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Attitudes toward technology-based learning and numeracy skills: the mediating role of mathematics self-efficacy

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Abstract

Poor numeracy skills is a problem in mathematics education. The mediating role of mathematics self-efficacy on the relationship between attitudes toward technology-based learning and numeracy skills was verified. Predictive design, proportionate stratified random sampling, survey technique, and mediation analysis were applied. The data from 200 grade 8 students revealed that the link between attitudes toward technology-based learning and numeracy skills was not significantly mediated. Future research may explore other mediating variables and qualitative insights, while curriculum planners may focus on integrating technology to improve students numeracy skills.

Keywords: Attitudes toward technology-based learning; numeracy skills; mediating role of mathematics self-efficacy

1. Introduction

Numeracy is the skill of applying mathematical knowledge to comprehend numbers, solve problems, interpret information, and make informed decisions in everyday life (Geiger et al., 2015). It remains a global challenge, with low skills widespread across populations (Bruine de Bruin et al., 2021).

In Australia, only about half meet the expected level of math proficiency (De Bortoli at al., 2023). Many students in Ghana exhibited low numeracy skills (Ansah et al., 2020; Fokuo et al., 2022; Essuman et al., 2021). Spaull (2022) found that most South African learners are several grade levels behind in basic numeracy, revealing deep systemic learning discrepancies.

In the Philippines, more than half of 15-year-olds scored very low in PISA math, with public school students performing worse (Bernardo et al., 2022). Igarashi and Suryadarma (2023) found that foundational mathematics skills among Filipino students deteriorated between 2003 and 2019. In Davao del Sur, Guevarra (2025) found that many learners started with weak numeracy skills.

Struggling with numeracy can have serious consequences (Díez-Palomar, et al., 2023). Unaddressed basic math skill discrepancies lead to persistently poor performance and hinder later learning (Mendoza et al., 2022). Research also showed deteriorations in performance and motivation during the transition to secondary school (Kaur et al., 2022). Students are likely to continue struggling in mathematics, limiting their future learning and academic opportunities (Nelson et al., 2018). Those with math difficulties continue to fall behind in arithmetic and cognitive math skills, making later catch-up difficult (Kivirähk et al., 2025). Low numeracy demoralizes informed decision-making in health, finance, and everyday life (Peters et al., 2023). These consequences prove that unaddressed numeracy deficits have serious academic and long-term impacts, underlining the urgent need for targeted interventions and further research.

The study is important for numerous stakeholders in education, as its findings may expand teaching, learning, and policy in mathematics. Globally, it supports the United Nations' Sustainable Development Goal 4 by highlighting how digital learning tools and students' math confidence boost numeracy, guiding policymakers and researchers in reducing numeracy gaps. For the Department of Education (DepEd), the results can reinforce programs like the MATATAG Curriculum and Learning Recovery initiates by integrating self-efficacy and digital learning into interventions. School administrators may use the findings to design digital integration, teacher support, and classroom strategies, while mathematics teachers may plan lessons that build self-confidence, engagement, and skills. Junior high students may benefit by developing positive attitudes and effective use of technology, and future researchers may expand a reference for studies on self-efficacy, technology, and numeracy progress across various contexts.

The study determined the significance of the mediating effect of mathematics self-efficacy on the correlation between attitudes towards technology-based learning and numeracy skills of junior high school students. Specifically, it has the following objectives:

1. To determine the levels of attitudes towards technology-based learning in terms of mathematics confidence, confidence with technology, attitude to learning mathematics with technology, affective engagement and behavioral engagement; mathematics self-efficacy in terms of mastery experiences, vicarious experiences, social persuasions and physiological state; and the numeracy skills in terms of whole numbers, fractions, decimals, percentages and signed numbers; 2. to determine the significance of the correlation between attitudes towards technology-based learning, mathematics self-efficacy, and the numeracy skills; 3. to determine the significance of the direct effect of mathematics self-efficacy on Attitudes towards technology-based learning, controlling for numeracy skills; 4. to determine the significance of the indirect effect of mathematics self-efficacy on attitudes towards technology-based learning, through numeracy skills. ; and 5. to determine the significance of the total effect of mathematics self-efficacy on Attitudes towards Technology-based Learning and numeracy skills.

