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Technology Utilization as a Mediator between Mathematics Self-Efficacy and Student Persistence in Learning

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Abstract

Low mathematics persistence remains a global concern. The mediating effect of technology utilization on the relationship between mathematics self-efficacy and student persistence in learning was verified. Using predictive design, data from 222 Grade 10 junior high school students selected through proportionate stratified random sampling were analyzed using mediation analysis. It was found that technology utilization partially mediates the relationship between mathematics self-efficacy and student persistence in learning, partly supporting Social Cognitive Theory. Future research may examine other mediators, while curriculum planners should integrate self-efficacy strategies with tools like Google Classroom, GeoGebra, and Khan Academy to improve mathematics persistence.

Keywords: Technology Utilization, mathematics self-efficacy, student persistence in mathematics

1. Introduction

Globally, many learners showed low persistence in mathematics, making it a continuing concern in mathematics education (DiNapoli, 2023). This issue is widely observed across educational contexts, affecting many students and highlighting its persistent and widespread nature (Madrilejos, 2025; Zhang et al., 2024).

International research consistently showed that low mathematical persistence is a shared concern across different educational systems. In the United States, students showed low persistence in mathematics when dealing with complex problems (Xiao & Sun, 2021). Similarly, secondary school students in Nigeria have difficulty maintaining persistence in challenging tasks (Ogbu & Ugwu, 2023). In Indonesia, senior high school students also struggle to maintain their persistence as problem difficulty increases (Prastiti, 2020). These findings from three countries highlight that low persistence is not limited to a specific region but is a widespread international issue.

In the Philippine context, low persistence in mathematics remains a pressing concern. Evidence from the 2019 TIMSS shows that only about 19% of Filipino learners reached the Low benchmark in mathematics, indicating widespread difficulty in sustaining effort (Carandang, Caguete, & Balmes, 2024). Similarly, local studies in the Davao Region reported that many junior high school students exhibit low levels of mathematical persistence (Digamo & Abuzo, 2024). Other findings further highlighted the continuing issue of low persistence among Filipino learners in mathematics across different educational settings (Asoy & Picaza, 2025).

Failing to address low persistence in mathematics may lead to long-term academic consequences. Students who struggle to persist often lose interest in mathematics tasks, which undermines their problem-solving abilities and overall academic performance (Stewart, 2023). Low persistence is also associated with reduced self-confidence and weaker mathematics proficiency, limiting students' readiness for higher-level learning (Asoy & Picaza, 2025). Furthermore, learners who lack mathematical persistence tend to disengage, resulting in consistently poor outcomes (Digamo & Abuzo, 2024). Given these serious implications, there is an urgent need to investigate how the use of technology and mathematics self-efficacy jointly influence persistence among Filipino junior high school students. Exploring this under-examined area is crucial, making the present study both timely and necessary.

This study is significant because it contributes to achieving United Nations Sustainable Development Goal (SDG) 4 on quality education by promoting inclusive, equitable, and technology-enhanced learning environments that support students' self-efficacy and persistence in mathematics. In the Philippine context, the findings may support the Department of Education's goals of improving mathematics education through the integration of technology and the development of learners' confidence, motivation, and engagement, which are essential to enhancing academic performance. At the institutional level, the results are valuable to Holy Cross of Davao College in designing and implementing technology-supported learning environments, strengthening instructional practices, and promoting innovation in mathematics education.

This study aimed to determine the mediating effect of technology utilization on the relationship between mathematics self-efficacy and student persistence in learning. Specifically, the following objectives were pursued: 1.) to determine the levels of the technology utilization in terms of use of technology, technology for communication and collaboration, and technology for visualization and understanding; mathematics self-efficacy in terms of mastery experiences, vicarious experiences, social persuasions, and physiological state; and the student persistence in learning in terms of persistence in classroom mathematics exercise, persistence in mathematics take home assignment, persistence in a group mathematics tasks, and persistence in mathematics examination; 2.) to determine the significance of the correlation between mathematics self-efficacy and student persistence in learning; 3.) to determine the significance of the correlation between technology utilization and student persistence in learning; 4.) to determine the significance of the direct effect of mathematics self-efficacy on student persistence in learning, while controlling for technology utilization; 5.) to determine the significance of the indirect effect of mathematics self-efficacy on student persistence in learning through technology utilization, and 6.) to determine the significance of the total effect of mathematics self-efficacy on student persistence in learning.

2. Methodology

2.1 Research Design

This study used a predictive research design, a quantitative method that examines how one or more independent variables predict an outcome variable through statistical analysis (Hair et al., 2022). This design was considered appropriate because it helped determine the relationships among the variables and examine mediation effects using statistical techniques such as structural equation modeling (Kline, 2023). In addition, predictive research design allows researchers to identify which variables significantly influence the outcome and determine the strength and direction of these relationships, providing useful evidence for decision-making and future interventions (Hair et al., 2022).

