across contexts (Miao et al, 2025).

Confidence in solving mathematical problems. Mathematics problem-solving confidence refers to students' domain-specific belief in their ability to successfully solve particular types of mathematical problems. As a component of self-efficacy, it influences task selection, persistence, and the choice of problem-solving strategies. Students with higher confidence are more likely to engage with challenging problems and persist when encountering difficulties. Research shows that instructional interventions that provide mastery experiences, such as technology-enhanced tools with dynamic visualization and adaptive practice, can effectively strengthen students' problem-solving confidence (Zakariya, 2022). In addition, studies indicate that students with higher confidence demonstrate greater persistence and resilience when solving mathematical problems (Asare et al., 2025). Empirical findings further confirm that mathematics self-efficacy strongly predicts problem-solving performance, as confident learners are more likely to apply varied strategies and explore multiple solution paths (Zhang et al., 2025). Moreover, instructional practices that incorporate scaffolding, feedback, and structured opportunities for success significantly enhance students' confidence in solving complex mathematical tasks (Sandal & Sperle, 2024).

Perseverance in mathematics tasks. Perseverance in mathematics refers to students' sustained effort in continuing to work through challenges and obstacles in problem-solving tasks. It is closely linked to self-efficacy, as students with higher confidence in their abilities are more likely to persist and invest greater effort in difficult tasks. Research distinguishes perseverance from related constructs such as grit and persistence, but consistently finds that these traits are strongly associated with engagement and mathematics achievement (Datu et al., 2023). Studies show that students who demonstrate greater perseverance tend to achieve higher mathematics performance and develop deeper conceptual understanding (DiNapoli, 2023). In addition, self-regulated learning research indicates that perseverance is shaped by motivational beliefs, including self-efficacy, task value, and goal orientation (Kitsantas et al., 2025). Furthermore, supportive and technology-enhanced instructional environments promote perseverance by providing structured guidance, incremental success experiences, and immediate feedback during problem-solving (Lee et al., 2026).

Application of mathematics in different contexts. The application of mathematics across contexts refers to students' beliefs in their ability to transfer mathematical knowledge to real-world, interdisciplinary, and problem-solving situations. This form of self-efficacy influences whether students initiate transfer tasks and how they regulate their thinking when applying mathematics beyond the classroom. Recent research indicates that technology-based tools, such as simulations and data analysis, help strengthen students' confidence in using mathematics across contexts by providing authentic and meaningful learning experiences (Granello et al., 2025). Similarly, contextualized mathematics instruction that connects lessons to real-life situations in science and professional fields has been shown to improve student engagement and achievement (Akmad, 2025). In addition, exposure to interdisciplinary applications across engineering, economics, and technology enhances students' mathematical reasoning skills (Goos et al., 2023). Moreover, engaging students in real-world problem-solving tasks strengthens their ability to transfer mathematical knowledge across contexts, leading to deeper learning and better retention (Anugraheni et al., 2025).

Self-regulation in mathematics learning. Self-regulation in mathematics learning refers to students' ability to plan, monitor, and manage their cognitive processes, strategies, and emotions while engaging in mathematical tasks. It is closely linked to self-efficacy: students with higher confidence are more likely to set goals, apply effective strategies, and sustain attention, and successful self-regulated learning further strengthens their sense of efficacy. Recent studies show that self-regulatory training and technology-supported tools, such as platforms providing guided planning, formative feedback, and metacognitive prompts, enhance both self-regulation and domain-specific self-efficacy (Owolabi & Owolabi, 2024). Research further indicates that self-regulated learners in mathematics are more capable of setting goals, selecting appropriate strategies, and persisting in complex problem-solving tasks (Kitsantas et al., 2025). In addition, metacognitive awareness and strategic planning have been found to significantly improve students' mathematical problem-solving performance (Kusuma et al., 2022). Moreover, strong self-regulation skills are consistently associated with higher academic achievement and deeper conceptual understanding in mathematics (Xu et al., 2025).

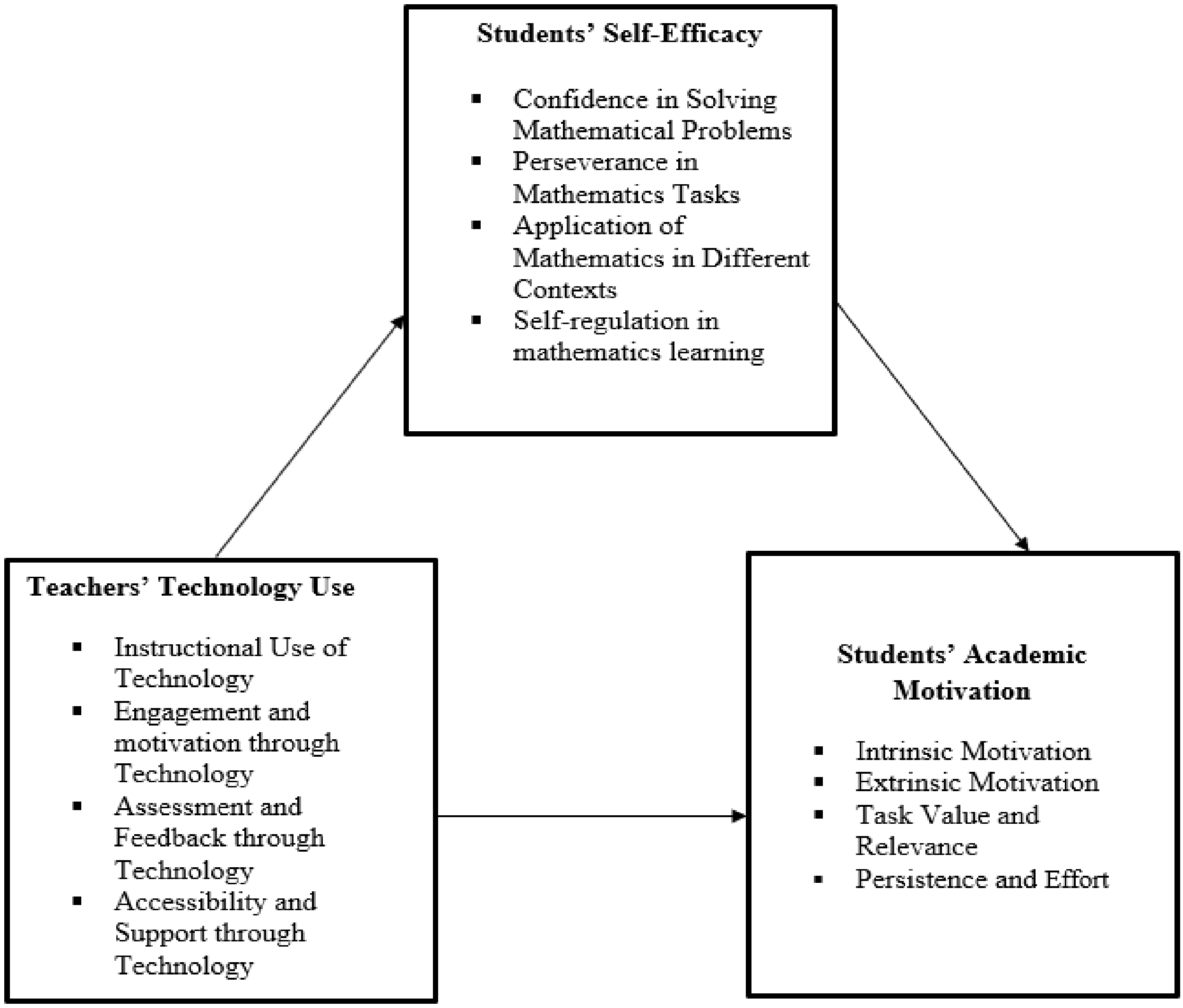

Figure 1: Schematic Diagram of the Study

Statement of the Problem

This study examined the extent of teachers' technology use, students' academic motivation in mathematics learning, and the mediating role of students' self-efficacy. It was conducted at a private higher education institution during the 2025-2026 school year. It sought answers to the following questions:

1. What is the extent of teachers' technology use in mathematics learning in terms of instructional use of technology, engagement and motivation, assessment and feedback, and accessibility and support through technology?

2. What is the level of students' self-efficacy in mathematics learning in terms of their confidence in solving mathematical problems, perseverance in mathematics tasks, application of mathematics in different contexts, and self-regulation in mathematics learning?

3. What is the level of students' academic motivation in mathematics learning in terms of their intrinsic motivation, extrinsic motivation, task value, relevance, and persistence and effort?

4. Is there a significant relationship between teachers' technology use and students' self-efficacy in mathematics learning?

5. Is there a significant relationship between students' self-efficacy and academic motivation in mathematics learning?

6. Is there a significant relationship between teachers' technology use and students' academic motivation in mathematics learning?

7. Which of the independent variables significantly predict students' academic motivation in mathematics learning?

8. What is the mediating effect of students' self-efficacy in the relationship between teachers' technology use and students' academic motivation in mathematics learning?

Null Hypothesis

Ho_1: There is no significant relationship between teachers' technology use and students' self-efficacy in mathematics learning.

Ho_2: There is no significant relationship between students' self-efficacy and academic motivation in mathematics learning.

Ho_3: There is no significant relationship between teachers' technology use and students' academic motivation in mathematics learning.

Ho_4: There are no predictors of students' academic motivation in mathematics learning.

Ho_5: Students' self-efficacy does not significantly mediate the relationship between teachers' technology use and students' academic motivation in mathematics learning.

METHODOLOGY

Design

This quantitative study employed an explanatory correlational research design with mediation analysis to examine the relationship between teachers' technology use and students' academic motivation in mathematics learning, with a focus on the mediating role of students' self-efficacy. An explanatory correlational design, a quantitative, non-experimental approach, determined the degree, direction, and strength of association among variables using statistical techniques such as correlation, regression, or PLS-SEM (Agormedah, 2025). Mediation analysis, on the other hand, explored how or why an independent variable influenced a dependent variable through an intervening variable (Abrar et al., 2024). This design was appropriate because it assessed teachers' extent of technology use, students' academic motivation, and the extent to which students' self-efficacy mediated the relationship between the two in mathematics learning.