2. Methodology

2.1. *Research Design*

The study employed a predictive research design. It focuses on historical and current data to forecast future outcomes, consequences, or effects, differing from descriptive or explanatory designs by highlighting prediction rather than simply describing or explaining phenomena (Jamarani et al., 2024). It is suitable to this study as it aims to anticipate future outcomes from existing data patterns, making it appropriate for studies in health, education, and business where forecasting guides decision-making and resource allocation (Efthimiou et al., 2024). Its advantages include historical data and advanced analytics to identify patterns and accurately predict future events, enabling better decision-making even in changing conditions (Desai S, & Deshpande D. S, 2024).

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2.2. *Locale of the Study*

The study was conducted in a public junior high school in Santa Cruz, Davao del Sur, which has been serving the community for 34 years. The school offers basic education from Grades 7 to 12, including two extension schools. It has established programs and initiatives in mathematics instruction. It was chosen as the study's locale because it provides an appropriate setting for examining students numeracy skills, their attitudes toward technology-based learning, and their mathematics self-efficacy.

2.3. *Sample and Sampling Technique*

The respondents of this study are the Grade 8 students enrolled at a National High School, including its two extension schools, during the School Year 2025–2026. The total enrollment of Grade 8 students is 415, which constitutes the study population. To determine the appropriate number of respondents, the researcher used the Raosoft Sample Size Calculator (2004), applying a 95% confidence level and a 5% margin of error. Based on these parameters, the recommended sample size was 200 students, which is adequate to represent the population while ensuring the reliability and validity of the study's findings.

This study employed a proportionate stratified random sampling, a method where a population is divided into subgroups (strata), and respondents are selected from each subgroup in proportion to its actual share of the population, ensuring fair representation of all groups (Etikan & Bala , 2023). This approach is commonly used in educational, health, and social science studies where subgroup differences are significant (Shahzad et al., 2023). Its benefit lies in its ability to boost representativeness by ensuring that all subgroups are proportionally included, thereby reducing bias and improving estimation accuracy (Triveni et al., 2023).

2.4. *Data Gathering Technique*

The survey technique was used in gathering data. This technique is a method of collecting data by asking standardized questions to respondents to define and generalize the characteristics, opinions, or behaviors of a population (Goodfellow 2023). It is used when researchers aim to explore questions or test hypotheses by gathering responses from participants (Chang et al., 2023). It is useful because it provides a practical and flexible way to collect data across different locations and groups (Mazikana, 2023).

In this study, three adapted and modified survey questionnaires were utilized. The first instrument was the Mathematics Self-Efficacy Scale (MSES), adapted from Usher and Pajares (2009) and grounded on Albert Bandura's concept of self-efficacy. It consists of 24 items designed to measure students' confidence in performing mathematical tasks. A four-point Likert scale was used to assess the degree to which students believe in their ability to succeed in mathematics learning activities. The adapted instrument underwent pilot testing and obtained a Cronbach's alpha coefficient of 0.874, indicating good reliability.

The second instrument was adapted from the Mathematics and Technology Attitudes Scale (MTAS) developed by Pierce et al., (2007). It is composed of 20 items that focus on students' attitudes toward mathematics and their confidence in using technology for learning. This questionnaire also employed a four-point Likert scale to determine students' attitudes toward technology-based learning. Pilot testing revealed a Cronbach's alpha coefficient of 0.874, indicating that the instrument was reliable for the study.

The third instrument was the Numeracy Inventory Device (NID), originally developed by Herrero (2022), which was adapted to assess the numeracy proficiency of junior high school students. The adapted numeracy inventory consists of 50 multiple-choice items, with 10 items allocated to each indicator, namely whole numbers, signed numbers, fractions, decimals, and percentages. The instrument provides an objective measure of students' ability to apply mathematical operations and reasoning in solving contextual problems. Pilot testing revealed a Cronbach's alpha coefficient of 0.920, indicating excellent reliability.