2.2 Locale of the Study

The study was conducted in three public junior high schools in Cluster 6 of the Tugbok District in Davao City. These schools serve students from nearby barangays and surrounding communities under the Department of Education, Division of Davao City. In recent years, the schools have gradually incorporated technology into mathematics instruction to support students' learning and use of digital tools in the classroom. The researcher selected these schools because their use of technology-assisted instruction provided an appropriate setting for examining how technology utilization influences students' learning experiences. In addition, the students' varied backgrounds and experiences enabled a broader analysis of differences in student persistence in mathematics.

2.3 Sample and Sampling

This study comprised 222 Grade 10 junior high school students enrolled during the School Year 2025–2026, determined using Raosoft software with a 95% confidence level, 5% margin of error, and 50% response distribution, from a population of 520 students across three schools: School A (240 Grade 10 students), School B (151 Grade 10 Students), and School C (130 Grade 10 students. This study employed proportionate stratified random sampling to ensure that respondents from each school were represented in proportion to their school's population size (Creswell & Creswell, 2023). The sample was proportionally distributed as follows: 102 students from School A, 64 from School B, and 56 from School C. Proportionate stratified random sampling is a probability sampling technique in which the population is divided into distinct subgroups (strata), and respondents are randomly selected from each subgroup in proportion to its size in the total population (Venkata Triveni et al., 2024). This technique is commonly used when the population is divided into distinct groups and the researcher wants to ensure each group is properly represented in the sample. By doing so, it helps produce a more balanced and representative set of respondents, minimizes sampling bias, and improves the accuracy and reliability of the study's findings (Makwana et al., 2023).

2.4 Data Gathering Technique

The survey technique was employed in this study as the primary data-gathering method through the use of structured questionnaires. This method is appropriate when researchers aim to efficiently collect data from a large population, as it is cost-effective, time-efficient, and capable of generating quantifiable data suitable for statistical analysis (Creswell & Creswell, 2023). In this study, three adapted and modified survey questionnaires were utilized. The first instrument, the Mathematics Self-Efficacy Questionnaire, was adapted from Frank Pajares and Ellen L. Usher (2009). It consisted of 24 items designed to measure students' confidence in performing mathematical tasks and solving problems using a four-point scale. Negatively worded items under the Physiological State dimension were reverse-coded during data processing to ensure that higher scores consistently reflected higher levels of self-efficacy. Pilot testing revealed a Cronbach's alpha of 0.861, indicating high reliability.

The second instrument measured technology utilization and was adapted from Tigbabao (2025). It consisted of 13 items intended to assess the extent to which students utilize technology in learning mathematics, also using a four-point Likert scale. The instrument obtained a Cronbach's alpha of 0.857 during pilot testing. The third instrument, adapted from the study of Ogbu and Ugwu (2023), measured students' learning persistence. It included 27 items that assessed students' determination and sustained effort in learning mathematics despite challenges. Similar to the other instruments, it used a four-point Likert scale and demonstrated good reliability with a Cronbach's alpha of 0.843.

2.5 Data Analysis Technique

In this study, the data analysis techniques employed were descriptive, correlation, and mediation analyses. Creswell and Creswell (2023) state that descriptive analysis uses the mean and standard deviation as statistical tools to organize and summarize data, thereby better understanding patterns and distributions. Additionally, correlation analysis is used to ascertain the strength and direction of the relationship, according to Schober et al. (2023). The Pearson Product-Moment Correlation coefficient is used in this study to examine the relationships among student persistence, technology utilization, and mathematics self-efficacy. Lastly, in line with Hair et al. (2022), a mediation analysis was conducted to examine whether technology utilization mediates the relationship between mathematics self-efficacy and student persistence, estimating the direct, indirect, and total effects using beta coefficients to provide a deeper understanding of the relationships among variables.

2.6 Ethical Considerations

The respondents were fully informed about the study's purpose, procedures, and their right to withdraw at any time without repercussions. Since the respondents were minors, written consent from parents or guardians and assent from students were obtained before data collection. The consent and assent forms clearly explained the study's objectives, methods, possible risks, and benefits to ensure voluntary participation. To maintain confidentiality, all responses were anonymized, securely stored, and accessed only by the research team. The study was carefully designed to minimize potential risks and prevent harm to participants. Ethical principles of honesty, integrity, respect, and fairness were observed throughout the research process, while participants' privacy and contributions were properly acknowledged. Ethical clearance was obtained from the Society for Moral Integrity and Legal Ethics (SMILE), and formal permission to conduct the study was secured from the Department of Education (DepEd). All findings were reported transparently, and any potential conflicts of interest were properly disclosed.