Setting

The study was conducted at a distinguished private, non-sectarian higher education institution in Ozamiz City, Misamis Occidental, Philippines. Recognized in 2024 with ISO 21001:2018 certification and as the only Autonomous Higher Education Institution in Misamis Occidental and Northwestern Mindanao, the institution was known for academic excellence, inclusivity, and continuous improvement. With its strong integration of educational technologies in mathematics instruction and emphasis on student development, the university provided an ideal setting to examine how teachers' technology use influenced students' academic motivation and how students' self-efficacy mediated this relationship.

Respondents

The study's respondents were 197 college students enrolled in Math 1. They were selected through stratified random sampling, followed by simple random sampling within each stratum to ensure equal representation and reduce sampling bias. They were selected from 403 total population of college students enrolled in Math 1 during the first semester of the academic year 2025–2026. Using the Raosoft sample size calculator, the target sample size was 197 college students. The selection criteria included the following: (1) students were officially enrolled

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during Academic Year 2025–2026; (2) they were taking the subject Math 1; and (3) they provided full and voluntary consent to participate in the study. Before conducting the study, the researcher ensured that all these criteria were met.

Instruments

The following were the research instruments used in gathering the data:

A. Teachers' Technology Use Questionnaire. The researcher-made instrument was designed to assess the extent of teachers' technology use in Mathematics. It included four constructs: instructional use of technology, engagement and motivation, assessment and feedback, and accessibility and support through technology. The questionnaire contained five indicators per construct and employed a five-point Likert scale, with items ranging from 1 (Always) to 5 (Never). The instrument was validated with experts and pilot-tested with selected respondents not included in the study. Cronbach's alpha (α = 0.918) indicated that it was highly reliable for use in the study.

In assessing the teachers' extent of technology use, the following scale was used:

Responses	**Continuum**	**Interpretation**
5 – Always (A)	4.20 – 5.00	Very Great Extent (VGE)
4 – Often (O)	3.40 – 4.19	Great Extent (GE)
3 –Sometimes (S)	2.60 – 3.39	Moderate Extent (E)
2 –Rarely (R)	1.80 – 2.59	Less Extent (LE)
1- Never (N)	1.0-1.79	Least Extent (LEE)

B. Students' Self-Efficacy Questionnaire. The researcher-designed instrument was developed to assess students' self-efficacy in mathematics learning. It included four constructs: confidence in solving mathematical problems, perseverance in mathematics tasks, application of mathematics in different contexts, and self-regulation in mathematics learning. The questionnaire contained five indicators per construct and employed a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The instrument was validated with experts and pilot-tested with selected respondents not included in the study. Cronbach's alpha (α = 0.948) indicated that it was highly reliable for use in the study.

In assessing students' level of self-efficacy, the following scale was used:

Responses	**Continuum**	**Interpretation**
5 – Strongly Agree (SA)	4.20 – 5.00	Very High (VH)
4 – Agree (A)	3.40 – 4.19	High (H)
3 –Neutral (N)	2.60 – 3.39	Moderate (M)
2 –Disagree (D)	1.80 – 2.59	Low (L)
1 –Strongly Disagree (SD)	1.0 – 1.79	Very Low (VL)

C. Students' Academic Motivation Questionnaire. The researcher-designed instrument was developed to evaluate students' academic motivation in mathematics learning. It included four constructs: intrinsic motivation, extrinsic motivation, task value and relevance, and persistence and effort. The questionnaire contained five indicators per construct and used a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The instrument was validated with experts and pilot-tested with selected respondents not included in the study. Cronbach's alpha (α = 0.950) indicated that it was highly reliable for use in the study.

In evaluating the students' level of academic motivation, the following scale was used:

Responses	**Continuum**	**Interpretation**
5 – Strongly Agree (SA)	4.20 – 5.00	Very High (VH)
4 – Agree (A)	3.40 – 4.19	High (H)

3 –Neutral (N)	2.60 – 3.39	Moderate (M)
2 –Disagree (D)	1.80 – 2.59	Low (L)
1-Strongly Disagree (SD)	1.0-1.79	Very Low (VL

Data Gathering Procedure

Before gathering the data, the researcher sought permission from the Dean of the Graduate School of Misamis University to conduct the study. After approval was obtained, the researcher requested permission from the Department of Student Affairs and Services and from the Math 1 instructors to survey the selected respondents. After obtaining the necessary approvals, the researcher prepared the consent form for the respondents and explained the study's importance to them. Data collection was conducted on the school premises only. The researcher used Google Forms to gather the data. The data gathered were tallied for statistical analysis. Interpretation of the results followed.

Ethical Consideration

The MU-Research Ethics Committee reviewed the study before data collection. Participation was voluntary, and respondents were informed that they would not be harmed in any way. Participants' dignity was prioritized, and confidentiality and anonymity were ensured. The researcher avoided deception and misrepresentation of the study's objectives and declared any affiliations, funding sources, or potential conflicts of interest.

Respondents were asked to sign an informed consent form as proof of their voluntary participation. They were informed that they could withdraw from the study at any time. Participants were assured that only the researcher had access to the collected data and that the research data would be discarded six months after the research findings were presented to the Thesis Committee.

Data Analysis

The following statistical tools were used in analyzing the data:

Mean and Standard Deviation. These tools were used to determine teachers' level of technology use, students' self-efficacy, and students' academic motivation in mathematics learning.

Spearman Rank-Order Correlation (Spearman's rho). This tool was used to test the significant relationships among teachers' technology use and students' self-efficacy; students' self-efficacy and academic motivation; and teachers' technology use and students' academic motivation in mathematics learning, despite the data not being normal.

Regression Analysis. This tool was utilized to identify which variables significantly predicted students' academic motivation in mathematics learning and to ensure compliance with multicollinearity assumptions by meeting the Variance Inflation Factor (VIF) criterion of less than 5.

General Linear Mediation Analysis. This tool was used to test the mediating effect of students' self-efficacy on the relationship between teachers' technology use and students' academic motivation in mathematics learning.

RESULTS AND DISCUSSION

Teachers' Extent of Technology Use

Table 1 presents the respondents' perceptions of the extent of teachers' technology use in mathematics instruction. The overall result revealed that teachers' technology use was practiced to a very great extent ($M = 4.25$, $SD = 0.80$). This indicates that teachers widely integrate technological tools in their instructional practices and learning activities. The finding suggests that digital technologies have become an essential component of teaching, enabling teachers to enhance lesson delivery, improve student engagement, and facilitate access to learning resources.

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Technology use in education refers to the integration of digital tools, platforms, and resources to support teaching, learning, and classroom management. It plays a significant role in enhancing instructional delivery, improving student engagement, and facilitating access to learning materials. The overall result suggests that teachers are actively integrating technological tools across various aspects of teaching, including instructional use, engagement and motivation, and accessibility and support. When teachers effectively utilize technology in instructional activities, engagement strategies, and accessibility of learning resources, it can contribute to more interactive, efficient, and meaningful learning experiences for students. Moreover, teachers' ability to integrate technology in these domains reflects their adaptability and competence in responding to the demands of modern education, where digital resources play an essential role in supporting effective teaching and learning.

It is shown that teachers' technology use in mathematics learning, particularly in instructional use, has the highest mean (M = 4.42, SD = 0.75), indicating it is practiced to a very great extent. This indicates that technology is strongly integrated into lesson delivery and classroom instruction. Teachers consistently use digital tools such as presentations, videos, simulations, and interactive applications to explain mathematical concepts and demonstrate procedures more clearly. Through these tools, lessons become more organized, visual, and engaging, which helps students better understand complex mathematical ideas. The integration of technology also encourages active participation and increases students' interest in learning mathematics by allowing teachers to present content in more interactive and meaningful ways. This result suggests that teachers recognize the value of technology in enhancing the effectiveness of mathematics instruction and supporting students' learning experiences.

Teachers' use of technology for accessibility and support was practiced to a very great extent (M = 4.36, SD = 0.82). This result suggests that teachers actively use digital tools to make learning materials more accessible and to provide continuous support to their students. Through online platforms, learning management systems, messaging applications, and shared digital resources, teachers can distribute lesson materials, assignments, and additional references that students can access anytime. This allows students to review lessons and study at their own pace, even outside the classroom. Moreover, technology enables teachers to communicate more easily with students by answering questions, giving clarifications, and providing guidance when needed. As a result, students can receive timely assistance with their academic concerns. Overall, the use of technology for accessibility and support extends learning opportunities beyond the classroom and creates a more flexible, supportive learning environment for students.

Also, teachers' use of technology for engagement and motivation was practiced to a very great extent (M = 4.34, SD = 0.84). This result indicates that teachers intentionally use a variety of digital tools to make mathematics lessons more interesting and engaging for students. By using multimedia presentations, educational videos, online quizzes, and gamified learning platforms, teachers can create a more interactive learning environment that captures students' attention. These technologies allow students to actively participate in online discussions, collaborative tasks, and problem-solving exercises, making the learning process more dynamic. As a result, students become more motivated to take part in classroom activities and show greater interest in learning mathematics. The integration of these digital tools supports student-centered learning, where learners are encouraged to interact, explore ideas, and work together, leading to deeper engagement and a more meaningful learning experience.

Among all the constructs, teachers' use of technology for assessment and feedback has the lowest mean, indicating it is practiced to a great extent (M = 3.89, SD = 1.20). This indicates that while teachers do use technology to evaluate students' learning and provide feedback, its integration is not as strong compared to other areas of technology use. Some teachers may still rely on traditional paper-and-pencil tests, written assignments, and manual checking when assessing students' performance. As a result, the use of digital tools such as online quizzes, automated assessments, and digital feedback platforms may not yet be fully maximized. However, integrating technology in assessment can help teachers check students' understanding more efficiently and provide quicker feedback that supports learning improvement. Therefore, the results suggest the need to further encourage and strengthen the use of digital assessment tools so that teachers can monitor student progress more effectively and provide timely, meaningful feedback to support students' learning in mathematics.