2.5. *Data Analysis Technique*

In this study, the data analysis techniques used were descriptive, correlation, and mediation analyses. Descriptive analysis is the process of organizing and summarizing data using statistical tools to describe the characteristics of a dataset without making interpretations beyond the data (Blbas, 2024). In this study, the mean and standard deviation statistical tools were used. Moreover, correlation analysis is a statistical method used to measure and describe the strength and direction of the relationship between two variables using correlation coefficients such as Pearson's r (Aslami et al., 2026). Lastly, mediation analysis examines how an independent variable affects an outcome through a mediator by separating the total effect into direct and indirect effects. (Schuler et al., 2025).

The matrix presenting the scale, descriptive level, and corresponding interpretation for each study variable is provided and specifically used to describe attitude towards technology-based learning, mathematics self-efficacy and numeracy skills.

2.6. *Ethical Considerations*

The respondents were fully informed about the study's goal, its methods, and their right to discontinue participation at any time without consequence, and prior to data collection, they provided informed consent. Their identities were kept confidential through anonymized data and safe storage accessible only to the research team. The goal of the study was to prevent harm, uphold participants' rights, and treat them fairly, honestly, and with respect at all times. Ethical approval was granted by the Society of Moral Integrity and Legal Ethics (SMILE), and authorization was secured from the Department of Education (DepEd). The research also aimed to maximize benefits, reduce risks, ensure fairness, and sustain transparency, including proper disclosure of any conflicts of interest.

3. Results and Discussions

3.1. *Descriptive Results*

Table 1 is a descriptive table. It contains the variables involved in the study, namely, attitudes towards technology-based learning, mathematics self-efficacy, and numeracy skills 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 Statistics (n=200)

Variables	Standard Deviation	Mean	Descriptive Level
Attitudes Toward Technology-Based Learning	**.39**	**2.98**	**High**
Behavioural Engagement	*.53*	*3.27*	*Very High*
Confidence With Technology	*.67*	*2.58*	*High*

Mathematics Confidence	*.54*	*2.85*	*High*
Affective Engagement	*.46*	*3.38*	*Very High*
Attitude To Learning Mathematics with Technology	*.58*	*2.84*	*High*
Mathematics Self -Efficacy	**.37**	**3.06**	**High**
Mastery Experiences	*.44*	*2.98*	*High*
Vicarious Experiences	*.48*	*3.26*	*Very High*
Social Persuasions	*.56*	*2.72*	*High*
Physiological State	*.41*	*3.27*	*Very High*
Numeracy Skills	**.39**	**1.23**	**Very Low**
Whole Numbers	*.83*	*2.50*	*Low*
Fractions	*.49*	*1.09*	*Very Low*
Decimals	*.66*	*1.49*	*Very Low*
Percentages	*.63*	*1.43*	*Very Low*
Signed Numbers	*.91*	*1.71*	*Very Low*

Specifically, the table shows that the attitudes toward technology-based learning variable obtained a mean of 2.98, described as high. This indicates that the respondents demonstrate a positive attitude toward technology-based learning. All indicators are described as very high, except for confidence in technology, mathematics confidence, and attitude to learning mathematics with technology, which were rated high. The corresponding standard deviation of 0.39, described as high consistent responses, denotes strong and uniform perception. Furthermore, the mathematics self-efficacy variable obtained a mean of 3.06, described as high. This indicates that the respondents are strong. All indicators obtained a very high level, except for mastery experiences and social persuasions, which obtained a high level. The standard deviation of 0.37, described as highly consistent responses, indicates a strong and uniform perception among the respondents. Finally, the numeracy skills variable obtained a mean of 1.64, described as a very low level. This signifies that the respondents' numeracy skills are very poor. Consistently, all indicators are described as very low level, except for whole numbers, which obtained a low level. The standard deviation of 0.39, described as high consistent responses, signifying strong and uniform perception.

The respondents demonstrated high mathematics self-efficacy and a positive attitude toward technology-based learning, indicating confidence in performing mathematical tasks and favorable perceptions of technology use in learning. However, their numeracy skills are very poor, showing that despite positive beliefs and attitudes, their actual mathematical performance remains weak.