3. Results and Discussions

3.1 Descriptive Analysis

Table 1 contains the variables involved in the study, namely, mathematics self-efficacy, technology utilization, and student persistence in learning, with their respective indicators; and the number of samples, standard deviation, mean, and descriptive level specifically corresponding with each of the variables.

Table 1. Descriptive Table (n= 222)

Variables and Their Indicators	Standard Deviation	Mean	Descriptive Level
Technology Utilization	**0.42**	**2.85**	**High**
Use of Technology	0.47	2.81	High
Technology for Communication and Collaboration	0.49	2.89	High
Technology for Visualization and Understanding	0.47	2.86	High
Student Persistence in Learning	**0.38**	**2.83**	**High**
Persistence in classroom mathematics exercises	0.41	2.83	High
Persistence in the mathematics take-home assignment	0.53	2.72	High
Persistence in group mathematics tasks	0.50	2.80	High
Persistence in mathematics examination	0.48	3.01	High
Mathematics Self-Efficacy	**0.37**	**2.60**	**High**
Mastery Experiences	0.39	2.64	High
Vicarious Experiences	0.47	2.90	High
Social Persuasion	0.57	2.48	Low
Physiological States	0.61	2.39	Low

The table shows that the technology utilization variable had a mean of 2.85, indicating a high level of technology utilization. This indicates that the respondents often use technology. All its indicators are described as high-level. The standard deviation of 0.42 is described as highly consistent, indicating strong and uniform perception. Furthermore, the student persistence in learning variable obtained a mean of 2.83, indicating high persistence. This indicates that respondents show strong persistence in math tasks. All its indicators are described as high-level. The standard deviation of 0.38 is considered highly consistent, indicating strong and uniform perception. Finally, the mathematics self-efficacy variable had a mean of 2.60, indicating high self-efficacy. This indicates that the respondents are confident in their ability to solve most math tasks. All its indicators were at a high level, except for social persuasion and physiological state, which were at a low level—the standard deviation of 0.37, described as highly consistent responses, signifying a strong and uniform perception.

The results showed that all variables are generally interpreted at a high level, with respondents demonstrating frequent technology use, strong persistence in mathematics tasks, and confidence in solving most math tasks, although mathematics self-efficacy shows a slight variation in some indicators.

3.2 Correlation Analysis

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

Table 2. Correlation Table (n= 222)

Variables	Student Persistence in Learning			
	r-value	**p-value**	**Decision on Ho**	**Interpretation**
Technology Utilization	0.438	0.000	Reject H_o	Moderately Low Positive, Significant Correlation
Mathematics Self-Efficacy	0.569	0.000	Reject H_o	Moderately High Correlation

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

As shown in the table, the correlation between technology utilization and student persistence in learning variables obtained a p-value of 0.000. Such a value is less than the 0.05 level of significance; hence, the null hypothesis was rejected. It indicates that the correlation is statistically significant. The r-value of 0.438 reflects a moderately low positive correlation between technology utilization and student persistence. This implies that greater technology use is associated with stronger persistence in mathematics among students, though the relationship is moderate. Similarly, mathematics self-efficacy yielded a p-value of 0.000, which is lower than the 0.05 level of significance; hence, the null hypothesis was rejected. This indicates that the correlation is statistically significant. The r-value of 0.569 shows a moderately high positive correlation between mathematics self-efficacy and student persistence in learning. This implies that students with higher mathematics self-efficacy tend to demonstrate greater persistence in mathematics.

Both technology utilization and mathematics self-efficacy showed significant positive relationships with student persistence in learning, with mathematics self-efficacy exhibiting a stronger correlation compared to technology utilization.

3.3 Mediation Analysis

Table 3 contains the path/effect, the Beta estimate, the standard error, the Z-value, the p-value, the decision on the null hypothesis, and the corresponding interpretation.

Table 3. Mediation Table (n= 222)

Label	Path/ Effect	Estimate (B)	SE	Z-value	p-value	Decision on Ho	Interpretation

A	Mathematics Self- Efficacy → Technology Utilization	0.324	0.088	3.68	0.000	Reject H_o	Significant
B	Technology Utilization→ Student Persistence in Learning	0.272	0.062	4.36	0.000	Reject H_o	Significant
c’	Mathematics Self- Efficacy →Student Persistence in Learning (Direct)	0.497	0.058	8.56	0.000	Reject H_o	Significant
a x b	Indirect Effect	0.088	0.030	2.90	0.004	Reject H_o	Significant
(axb)+c	**Total Effect**	**0.585**	**0.061**	**9.65**	**0.000**	**Reject H_o**	**Significant**

Level of Significance: 0.05
Decision Rule: Reject Ho if p< 0.05
Proportion Mediated: indirect effect/ total effect= 0.15