Teachers' integration of digital technology in mathematics education plays an important role in improving instructional practices, increasing student engagement, and enhancing learning outcomes. Studies from 2020 to 2024 show that digital tools such as GeoGebra, augmented reality, and AI-supported applications help students better understand mathematical concepts and promote active, student-centered learning (Amaludin et al., 2024). When effectively implemented, technology integration is associated with higher academic achievement, deeper conceptual understanding, and increased student motivation (Hidayat & Firmanti, 2024). In the Philippine context, research also found that teachers' high level of technology integration is significantly related to greater student engagement and improved academic performance, highlighting the importance of digital pedagogy (Cajandig & Saliao, 2025). Similarly, teachers in Botswana reported positive perceptions of classroom technology use, emphasizing that teacher readiness and effective instructional strategies are essential for successful technology integration (Thabologo & Keganneng, 2025).

Overall, teachers exhibit a high level of technology integration in mathematics instruction, particularly in instructional use, engagement and motivation, and accessibility and support through technology. However, the use of technology for assessment and feedback remains an area for improvement. Strengthening teachers' competencies in technology-based assessment can enhance the monitoring of student progress and provide timely, personalized feedback that supports learning improvement. The strategic integration of digital assessment platforms, adaptive learning systems, and learning analytics enables teachers to identify learning gaps, provide targeted support, and foster deeper understanding in mathematics. By utilizing online quizzes, interactive platforms, and learning management systems, teachers can help students quickly recognize errors, track their progress, and refine problem-solving strategies. Enhancing the use of these technologies ensures that feedback becomes continuous, meaningful, and reflective, fostering sustained engagement, self-reflection, and improved learning outcomes.

Table 1. Teachers' Extent of Technology Use

Constructs	M	SD	Interpretation
Instructional Use of Technology	4.42	0.75	Very Great Extent
Engagement and Motivation through Technology	4.34	0.84	Very Great Extent
Assessment and Feedback through Technology	3.89	1.20	Great Extent
Accessibility and Support through Technology	4.36	0.82	Very Great Extent
Overall Teachers' Extent of Technology Use	**4.25**	**0.80**	**Very Great Extent**

Scale: 4.20-5.00(Very Great Extent); 3.40-4.19 (Great Extent); 2.60-3.39 (Moderate Extent); 1.80-2.59 (Less Extent); 1.0-1.79 (Least Extent)

Level of the Students' Self-Efficacy

Table 2 shows that students demonstrated a high level of self-efficacy ($M = 4.18$, $SD = 0.67$). This indicates that they generally have strong confidence in their ability to successfully perform mathematical tasks. A high level of self-efficacy suggests that students feel capable of handling mathematical challenges and believe that they can succeed through effort and appropriate learning strategies. This confidence encourages active participation, sustained effort, and resilience in overcoming academic challenges, which ultimately supports improved learning experiences and better academic performance in mathematics.

Students' self-efficacy refers to learners' belief in their ability to successfully perform academic tasks and overcome learning challenges. It plays an important role in shaping students' motivation, persistence, and overall academic performance. When students believe that they are capable of accomplishing academic tasks, they are more likely to approach challenging activities with determination, apply appropriate learning strategies, and remain persistent despite difficulties. Feeling confident in their abilities enables students to actively participate in classroom activities, exert greater effort in completing tasks, and maintain a positive attitude toward learning. This sense of competence and capability can strengthen students' engagement and ultimately improve academic performance and success in mathematics.

It was shown that students had a very high level of self-efficacy in terms of application of mathematics in different contexts (M=4.31, SD=0.74). This indicates that students are confident in their ability to apply mathematical concepts and skills in a range of situations beyond routine classroom exercises. In other words, they believe that they can apply what they have learned in mathematics to solve real-life problems, analyze situations, and make logical decisions. Such confidence suggests that students not only understand mathematical procedures but also recognize how these concepts can be applied in practical, meaningful ways, such as in daily activities, problem-solving tasks, or future career-related situations. When students feel capable of applying mathematics in different contexts, they are more likely to participate actively in learning activities, approach complex problems with confidence, and explore multiple strategies to arrive at solutions. This strong belief in their ability to apply mathematical knowledge also encourages deeper understanding, strengthens problem-solving skills, and promotes greater engagement in learning mathematics. As a result, students with high self-efficacy in applying mathematics are better prepared to use mathematical thinking effectively both in and out of the classroom.

It is also revealed that the respondents had a high level of self-efficacy regarding self-regulation in mathematics learning (M = 4.17, SD = 0.76), indicating that students generally believe in their ability to manage and control their own learning processes. Self-regulation involves setting goals, organizing study time, monitoring understanding, and applying strategies to improve performance. This suggests that students feel confident in planning their learning activities, staying focused on tasks, and adjusting when they encounter difficulties in mathematical concepts. However, a high rather than very high result may indicate that some students still experience challenges in consistently regulating their learning independently, such as difficulties with time management, maintaining focus, or applying effective study strategies. Thus, while students demonstrate positive confidence in managing their mathematics learning, there remains room to further strengthen their self-regulation skills to enhance their understanding and academic performance.

Likewise, the respondents demonstrated a high level of self-efficacy in persevering with mathematics tasks (M = 4.15, SD = 0.78), indicating that students generally believe in their ability to continue working on mathematical problems even when they encounter difficulties. This suggests that many students are confident in their ability to remain patient and persistent when solving challenging tasks. Perseverance is important in mathematics because understanding concepts often requires sustained effort and repeated practice. However, a high score rather than a very high one may indicate that some students still experience difficulty, frustration, or uncertainty when dealing with complex problems, which can sometimes affect their persistence. Nonetheless, this level of confidence still supports students' continued engagement and gradual improvement in solving mathematical tasks.

Also, regarding confidence in solving mathematical problems, the respondents reported a high level of self-efficacy (M = 4.08, SD = 0.80), indicating that students generally believe in their ability to understand and solve mathematical tasks. This suggests that many students feel capable of applying mathematical concepts and strategies to problems. However, a high rather than very high level may imply that some students still experience uncertainty or hesitation when dealing with complex or unfamiliar mathematical problems. Factors such as the difficulty of certain topics or the fear of making mistakes may affect their confidence. Nonetheless, the overall high level of confidence supports students' engagement in learning and helps them gradually improve their problem-solving skills in mathematics.

Students' self-efficacy refers to learners' beliefs in their ability to organize and execute the actions required to successfully perform academic tasks (Bandura, 1997). According to Social Cognitive Theory, self-efficacy shapes how individuals think, feel, motivate themselves, and behave, influencing their approach to challenging tasks, persistence, and effort. Students with strong self-efficacy are more likely to engage actively, invest greater effort, and sustain motivation even when faced with difficulties. Empirical studies consistently show that mathematics self-efficacy predicts engagement, achievement, and future educational choices in mathematics-related fields (Street et al., 2024). Students confident in applying mathematical knowledge demonstrate stronger problem-solving abilities, conceptual understanding, and active participation in learning tasks (Zhou et al., 2023). Moreover, self-regulated learning skills enhance self-efficacy, promoting academic independence and improved performance (Schunk & DiBenedetto, 2020). And He et al. (2025) also indicate that perseverance mediates achievement in mathematics, as sustained effort fosters deeper conceptual understanding and problem-solving skills.

Overall, the findings indicate that students demonstrate a strong level of self-efficacy in mathematics learning, particularly in applying mathematical knowledge to real-life contexts. Although students exhibit very high self-efficacy in applying mathematics across different contexts, other areas, such as confidence in solving mathematical problems, perseverance in mathematics tasks, and self-regulation in learning, can still be further strengthened to enhance their ability to manage complex mathematical challenges more effectively. Teachers are encouraged to provide structured guidance on goal setting, effective study habits, and problem-solving strategies, while also offering regular feedback and opportunities for practice. Creating a supportive learning environment that encourages students to learn from mistakes and gradually tackle more challenging problems can further strengthen their confidence and persistence, thereby enhancing self-efficacy and improving students' overall success in mathematics.

Table 2. Level of the Students' Self Efficacy

Constructs	M	SD	Interpretation
Confidence in Solving Mathematical Problems	4.08	0.80	High
Perseverance in Mathematics Tasks	4.15	0.78	High
Application of Mathematics in Different Contexts	4.31	0.74	Very High
Self-Regulation in Mathematics Learning	4.17	0.76	High
Overall Level of Students' Self-Efficacy	**4.18**	**0.70**	**High**

Scale: 4.20-5.00(Very High); 3.40-4.19 (High); 2.60-3.39 (Moderate); 1.80-2.59 (Low); 1.0-1.79 (Very Low)

Level of the Students' Academic Motivation

Table 3 shows that students' overall academic motivation for learning mathematics is very high (M = 4.33, SD = 0.77). This indicates that students demonstrate strong enthusiasm, commitment, and psychological investment in their academic tasks. The findings also imply that students are actively engaged in their learning, likely supported by a conducive learning environment, meaningful instructional practices, and clear personal academic goals that sustain their effort and persistence.

Academic motivation refers to the internal and external forces that stimulate, guide, and sustain students' engagement in learning activities. It encompasses intrinsic factors, such as curiosity, enjoyment, and personal interest in learning, as well as extrinsic influences, including rewards, recognition, and the desire to achieve academic goals. The level of students' academic motivation reflects the extent to which learners are driven to participate in academic tasks, persist in challenging learning activities, and strive for educational success. As a critical component of students' learning behavior, academic motivation significantly influences their level of participation, effort, and commitment to academic responsibilities. When students have strong academic motivation, they are more likely to actively engage in classroom activities, complete academic requirements with dedication, and pursue meaningful, sustained learning experiences that contribute to their overall academic development.

It is shown that students' academic motivation in mathematics learning, particularly in terms of task value and relevance, has the highest mean, indicating very high motivation (M = 4.50, SD = 0.71). This suggests that students recognize the importance of what they are learning and understand how their academic activities can contribute to their future goals, careers, and real-life applications. When students perceive their learning tasks as valuable and relevant, they become more committed to completing their academic responsibilities and are more motivated to perform well in their studies. This perception helps students connect classroom lessons with real-world situations, making learning more meaningful and practical rather than simply theoretical. As a result, students tend to invest more effort, attention, and time in their academic tasks because they see clear benefits. Furthermore, when students value their academic work, they are more likely to develop stronger goals, remain focused on achieving them, and persist even when they encounter difficulties. This strong sense of relevance and purpose, therefore, plays a crucial role in strengthening students' motivation, engagement, and overall commitment to their academic success.