The table specifically shows that the direct effect of mathematics self-efficacy on student persistence in learning, controlling for technology utilization, yielded an estimated Beta of 0.497 (p = 0.000), which is less than the 0.05 level of significance. Hence, the null hypothesis was rejected. This indicates that the direct effect is significant. This implies that students with higher confidence in their mathematical abilities are more likely to persist in solving mathematical tasks, indicating that self-efficacy independently contributes to student persistence even when technology utilization is not considered. Similarly, the indirect effect of mathematics self-efficacy on student persistence in learning through technology utilization obtained an estimated Beta of 0.088, with a p-value of 0.004, which is lower than the 0.05 level of significance. Thus, the null hypothesis was rejected. This indicates that the indirect effect is significant. This implies that mathematics self-efficacy enhances student persistence both directly and indirectly through technology utilization, which serves as a meaningful pathway supporting sustained engagement in mathematics tasks. Lastly, the total effect of mathematics self-efficacy on students’ persistence in learning obtained an estimated Beta of 0.585, with a p-value of 0.000, which is lower than the 0.05 level of significance. Thus, the null hypothesis was rejected. This indicates that the total effect of mathematics self-efficacy on the criterion is significant. This implies that mathematics self-efficacy has a strong overall influence on student persistence, both directly and through technology utilization, indicating that enhancing self-efficacy can improve persistence, especially when supported by effective technology use.

The table also reported a mediated proportion of 0.15, indicating that the mediating effect of technology utilization on the relationship between mathematics self-efficacy and student persistence is weak. Since the direct effect of mathematics self-efficacy on student persistence remains significant even when controlling for technology utilization, and the indirect effect is also significant, the results indicate partial mediation.

3.4 Mathematics Self-Efficacy and Student Persistence in Learning Correlation

The finding that mathematics self-efficacy has a significant, moderately high correlation with student persistence in learning supports the study of Street et al. (2024), which found that higher mathematics self-efficacy is associated with greater engagement, effort, and persistence in mathematical tasks. Likewise, it is consistent with Asoy and Picaza (2025), who reported that self-efficacy significantly predicts students’ persistence and other positive academic behaviors in mathematics, reinforcing the idea that students who believe in their abilities are more likely to persist in learning mathematics. On the contrary, the current finding contradicts Madrilejos (2025), who suggested that persistence may be more strongly influenced by other motivational and contextual factors, indicating that the relationship between mathematics self-efficacy and persistence is not always direct or dominant.

3.5 Technology Utilization and Student Persistence in Learning Correlation

The finding that technology utilization has a moderately low positive correlation with student persistence in learning supports the study of Abdulganie et al. (2025), which reports a positive relationship between technological resources and student engagement, suggesting that technology use fosters greater involvement and persistence in academic tasks, including mathematics. Similarly, the current finding also aligns with Ali et al. (2023), who found that technology integration in mathematics education enhances both student achievement and engagement, indirectly supporting the idea that technology use contributes to maintaining student persistence in mathematics. However, the current finding contradicts the study by Colanggo and Ucang (2025), which found no significant correlation between students' technology use and their academic performance in mathematics, suggesting that technology may not always have a direct impact on persistence. Colanggo and Ucang had 203 samples, whereas 222 samples were used to establish the current finding.

3.6 Mediating Effect of Technology Utilization

The findings of this study show that technology utilization partially mediates the correlation between mathematics self-efficacy and student persistence in learning variables, affirming the study of Huang, Hidayat, and Ayub (2024), demonstrating that learning engagement partially mediates the relationship between self-efficacy and perceived learning in online mathematics environments, suggesting that technology-enhanced engagement plays a key role in fostering persistence. Similarly, the current finding aligns with Bright et al. (2024), who found that technology use in mathematics education positively influenced students' interest, which in turn mediated the relationship between technology use and mathematics performance, supporting the idea that technology can help maintain persistence through factors such as engagement and interest. However, the current finding contradicts the study by Roquero et al. (2025), which reported no significant mediating effect of AI utilization (a form of technology use) on the relationship between study attitude and mathematics achievement, suggesting that the role of technology in mediating persistence may vary across educational contexts.

4. Conclusion

Based on the findings, technology utilization partially mediates the relationship between mathematics self-efficacy and student persistence in learning. Hence, this conclusion partly affirms Social Cognitive Theory, which posits that the dynamic interaction between environmental, personal, and behavioral factors shapes human behavior.

5. Recommendations

Based on the study's findings, future researchers are encouraged to examine other possible mediating variables that may explain the remaining 85% of the mediation effect not accounted for in this study. In addition, curriculum planners may help improve students' persistence in mathematics by incorporating strategies that strengthen self-efficacy through structured learning activities supported by technological tools such as Google Classroom, GeoGebra, and Khan Academy.

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