Likewise, the respondents reported a very high level of students' intrinsic motivation (M = 4.33, SD = 0.76). This suggests that many students value learning not only for grades or external rewards but also for the knowledge and understanding they gain from their academic experiences. When students are intrinsically motivated, they tend to participate more actively in classroom discussions, explore ideas more deeply, and demonstrate greater curiosity toward the subject matter. This form of motivation also encourages students to think critically, solve problems creatively, and continue learning even when tasks become challenging. As a result, intrinsic motivation plays an important role in strengthening students' academic engagement, persistence, and commitment to achieving meaningful learning outcomes.

The respondents also obtained a very high level of academic motivation in terms of persistence and effort (M = 4.29, SD = 0.77), indicating that students are generally willing to work hard, stay focused, and continue learning even when they encounter difficulties in their academic tasks. This suggests that many students do not easily give up when faced with challenging lessons or demanding requirements; instead, they demonstrate determination and dedication in completing their responsibilities. Persistence reflects how motivation translates into actual behavior, as motivated students are more likely to invest time and energy in studying, completing assignments, and deepening their understanding of the subject matter. When students consistently exert effort, they gradually develop stronger skills, deeper knowledge, and greater confidence in their academic abilities. Over time, this sustained effort helps them master concepts and improve their academic performance. Therefore, a very high level of persistence and effort indicates that students possess strong determination to succeed in their studies and are willing to overcome obstacles to reach their educational goals.

Among the constructs of students' academic motivation, extrinsic motivation had the lowest mean, indicating that students demonstrated a high level of academic motivation in this domain (M = 4.19, SD = 0.83). This suggests that many students are motivated to perform well in their studies because they aim to achieve good grades, receive positive feedback from teachers and parents, or prepare for better educational and employment opportunities in the future. Although extrinsic motivation is slightly lower than intrinsic motivation, it still contributes significantly to students' academic engagement by encouraging them to meet academic expectations and complete required tasks. External motivations, such as performance standards, awards, or academic recognition, can help students remain focused and disciplined in their studies. Moreover, these external incentives often serve as starting points that encourage students to participate in learning activities. Over time, as students continue to engage with academic tasks, these externally driven motivations may gradually develop into more personal interest and internal commitment to learning, ultimately strengthening their overall academic motivation and achievement.

Students' academic motivation plays a critical role in mathematics achievement, as both intrinsic and extrinsic factors significantly influence engagement and performance. Intrinsic motivation, including self-efficacy, goal orientation, and perceived task value, enhances persistence, creativity, and deeper cognitive engagement in mathematics learning (Asanre, 2024). In contrast, extrinsic motivators, such as rewards, recognition, and performance feedback, reinforce motivation and promote academic discipline (Viterouli et al., 2025). Empirical studies further confirm that highly motivated students are more likely to adopt effective learning strategies, achieve conceptual understanding, and persist in problem-solving tasks (Nurhayati et al., 2025). Despite these positive outcomes, research indicates that many students demonstrate moderate levels of motivation, often accompanied by fluctuations in interest and engagement, particularly when mathematics is perceived as difficult or irrelevant (Rahayu et al., 2024). However, other studies suggest that students can exhibit high levels of academic motivation when supported by effective teaching strategies, positive classroom environments, and meaningful learning experiences (Fitz, 2025).

Overall, the findings indicate that students demonstrate a very high level of academic motivation in learning mathematics, particularly in intrinsic motivation, task value and relevance, and persistence and effort. However, students' levels of extrinsic motivation could be further strengthened. Schools and educators can enhance students' engagement by setting clear academic expectations, providing constructive feedback, recognizing accomplishments, and offering meaningful incentives that encourage students to maintain focus and persistence in their studies. By strengthening these external motivational supports, teachers can help students remain committed to learning, especially when they encounter challenging academic tasks. Moreover, aligning external encouragement with students' intrinsic interests and the perceived relevance of learning can further promote deeper engagement and sustained effort. Through these supportive practices, educational institutions can foster a motivating learning environment that not only strengthens students' persistence and academic performance but also encourages long-term commitment to learning and academic success.

Table 3. Level of the Students' Academic Motivation

Constructs	M	SD	Interpretation
Intrinsic Motivation	4.33	0.76	Very High
Extrinsic Motivation	4.19	0.83	High
Task Value and Relevance	4.50	0.71	Very High
Persistence and Effort	4.29	0.77	Very High
Overall Level of Students' Academic Motivation	**4.33**	**0.67**	**Very High**

Scale: 4.20-5.00(Very High); 3.40-4.19 (High); 2.60-3.39 (Moderate); 1.80-2.59 (Low); 1.0-1.79 (Very Low)

Significant Relationship between Teachers' Technology Use and Students' Self-Efficacy

Table 4 presents the results of the Spearman's rho correlation analysis examining the relationship between teachers' technology use and students' self-efficacy in mathematics learning. Teachers' technology use was examined across four dimensions: instructional use of technology, engagement and motivation, assessment and feedback, and accessibility and support. Meanwhile, students' self-efficacy was analyzed in terms of confidence in solving math problems, perseverance in math tasks, application of mathematics in different contexts, and self-regulation in mathematics learning.

The results show that all correlations were statistically significant (p-values < .001), indicating consistent positive relationships between teachers' technology use and students' self-efficacy in mathematics. This means that when teachers effectively integrate technology into their teaching, students tend to develop greater confidence in their mathematical abilities. Technology-supported learning environments appear to help students feel more capable of solving mathematical problems, applying concepts in different situations, persisting through challenging tasks, and managing their own learning. These findings suggest that technology integration can play an important role in strengthening students' beliefs in their ability to learn and perform well in mathematics.

The instructional use of technology was significantly and positively correlated with confidence in solving math problems ($r_s = .403$, $p < .001$), perseverance in math tasks ($r_s = .441$, $p < .001$), application of math in different contexts ($r_s = .453$, $p < .001$), and self-regulation in math learning ($r_s = .384$, $p < .001$). These correlations range from moderate to moderately strong, indicating that when teachers actively incorporate digital tools into instruction, students tend to develop greater confidence, persistence, and independent learning skills in mathematics. The strongest relationship was observed in the application of mathematics in different contexts, suggesting that technology-supported instruction may help students visualize mathematical ideas and connect them to real-world situations. When digital tools such as simulations, visual representations, and interactive exercises are used to present mathematical concepts, students may better understand how mathematics works in practical contexts, which strengthens their confidence in applying these concepts effectively. These findings are supported by the Technology Acceptance Model, which emphasizes that learners are more likely to benefit from technologies they perceive as useful and easy to use (Davis, 1989), and the Social Cognitive Theory, which highlights the role of learning experiences and mastery in strengthening self-efficacy and persistence (Bandura, 1978).

Similarly, engagement and motivation through technology also showed significant positive relationships with confidence in solving math problems ($r_s = .408$, $p < .001$), perseverance in math tasks ($r_s = .455$, $p < .001$), application of math in different contexts ($r_s = .504$, $p < .001$), and self-regulation in math learning ($r_s = .400$, $p < .001$). These results suggest that when technology is used to encourage active participation and interaction in the learning process, students become more confident in their ability to perform mathematical tasks. The strongest relationship again emerged in the application of mathematics across contexts, indicating that interactive digital environments help students connect mathematical ideas to real-life situations. Technology that encourages exploration, collaboration, and participation may therefore strengthen students' self-efficacy by helping them better understand and apply mathematical concepts. These findings are consistent with the Social Cognitive Theory, which emphasizes the influence of active learning experiences and environmental factors on learners' beliefs and behaviors (Bandura, 1978), and the Self-Determination Theory, which posits that learning environments that support autonomy, competence, and relatedness enhance students' motivation and engagement (Deci & Ryan, 1985).

Assessment and feedback through technology also demonstrated significant correlations with confidence in solving math problems ($r_s = .446, p < .001$), perseverance in math tasks ($r_s = .429, p < .001$), application of math in different contexts ($r_s = .397, p < .001$), and self-regulation in math learning ($r_s = .361, p < .001$). Although these relationships are slightly lower than those in other dimensions, they remain moderate and statistically significant. These findings suggest that technology-based assessment tools, such as online quizzes, automated feedback systems, and digital progress-monitoring platforms, can help students become more aware of their strengths and areas for improvement. When students receive timely and clear feedback, they are better able to evaluate their performance, correct mistakes, and develop confidence in their mathematical abilities. As a result, technology-supported feedback may encourage students to remain persistent when solving challenging problems. These findings align with the Social Cognitive Theory, which emphasizes the role of feedback and mastery experiences in strengthening self-efficacy (Bandura, 1978), and the Self-Determination Theory, which highlights the importance of competence-supportive environments in fostering sustained motivation and learning (Deci & Ryan, 1985).

Finally, accessibility and support provided through technology showed significant positive relationships with confidence in solving math problems ($r_s = .444, p < .001$), perseverance in math tasks ($r_s = .484, p < .001$), application of math in different contexts ($r_s = .541, p < .001$), and self-regulation in math learning ($r_s = .442, p < .001$). These results indicate that when technology improves students' access to learning materials, instructional guidance, and mathematical resources, their self-efficacy in mathematics also increases. The strongest relationship was again observed in the application of mathematics across contexts, suggesting that accessible digital resources enable students to explore mathematical concepts more independently and apply them to different situations. When students have continuous access to learning tools and support, they are more likely to feel confident in their abilities, take greater responsibility for their learning, and persist in solving mathematical tasks. These findings are supported by the Technology Acceptance Model, which explains that learners engage more with technologies they perceive as useful and accessible (Davis, 1989), and the Self-Determination Theory, which emphasizes that supportive learning environments that promote autonomy and competence enhance students' motivation and self-efficacy (Deci & Ryan, 1985).

Integrating digital technology in education presents challenges, particularly when teachers do not actively model and structure its effective use, which may result in fragmented instruction and reduced learning coherence for students (Viberg et al., 2023). Teachers' competence and training in technology integration, both during pre-service preparation and ongoing professional development, are essential for maximizing instructional impact (Niiku et al., 2022). Moreover, self-efficacy plays a critical role in students' mathematics success, and effective interventions should directly strengthen self-efficacy sources or embed efficacy-enhancing features into instructional strategies (Clemente et al., 2024). These findings underscore the importance of evidence-based, context-sensitive instructional practices that integrate technology purposefully while fostering students' confidence and competence in mathematics learning. According to Niiku et al. (2022), teacher training in technology integration, whether in college training or as part of professional development, is important for shaping teachers' self-efficacy in using technology in the classroom.

The integration of technology into mathematics instruction is an important way to strengthen students' self-efficacy and confidence in learning. Teachers are encouraged to strategically use digital tools such as simulations, visualizations, and interactive exercises to clarify and engage with abstract mathematical concepts, while also designing technology-supported activities that allow students to explore concepts, practice skills, and learn from

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mistakes in a supportive environment. Providing timely digital feedback, guided hints, and constructive comments can help students recognize their progress, improve their problem-solving strategies, and maintain confidence in their abilities. At the same time, educational institutions play a vital role in sustaining this positive relationship by providing reliable technological infrastructure, access to digital learning platforms, and continuous professional development that equip teachers to effectively integrate technology into instruction. Institutions can also foster collaborative, student-centered learning environments that encourage innovation and meaningful technology use. Through the combined efforts of teachers and educational institutions, purposeful technology integration can continuously reinforce students' confidence, independence, and persistence in learning mathematics.

Table 4. Significant Relationship between Teachers' Technology Use and Students' Self-Efficacy

Variables		Confidence in Solving Math Problems	Perseverance in Math Tasks	Application of Math in Different Contexts	Self-Regulation in Math Learning
Instructional Use of Technology	r_s	0.403***	0.441***	0.453***	0.384***
	p	<.001	<.001	<.001	<.001
Engagement and Motivation	r_s	0.408***	0.455***	0.504***	0.400***
	p	<.001	<.001	<.001	<.001
Assessment and Feedback	r_s	0.446***	0.429***	0.397***	0.361***
	p	<.001	<.001	<.001	<.001
Accessibility and Support	r_s	0.444***	0.484***	0.541***	0.442***
	p	<.001	<.001	<.001	<.001

Notes: Ho_1: There is no significant relationship between teachers' technology use and students' self-efficacy.

P value Scale: *** p < .001 (Very Highly Significant); **p<0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not Significant)

Significant Relationship between Students' Self-Efficacy and Academic Motivation

Table 5 presents the results of the Spearman's rho correlation analysis examining the relationship between students' self-efficacy and academic motivation in mathematics learning. Students' self-efficacy was examined across four dimensions: confidence in solving math problems, perseverance in math tasks, application of mathematics in different contexts, and self-regulation in math learning. Meanwhile, academic motivation was analyzed in terms of intrinsic motivation, extrinsic motivation, task value and relevance, and persistence and effort.

The results reveal that all correlations were statistically significant (p-values < .001), indicating strong and consistent positive relationships between students' self-efficacy and academic motivation. This means that students who believe more strongly in their ability to perform mathematical tasks tend to demonstrate higher levels of motivation in learning mathematics. When students feel confident in solving problems, persist through challenges, apply mathematical concepts in various situations, and regulate their own learning, they are more likely to develop both internal and external motivation toward academic tasks. These findings suggest that strengthening students' self-efficacy may play an important role in enhancing their overall motivation, engagement, and effort in mathematics learning.

Confidence in solving math problems was significantly and positively correlated with intrinsic motivation (r_s = .606, p < .001), extrinsic motivation (r_s = .529, p < .001), task value and relevance (r_s = .588, p < .001), and persistence and effort (r_s = .642, p < .001). These results indicate that students who feel confident in their ability to solve mathematical problems tend to show stronger interest in learning mathematics, recognize the importance and usefulness of mathematical concepts, and exert greater effort when completing mathematical tasks. When learners believe they can successfully solve problems, they are more likely to engage actively in learning activities and remain motivated even when tasks become challenging. These findings are consistent with Social Cognitive Theory, which emphasizes that self-efficacy influences individuals' motivation, effort, and persistence in performing tasks (Bandura, 1978).

Similarly, perseverance in math tasks demonstrated significant positive relationships with intrinsic motivation ($r_s = .679$, $p < .001$), extrinsic motivation ($r_s = .570$, $p < .001$), task value and relevance ($r_s = .666$, $p < .001$), and persistence and effort ($r_s = .808$, $p < .001$). These correlations suggest that students who persist in solving mathematical problems, even when faced with difficulties, tend to exhibit stronger motivation toward learning mathematics. The strongest relationship was observed with persistence and effort, indicating that students who demonstrate perseverance are more likely to remain committed to completing mathematical tasks and achieving learning goals. This pattern implies that resilience and determination in mathematics learning contribute significantly to sustaining students' motivation and engagement. These findings align with Social Cognitive Theory, which highlights the role of perseverance and mastery experiences in shaping individuals' motivation and belief in their capabilities (Bandura, 1978).

The application of mathematics in different contexts was also significantly and positively correlated with intrinsic motivation ($r_s = .651$, $p < .001$), extrinsic motivation ($r_s = .563$, $p < .001$), task value and relevance ($r_s = .756$, $p < .001$), and persistence and effort ($r_s = .744$, $p < .001$). These findings indicate that students who can apply mathematical concepts in various real-life situations tend to be more motivated to learn mathematics. The strongest relationship was observed with task value and relevance, suggesting that when students recognize the usefulness of mathematics in everyday contexts, they are more likely to value the subject and remain motivated to learn it. Understanding the real-world relevance of mathematics may therefore strengthen both students' interest and commitment to learning mathematical concepts. This finding supports Self-Determination Theory, which emphasizes that learners are more motivated when they perceive learning tasks as meaningful and relevant to their experiences (Deci & Ryan, 1985).

Finally, self-regulation in math learning showed significant positive correlations with intrinsic motivation ($r_s = .614$, $p < .001$), extrinsic motivation ($r_s = .502$, $p < .001$), task value and relevance ($r_s = .543$, $p < .001$), and persistence and effort ($r_s = .673$, $p < .001$). These results suggest that students who can manage their learning strategies, monitor their progress, and control their study behaviors tend to demonstrate higher levels of academic motivation. Self-regulated learners are more likely to set learning goals, maintain focus during challenging tasks, and persist until they achieve desired outcomes. As a result, their ability to regulate their learning process contributes to stronger motivation and sustained engagement in mathematics. These findings are supported by Self-Determination Theory, which highlights the importance of autonomy and self-directed learning in fostering intrinsic motivation and sustained academic engagement (Deci & Ryan, 1985).

Self-efficacy, defined as learners' belief in their ability to perform academic tasks successfully, has consistently been identified as a significant factor influencing both intrinsic and extrinsic motivation. Students who perceive themselves as competent are more likely to actively engage in learning, persist in challenging tasks, and recognize the value of academic activities (Yang et al., 2025). Empirical evidence supports this relationship: a correlational study among senior high school students found a statistically significant association between self-efficacy and academic motivation, indicating that higher self-belief is associated with greater motivation for academic tasks (Tipon et al., 2025). Similarly, research involving undergraduate students demonstrated that self-efficacy significantly predicts both intrinsic and extrinsic motivation, suggesting that students' confidence in their abilities enhances their willingness to learn and achieve academic goals (Celcima et al., 2024). Furthermore, Valenzuela-Peñuñuri et al. (2024) reported a strong positive association between self-efficacy and motivation, emphasizing that students who exhibit sustained interest and enthusiasm in subjects such as science and mathematics tend to develop stronger confidence through prior mastery experiences.

Strengthening students' self-efficacy is essential for enhancing academic motivation in mathematics. Teachers can support this relationship by providing meaningful problem-solving activities, offering clear guidance and encouragement, recognizing students' progress, and emphasizing the real-life relevance of mathematical concepts so that learners see the value of what they are studying. Providing constructive feedback, celebrating small achievements, and creating a supportive classroom environment where mistakes are viewed as opportunities for learning can further help students build confidence and remain motivated. At the same time, students play an important role by actively engaging in learning tasks, setting personal learning goals, practicing self-regulated strategies such as monitoring their progress and reflecting on their understanding, and seeking help when difficulties arise. Educational institutions can sustain this positive relationship by promoting learner-centered teaching approaches, providing access to academic support programs and learning resources, and offering professional development for teachers to strengthen strategies that foster students' confidence and motivation. Through the collaborative efforts of teachers, students, and educational institutions, the positive relationship between self-efficacy and academic motivation can be maintained, encouraging greater persistence, engagement, and success in mathematics learning.

Table 5. Significant Relationship between Students' Self-Efficacy and Academic Motivation

Variables		Intrinsic Motivation	Extrinsic Motivation	Task Value and Relevance	Persistence and Effort
Confidence in Solving Math Problems	r_s	0.606***	0.529***	0.588***	0.642***
	p	<.001	<.001	<.001	<.001
Perseverance in Math Tasks	r_s	0.679***	0.570***	0.666***	0.808***
	p	<.001	<.001	<.001	<.001
Application of Math in Different Contexts	r_s	0.651***	0.563***	0.756***	0.744***
	p	<.001	<.001	<.001	<.001
Self-Regulation in Math Learning	r_s	0.614***	0.502***	0.543***	0.673***
	p	<.001	<.001	<.001	<.001

Notes: Ho_2: There is no significant relationship between students' self-efficacy and academic motivation.

P value Scale: *** p < .001 (Very Highly Significant); **p<0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not Significant)

Significant Relationship between Teachers' Technology Use and Students' Academic Motivation

Table 6 presents the results of the Spearman's rho correlation analysis examining the relationship between teachers' instructional use of technology and students' academic motivation. Teachers' instructional use of technology was operationalized across four dimensions: instructional use of technology, engagement and motivation, assessment and feedback, and accessibility and support. Students' academic motivation was examined through intrinsic motivation, extrinsic motivation, task value and relevance, and persistence and effort.

The results reveal that all correlations were highly significant. This demonstrates that teachers' use of technology is meaningfully associated with students' academic motivation. In other words, as teachers increasingly integrate technological tools and digital resources into their instructional practices, students tend to show higher levels of motivation to learn. This further suggests that technology-supported instruction may create more engaging, interactive, and supportive learning environments that stimulate students' interest and participation in academic tasks. Consequently, these findings highlight the important role of technology integration in fostering students' motivation and enhancing the overall classroom learning experience.

Instructional use of technology showed a highly significant relationship with students' academic motivation, including intrinsic motivation (r_s = .558, p < .001), extrinsic motivation (r_s = .454, p < .001), task value and relevance (r_s = .519, p < .001), and persistence and effort (r_s = .522, p < .001). This indicates that as teachers integrate technology into instruction, students' motivation to learn mathematics increases. Technology can make lessons more engaging and interactive, enhancing intrinsic motivation by stimulating curiosity and interest in learning. It also supports extrinsic motivation through digital feedback, recognition, and interactive tasks. Moreover, technology helps students recognize the value and relevance of learning by connecting mathematical concepts to real-life situations through visualizations and simulations. Technology-supported instruction also promotes persistence and effort by providing opportunities for repeated practice, exploration of problem-solving strategies, and immediate feedback. These findings support the Technology Acceptance Model, which explains

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that learners adopt technology when it is perceived as useful and easy to use (Davis, 1989), and the Social Cognitive Theory, which highlights the role of learning experiences and feedback in strengthening students' self-efficacy, effort, and persistence (Bandura, 1978).

Engagement and motivation through technology also showed a highly significant relationship with students' academic motivation, including intrinsic motivation ($r_s = .542$, $p < .001$), extrinsic motivation ($r_s = .469$, $p < .001$), task value and relevance ($r_s = .557$, $p < .001$), and persistence and effort ($r_s = .468$, $p < .001$). This indicates that when technology enhances students' engagement in learning, their motivation in mathematics also increases. Technology-supported activities stimulate intrinsic motivation by making learning more interactive and interesting, while digital feedback and recognition strengthen extrinsic motivation. Technology also helps students recognize the value and relevance of mathematical concepts through visualizations and real-world applications, while encouraging persistence and effort through repeated practice and immediate feedback. These findings are supported by the Technology Acceptance Model (Davis, 1989), the Social Cognitive Theory, which emphasizes the role of self-efficacy and learning experiences in motivating behavior (Bandura, 1978), and the Self-Determination Theory, which states that learning environments supporting autonomy, competence, and relatedness enhance students' motivation (Deci & Ryan, 1985).

Assessment and feedback through technology showed a significant relationship with students' academic motivation, including intrinsic motivation ($r_s = .407$, $p < .001$), extrinsic motivation ($r_s = .396$, $p < .001$), task value and relevance ($r_s = .396$, $p < .001$), and persistence and effort ($r_s = .380$, $p < .001$). This suggests that technology-supported assessment and feedback enhance students' motivation in learning mathematics. Technology-based tools such as online quizzes, automated feedback, and digital evaluation platforms allow students to monitor their progress and identify areas for improvement, thereby strengthening intrinsic motivation. Digital scores, recognition, and feedback also reinforce extrinsic motivation by encouraging students to improve their performance. Furthermore, timely feedback helps students understand the value and relevance of learning tasks, while repeated practice opportunities promote persistence and effort in mastering mathematical concepts. These findings are supported by the Technology Acceptance Model (Davis, 1989), the Social Cognitive Theory, which highlights the role of feedback and mastery experiences in strengthening self-efficacy and persistence (Bandura, 1978), and the Self-Determination Theory, which posits that learning environments supporting competence, autonomy, and relatedness enhance intrinsic and extrinsic motivation (Deci & Ryan, 1985).

Accessibility and support provided through technology also showed a highly significant relationship with students' academic motivation, including intrinsic motivation ($r_s = .560$, $p < .001$), extrinsic motivation ($r_s = .459$, $p < .001$), task value and relevance ($r_s = .556$, $p < .001$), and persistence and effort ($r_s = .497$, $p < .001$). This indicates that when technology improves students' access to learning resources and instructional support, their motivation in mathematics also increases. Accessible digital tools, online resources, and learning platforms enhance intrinsic motivation by making mathematical learning more engaging and understandable. Technology also supports extrinsic motivation through digital guidance, feedback, and structured learning resources. In addition, access to technology helps students recognize the value and relevance of mathematical concepts through simulations, visualizations, and real-world applications. Continuous access to materials and academic support also promotes persistence and effort, as students can revisit lessons and practice skills at any time. These findings align with the Technology Acceptance Model (Davis, 1989), the Social Cognitive Theory, which emphasizes the role of supportive environments in strengthening self-efficacy and persistence (Bandura, 1978), and the Self-Determination Theory, which highlights the importance of autonomy, competence, and relatedness in fostering academic motivation (Deci & Ryan, 1985).

Digital learning environments provide dynamic and engaging contexts that enhance conceptual understanding, streamline instruction, and foster students' interest in learning (Cirneanu & Moldoveanu, 2024). The integration of interactive digital materials allows teachers to assess student progress more effectively, identify strengths and weaknesses, and implement targeted instructional adjustments. In specialized disciplines, such as defense and security, virtual simulations further support skill development and decision-making in safe, controlled settings. In mathematics education, educational technologies, including digital games, have demonstrated potential to increase student engagement and motivation (Fadda et al., 2022). Moreover, faculty support plays a crucial role in sustaining motivation, as psychological and functional support are positively associated with intrinsic academic motivation and negatively related to academic motivation (Raboca & Carbunarean, 2024). Collectively, these findings emphasize that technology integration, when combined with supportive teaching practices, enhances both engagement and academic motivation.

Teachers' use of technology in instruction plays a significant role in enhancing students' academic motivation and engagement, particularly when it is purposefully and pedagogically integrated into learning activities. Evidence suggests that the effectiveness of technology lies not merely in its availability, but in how teachers design and facilitate its use. For instance, Tailor et al. (2023) found that the frequency and quality of teachers' digital interactions with students during and after remote teaching contexts were positively associated with improved student motivation. However, pedagogical approaches exerted a stronger influence than access to technology alone. Similarly, Guaña-Moya et al. (2024) reported that interactive technologies aligned with clear learning objectives and supported by guided instruction significantly enhance students' intrinsic motivation and engagement, highlighting the mediating role of teacher implementation strategies.

Educational institutions are encouraged to strengthen the purposeful integration of digital tools in mathematics teaching and learning. Teachers can use interactive technologies, such as simulations, visual presentations, and real-world applications, to make mathematical concepts more meaningful, engaging, and easier for students to understand. Meanwhile, educational institutions can support this process by providing adequate technological infrastructure, digital learning platforms, and professional development opportunities that enable teachers to effectively implement technology-enhanced instruction. Technology-based assessment systems can also help teachers deliver timely and constructive feedback, allowing students to monitor their progress, identify errors, and improve their problem-solving strategies. Furthermore, institutions can ensure that students have wider access to digital learning resources that allow them to review lessons, practice mathematical skills, and learn at their own pace beyond the classroom. Through coordinated efforts among teachers and educational institutions, the purposeful and well-designed integration of technology into mathematics education can significantly strengthen students' motivation, deepen engagement, and promote sustained learning persistence.

Table 6. Significant Relationship between Teachers' Technology Use and Students' Academic Motivation

Variables		Intrinsic Motivation	Extrinsic Motivation	Task Value and Relevance	Persistence and Effort
Instructional Use of Technology	r_s	0.558***	0.454***	0.519***	0.522***
	p	<.001	<.001	<.001	<.001
Engagement and Motivation	r_s	0.542***	0.469***	0.557***	0.468***
	p	<.001	<.001	<.001	<.001
Assessment and Feedback	r_s	0.407***	0.396***	0.396***	0.380***
	p	<.001	<.001	<.001	<.001
Accessibility and Support	r_s	0.560***	0.459***	0.556***	0.497***
	p	<.001	<.001	<.001	<.001

Notes: Ho_3: There is no significant relationship between teachers' technology use and students' academic motivation.

P value Scale: *** p < .001 (Very Highly Significant); **p<0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)

Predictor of Students' Academic Motivation

A multiple linear regression analysis was conducted to examine whether dimensions of teachers' technology use and students' self-efficacy significantly predict students' academic motivation. Specifically, the predictors included instructional use of technology, engagement and motivation, assessment and feedback, accessibility and support, confidence in solving mathematical problems, perseverance in mathematics tasks, application of mathematics in different contexts, and self-regulation in mathematics learning. The analysis aimed to determine the extent to which these variables contribute to explaining variations in students' academic motivation.

The results show that the regression model revealed a highly significant relationship between the predictors and students' academic motivation in mathematics learning. This indicates that instructional use of technology, perseverance in math tasks, and the application of mathematics across different contexts are important factors in explaining students' levels of academic motivation. The adjusted R^2 value of 78.42% indicates that approximately 78.42% of the variation in students' academic motivation can be explained by the combined influence of these three variables, which is considered a strong explanatory power and suggests that the model is highly effective in predicting students' motivation in mathematics. In addition, the model is statistically significant ($F = 90.04$, $p < 0.04$), meaning that the results are not due to chance and that the predictors collectively provide a meaningful and reliable explanation of students' academic motivation.

Examining the individual predictors, all variables were found to have a positive and significant influence on students' academic motivation in mathematics. Among them, the application of mathematics across different contexts emerged as the strongest predictor ($\beta = 0.28$, $t = 5.06$, $p < .001$), indicating that students who can connect mathematical concepts to real-life situations tend to demonstrate higher academic motivation. This suggests that when learners see the relevance of mathematics in everyday life, they become more engaged, interested, and motivated to learn. Real-world applications strengthen students' understanding by making abstract concepts more meaningful, thereby increasing their willingness to actively participate in mathematics learning tasks.

According to Sipin and Paglinawan (2024), students who perceive mathematics as relevant to real-life situations demonstrate increased motivation, engagement, and more positive attitudes toward learning. The integration of authentic tasks, technological tools, and contextualized problems strengthens intrinsic motivation and creativity, supporting deeper learning. Students who recognize the usefulness of mathematics in social and practical contexts also show higher levels of academic motivation, which mediates their achievement and engagement in mathematics learning (Ulum & Küçükaydın, 2024). The use of interactive strategies such as gamification and real-world problem-solving enhances motivation and engagement by making mathematical concepts more meaningful and applicable (Ratinho et al., 2026). Empirical evidence indicates that academic motivation in mathematics is closely associated with self-efficacy and affective engagement, with the successful application of concepts building confidence and a willingness to learn (Valenzuela-Peñuñuri et al., 2024). Instructional practices and the perceived relevance of mathematics further shape motivation, as contextualized teaching approaches promote positive perceptions and sustained interest in the subject (Hossein-Mohand & Hossein-Mohand, 2023).

The application of mathematics in different contexts becomes more meaningful when viewed through the ideas of the Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), and Self-Determination Theory (SDT), as these helps explain how students become more motivated to learn. When mathematical concepts are connected to real-life situations, students are more likely to see their value and find them easier to understand, which encourages greater interest and participation. Exposure to real and varied applications also helps build students' confidence, as they gain experience, observe others, and engage more actively in the learning process. At the same time, allowing students to explore problems on their own, develop their skills through practical use, and work with others supports their basic learning needs. These kinds of experiences make mathematics feel more relevant and useful, helping students enjoy the subject more and stay motivated. In this way, applying mathematics in different contexts bridges theory and practice while strengthening both confidence and motivation in learning.

Instructional use of technology was also identified as a significant positive predictor of academic motivation ($\beta = 0.25$, $t = 4.94$, $p < .001$). This implies that when teachers effectively integrate technology into mathematics instruction, such as through interactive tools, visualizations, and digital learning platforms, students become more engaged and motivated to learn. Technology-enhanced instruction provides more dynamic, interactive learning experiences that help sustain students' attention and support deeper conceptual understanding.

The integration of digital tools such as learning management systems, artificial intelligence, and interactive platforms increases students' engagement, creativity, and motivation by making learning more interactive and accessible (Sipin & Paglinawan, 2024). Technology-enhanced instruction improves teaching effectiveness and student motivation by dynamically presenting mathematical concepts and enabling more efficient learning

(Shalgimbekova et al., 2024). Emerging technologies, including AI and extended reality, influence students' attention, confidence, and satisfaction, which are essential components of academic motivation (Alé-Silva, 2025). In mathematics classrooms, technological tools strengthen instructional practices by encouraging active learning, sustaining engagement, and supporting deeper conceptual understanding (Pabilario, 2025). Instructional materials delivered through synchronous and technology-mediated environments are positively associated with students' motivation and academic performance in mathematics (Sabayton et al., 2023).

The instructional use of technology in mathematics can be explained through the combined perspectives of the Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), and Self-Determination Theory (SDT). TAM suggests that teachers' integration of technology depends on its perceived usefulness and ease of use, which influence how effectively it is applied in instruction. SCT highlights that technology-rich learning environments enhance students' self-efficacy through interactive tasks, feedback, and modeling, thereby increasing their motivation and persistence. Meanwhile, SDT emphasizes that technology supports students' autonomy, competence, and relatedness, which are essential for fostering intrinsic motivation. Together, these frameworks indicate that effective technology integration in mathematics instruction promotes students' academic motivation by improving teaching practices, strengthening self-efficacy, and addressing key psychological needs.

Perseverance in math tasks likewise showed a significant positive effect on academic motivation ($\beta = 0.25$, $t = 4.46$, $p < .001$). This indicates that students who demonstrate persistence in solving mathematical problems, even when faced with difficulties, are more likely to maintain higher levels of motivation. Persistence allows learners to experience gradual success through continued effort, which reinforces their willingness to engage in challenging mathematical tasks.

A study on perseverance, persistence, and grit in mathematics emphasizes sustained effort and productive struggle as essential factors in developing deep mathematical understanding, highlighting these traits as important in students' engagement with challenging tasks (Aquino & Ibarra, 2024). Research on scaffolding problem-solving tasks shows that when students are guided to conceptualize mathematical situations before solving problems, their ability to persist through difficulties improves, indicating that perseverance can be developed alongside better effort and strategy use (Kapur & Roll, 2023). Evidence from profiles of growth mindset and grit among students in rural China reveals that perseverance of effort and a growth-oriented mindset contribute to higher motivation and stronger self-efficacy in mathematics, with persistent students showing greater confidence in their abilities (Wijaya et al., 2025). Studies involving pre-service teachers demonstrate that greater engagement in mathematical problem-solving activities is associated with increased perseverance, suggesting that persistence strengthens motivation to handle complex mathematical tasks (DiNapoli, 2024).

Perseverance in mathematics can be understood through the integrated perspectives of the Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), and Self-Determination Theory (SDT), which explain how sustained effort develops in technology-enhanced learning environments. From the TAM perspective, teachers' acceptance and use of technology, driven by perceived usefulness and ease of use, create meaningful and accessible mathematical experiences that encourage students to persist in solving challenging tasks. SCT explains perseverance as a product of self-efficacy, where students who experience mastery, observe successful problem-solving, and receive feedback through technology-supported instruction are more likely to sustain effort and remain engaged despite difficulties. SDT further supports this by emphasizing that perseverance is strengthened when students' needs for autonomy, competence, and relatedness are satisfied, as technology-integrated mathematics instruction allows learners to explore problems independently, build competence through guided practice, and engage collaboratively with peers. These combined processes show that perseverance in mathematics is not only a personal trait but also a motivational outcome shaped by instructional technology use, self-efficacy development, and the fulfillment of basic psychological needs, ultimately leading to stronger academic motivation and persistence in learning mathematics.

Students' academic motivation in mathematics is strongly shaped by instructional practices that connect mathematics to real-life contexts, integrate technology effectively, and foster perseverance in learning tasks. The strong predictive power of the model suggests that mathematics instruction should be intentionally designed to be contextualized, technology-enhanced, and persistence-oriented, as these factors collectively enhance motivation. Teachers are encouraged to design lessons that emphasize real-world applications of mathematics, as this strengthens relevance, engagement, and conceptual understanding. Schools are also encouraged to prioritize the provision of digital tools and training that support meaningful technology integration, since instructional technology plays a significant role in sustaining students' interest and deepening understanding. In addition, cultivating perseverance through structured problem-solving activities, scaffolding, and gradual exposure to challenges can help students develop resilience and sustained effort in mathematics learning. Overall, improving students' motivation requires a balanced approach that strengthens relevance, supports engagement through technology, and builds persistence in mathematical thinking.

Table 7. Predictor of Students' Academic Motivation

Predictors	Coef (β)	SE Coef	t- value	p-value
(Constant)	0.32	0.16	2.06	<.004
Instructional Use of Technology	0.25	0.05	4.94	<.001
Perseverance in Math Tasks	0.25	0.06	4.46	<.001
Application of Math in Different Contexts	0.28	0.05	5.06	<.001
Adjusted r^2	78.42%			
F value	90.04			
p-value	< .001			
Students' Academic Motivation= 0.32+ 0.25* Instructional Use of Technology +0.25* Perseverance in Math Tasks+0.28* Application of Math in Different Contexts				

Mediation Analysis on the Effect of Students' Self-Efficacy in the Relationship between Teachers' Technology Use and Students' Academic Motivation in Mathematics Learning

In Table 8, a mediation analysis was conducted to determine whether students' self-efficacy mediates the relationship between teachers' technology use and students' academic motivation in mathematics learning. The results indicated that the total effect of teachers' technology use on students' academic motivation was statistically significant, [B = 0.553, SE = 0.0443, 95% CI [0.466, 0.640], Z = 12.49, $p < .001$], suggesting that greater integration of technology in instruction is associated with higher levels of students' academic motivation in mathematics.

Greater integration of technology in mathematics instruction has been consistently associated with enhanced student motivation, as supported by recent empirical and review-based studies. Hidayat and Firmanti (2024) reported that technology-enhanced learning environments significantly increase students' eagerness and sustained motivation to engage with mathematical concepts. This improvement is attributed to the interactive, student-centered nature of digital tools, which enable learners to actively participate in problem-solving and conceptual exploration rather than passively receive information, thereby fostering deeper interest and persistence in learning. Alé and Arancibia (2025) demonstrated that technology-based instructional strategies positively influence key motivational dimensions, including attention, relevance, confidence, and satisfaction. Their findings indicate that when instructional technologies are meaningfully integrated, they help students maintain focus, recognize the real-world value of mathematics, and develop a stronger sense of competence and achievement. Empirical evidence from classroom-based research by Saliao and Cajandig (2025) further reinforces this relationship, revealing that digital pedagogy and adaptive technologies enhance students' engagement in mathematics. Engagement, as a core component of academic motivation, is strengthened through technology-supported instruction that promotes active involvement, sustained attention, and increased willingness to invest effort in mathematical tasks.

The direct effect of teachers' technology use on students' academic motivation, controlling for students' self-efficacy, also remained statistically significant, [B = 0.255, SE = 0.0364, 95% CI [0.184, 0.327], Z = 7.01, $p < .001$]. This indicates that teachers' independent technology use contributes to increased students' academic motivation, even when the mediating variable is considered. However, the indirect effect through students' self-efficacy was likewise statistically significant, [B = 0.297, SE = 0.0379, 95% CI [0.223, 0.372], Z = 7.85, p < .001], demonstrating that students' self-efficacy significantly mediates the relationship between teachers' technology use and students' academic motivation.

Valenzuela-Peñuñuri et al. (2024) demonstrated, through a mediation analysis, that self-efficacy plays a central role in linking learning-related variables to academic motivation and engagement. Their findings emphasize that students' beliefs in their own capabilities function as an internal mechanism that strengthens the translation of instructional inputs into meaningful motivational outcomes, suggesting that even well-designed learning environments become more effective when learners feel सक्षम and confident in their abilities. Mekheimer (2025) provided further evidence by showing that students' technological self-efficacy enhances intrinsic motivation and positive learning behaviors. This highlights that confidence in using digital tools does not merely support task completion but actively shapes students' interest, persistence, and willingness to engage in learning activities, positioning self-efficacy as a key pathway through which digital learning environments influence motivation. Pérez Vargas et al. (2024) examined post-pandemic digital education contexts and found that self-efficacy mediates the relationship between technology-related factors and academic engagement. Their study underscores that learners' confidence in navigating digital platforms determines the extent to which technology integration leads to meaningful participation and sustained involvement in academic tasks. Taken together, these studies illustrate that self-efficacy operates as a critical explanatory mechanism, clarifying how and why technology-related instructional practices can effectively enhance students' academic motivation and engagement.

Path estimates further support this mediation relationship. Teachers' technology use significantly predicted students' self-efficacy, [B = 0.478, SE = 0.0517, 95% CI [0.376, 0.579], Z = 9.24, p < .001], indicating that increased use of instructional technology is associated with higher levels of students' confidence in their ability to perform academic tasks. In turn, students' self-efficacy significantly predicted academic motivation, [B = 0.623, SE = 0.0419, 95% CI [0.541, 0.705], Z = 14.85, p < .001], suggesting that students who possess stronger beliefs in their capabilities are more likely to demonstrate higher motivation in mathematics learning. The proportion of mediation indicates that 53.8% of the total effect of teachers' technology use on academic motivation occurs indirectly through students' self-efficacy, while 46.2% of the effect remains direct.

These findings indicate a partial mediation, suggesting that students' self-efficacy serves as a significant mechanism through which teachers' technology use enhances students' academic motivation in mathematics. The results imply that technology integration in instruction may foster students' motivation not only by making learning activities more engaging but also by strengthening students' beliefs in their ability to understand and perform mathematical tasks. When teachers effectively incorporate technology into mathematics instruction, students may experience more interactive and supportive learning environments that promote confidence and competence.

Technology-supported instruction enables teachers to present mathematical concepts through simulations, multimedia, and interactive problem-solving activities, making learning more meaningful and accessible to students. When technology is strategically integrated into mathematics instruction, it enhances students' engagement and motivation in learning (Bright et al., 2024). Moreover, students' self-efficacy, defined as their belief in their ability to perform academic tasks, plays a crucial role in shaping academic motivation, as learners with higher self-efficacy demonstrate greater persistence and willingness to engage in mathematical activities (Geng et al., 2024). Self-efficacy also functions as a mediating factor in the learning process. Baog (2025) explained that self-efficacy mediates the relationship between learning-related factors and students' motivation, indicating that students who believe in their capabilities are more likely to develop stronger intrinsic motivation and sustained academic engagement.

This finding can be anchored in Self-Determination Theory (Deci & Ryan, 2020), which posits that learning environments that support autonomy and competence enhance students' intrinsic motivation, as well as in Social Cognitive Theory (Bandura, 1997), which emphasizes that instructional practices and technological tools influence motivation through the development of self-efficacy. Technology-enhanced instruction provides interactive, student-centered experiences, opportunities for mastery, and immediate feedback, thereby

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strengthening students' confidence and motivation. Moreover, the result aligns with Expectancy-Value Theory (Eccles & Wigfield, 2020), which explains that motivation is shaped by learners' expectations for success and the value they assign to tasks; thus, technology integration increases both expectancy and task value, leading to higher levels of academic motivation in mathematics.

Educators are therefore encouraged not only to ensure the availability of technological tools but also to focus on how these tools are intentionally used to support students' confidence, competence, and active participation in learning. Teachers are recommended to design technology-supported activities that allow students to gradually experience success through guided practice, interactive problem-solving, and visual representations of mathematical concepts. Providing timely and constructive feedback through digital platforms, offering opportunities for students to track their progress, and encouraging reflection on their learning can further reinforce students' confidence in their abilities. In addition, integrating collaborative digital tasks, real-world applications, and inquiry-based activities can increase students' curiosity and intrinsic interest in mathematics while strengthening their persistence when encountering challenging problems. Educational institutions also play an important role by ensuring reliable technological infrastructure, providing access to diverse digital learning resources, and supporting continuous professional development that equips teachers with effective strategies for technology-enhanced instruction. When technology is used purposefully to create supportive, engaging, and student-centered learning environments, it can significantly enhance students' motivation, strengthen their self-efficacy, and encourage sustained persistence in mathematics learning.

Table 8. Mediation Analysis on the Effect of Students' Self-Efficacy in the Relationship between Teachers' Technology Use and Students' Academic Motivation in Mathematics Learning

Effect			Label	Estimate	SE	95% Confidence Interval Lower	Upper	Z	p	% Mediation
Indirect			a x b	0.297	0.0379	0.223	0.372	7.85	< .001	53.8
Direct			c	0.255	0.0364	0.184	0.327	7.01	< .001	46.2
Total			c+a x b	0.553	0.0443	0.466	0.640	12.49	< .001	100.0
Path Estimates										
Teachers' Technology Use	→	Self-Efficacy	a	0.478	0.0517	0.376	0.579	9.24	< .001	
Students' Self Efficacy	→	Students' Academic Motivation	b	0.623	0.0419	0.541	0.705	14.85	< .001	
Teachers' Technology Use	→	Academic Motivation	c	0.255	0.0364	0.184	0.327	7.01	< .001	

Figure 2 presents the structural model illustrating the relationships among Teachers' Technology Use, Students' Self-Efficacy, and Students' Academic Motivation. The model demonstrates both direct and indirect pathways that indicate how instructional practices influence student outcomes. Specifically, Teachers' Technology Use is shown to have a direct effect on Students' Academic Motivation ($\beta = 0.26$) and an indirect effect mediated through Students' Self-Efficacy. The path coefficients reveal that Teachers' Technology Use significantly predicts Students' Self-Efficacy ($\beta = 0.48$), while Students' Self-Efficacy, in turn, exerts a strong influence on Students' Academic Motivation ($\beta = 0.62$). This structure supports a partial mediation model, in which self-efficacy serves as a key intervening variable.

The direct relationship between Teachers' Technology Use and Students' Academic Motivation suggests that integrating technology into teaching positively contributes to students' engagement and willingness to learn. Technology-enhanced instruction, such as interactive platforms, digital resources, and multimedia tools, creates

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more dynamic and stimulating learning environments that can directly increase students' interest and participation in academic tasks. This finding underscores the importance of meaningful technology integration as a driver of motivation in contemporary education.

More significantly, the model highlights the mediating role of Students' Self-Efficacy. The substantial path coefficient from Teachers' Technology Use to Students' Self-Efficacy (β = 0.48) indicates that effective technology use strengthens students' confidence in their ability to perform academic tasks. When students are provided with opportunities to interact with user-friendly digital tools, receive immediate feedback, and experience success in learning activities, their sense of competence and control over learning increases. This enhanced belief in their capabilities becomes a critical psychological resource that supports academic engagement.

Furthermore, the strong relationship between Students' Self-Efficacy and Students' Academic Motivation (β = 0.62) highlights the central role of self-belief in shaping motivational outcomes. Consistent with Self-Efficacy Theory, students who perceive themselves as capable are more likely to demonstrate persistence, effort, and intrinsic interest in their studies. The strength of this relationship suggests that self-efficacy is a more powerful predictor of motivation than technology use alone, reinforcing its importance as a mediating construct.

The presence of both direct and indirect effects confirms partial mediation, indicating that while Teachers' Technology Use independently enhances Students' Academic Motivation, a significant portion of its influence operates through Students' Self-Efficacy. This implies that the effectiveness of technology in education is not solely dependent on its presence but on how it is utilized to foster students' confidence and autonomy in learning.

Overall, the model provides empirical evidence that optimizing technology integration in teaching must go hand in hand with strategies that build students' self-efficacy. By strengthening both instructional practices and learners' psychological readiness, educational institutions can more effectively enhance students' academic motivation and overall learning outcomes.

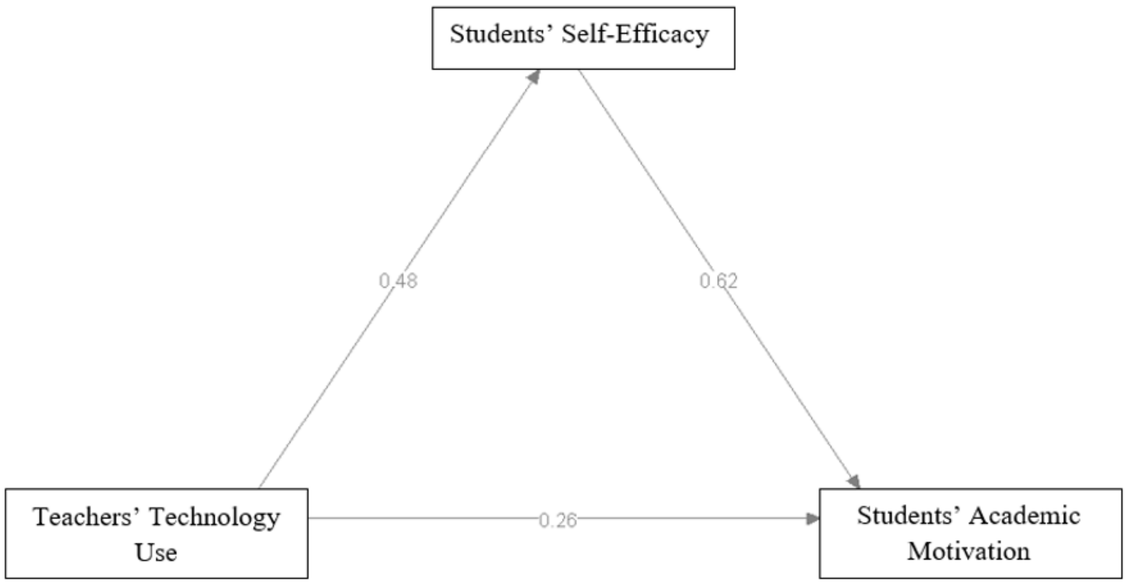

Figure 2. Structural Model on the Effect of Students' Self-Efficacy in the Relationship between Teachers' Technology Use and Students' Academic Motivation in Mathematics Learning

CONCLUSION

Technology integration has become an established practice in mathematics instruction and significantly contributes to students' mathematics learning experiences. The findings further revealed that students have developed positive beliefs in their capability to learn mathematics and demonstrate a high level of academic motivation toward the subject. Moreover, technology-enhanced teaching practices help strengthen students' confidence in their mathematical abilities, while students' beliefs about their own capabilities significantly influence their motivation to learn mathematics. The study also showed that technology-supported instruction plays a vital role in enhancing students' academic motivation in mathematics learning. In addition, the application of mathematics across various contexts, the instructional use of technology, and students' perseverance in accomplishing mathematical tasks are all essential factors that contribute to the enhancement of academic motivation. Furthermore, students' self-efficacy serves as an important mechanism through which technology integration fosters and strengthens academic motivation in mathematics learning.

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