3.2. *Correlation Results*

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

Table 2: Correlation Table (n=200)

Variables	**Numeracy Skills**			
	r-value	**p-value**	**Decision on H_0**	**Interpretation**
Mathematics Self- Efficacy	.069	.333	Fail to Reject H_0	Low positive correlation
Attitudes Towards Technology-Based Learning	.055	.438	Fail to Reject H_0	Low positive correlation

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

Specifically, the table shows that the correlation between mathematics self-efficacy and numeracy skills variables obtained a p-value of 0.333, which is higher than the 0.05 level of significance; hence, the null hypothesis was accepted. This indicates that the correlation is not significant. The r-value of 0.069 reflects a low positive correlation between mathematics self-efficacy and numeracy skills. This implies that when student confidence in mathematics changes, there is no corresponding change in numeracy skills. Similarly, the correlation between attitudes toward technology-based learning and numeracy skills variables yielded a p-value of 0.438, which is also higher than the 0.05 level of significance; hence, the null hypothesis is accepted. This indicates that the correlation is not significant. The r-value of 0.055 shows a low positive correlation between attitudes toward technology-based learning and numeracy skills. This implies that when student attitudes toward technology-based learning change, there is no corresponding change in numeracy skills.

The results showed that both mathematics self-efficacy and attitudes toward technology-based learning variables do not have a meaningful relationship with numeracy skills. This means that students' confidence in mathematics and their attitudes toward technology do not show a meaningful association with their actual numeracy performance.

3.3. Mediation Results

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

Table 3. Mediation Table (n = 200)

Label	Path / Effect	Estimate (B)	SE	Z-value	p-value	Decision on H_0	Interpretation
A	Attitudes Toward Technology-Based Learning → Mathematics Self-Efficacy	.678	.047	14.420	.001	Reject H_0	Significant
B	Mathematics Self-Efficacy→ Numeracy Skills	.047	.079	.598	.550	Fail to Reject H_0	Not Significant
c'	Attitudes Toward Technology-Based	.009	.075	.120	.904	Fail to Reject H_0	Not Significant

Label	Path / Effect	Estimate (B)	SE	Z-value	p-value	Decision on H_0	Interpretation
	Learning → Numeracy Skills (Direct Effect)						
a × b	Indirect Effect	.032	.053	.597	.550	Fail to Reject H_0	Not Significant
(a × b)-c	(Total Effect)	.023	.052	.781	.435	Fail to Reject H_0	Not Significant

Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$
Proportion Mediated: indirect effect/ total effect = ***No mediation***

The table specifically shows that the direct effect of attitudes toward technology-based learning on the numeracy skills variables, controlling for mathematics self-efficacy, yielded an estimated Beta of 0.009, with a corresponding p-value of 0.904, which is greater than the 0.05 level of significance. Hence, the null hypothesis was not rejected. This indicates that the direct effect of attitudes toward technology-based learning on numeracy skills, when mathematics self-efficacy is included in the model, is not statistically significant. In contrast, the indirect effect of attitudes toward technology-based learning on numeracy skills variables through mathematics self-efficacy obtained an estimated Beta of 0.032, with a corresponding p-value of 0.550, which is greater than the 0.05 level of significance. Thus, the null hypothesis was not rejected. This indicates that the indirect effect of attitudes toward technology-based learning through the mediator is not statistically significant. Lastly, the total effect of attitudes towards technology-based learning on numeracy skills variables resulted in an estimated Beta of 0.023. The corresponding p-value of 0.435, which is above the 0.05 level of significance, therefore, the null hypothesis was not rejected. This indicates that the total effect of attitudes toward technology-based learning on the criterion is not significant.

Since the direct and indirect effects of the predictor on the criterion variable are found to be not significant, the mathematics self-efficacy is determined to have no mediating effect on the correlation between attitudes toward technology-based learning and numeracy skills.

3.4. *Attitudes toward Technology-based Learning and Numeracy Skills Correlation*

The finding that attitudes toward technology-based learning have a low positive but non- significant correlation with numeracy skills affirms the study of Getenet et al. (2024), which suggest that students positive attitudes toward technology use do not always translate into measurable improvements in academic or quantitative skills, as these attitudes may not significantly predict outcomes such as numeracy or achievement levels. Likewise, this current finding affirms the claim of Al-khresheh et al. (2024), emphasizing that although learners may demonstrate favorable attitudes toward technology integration, these attitudes do not necessarily have a significant direct effect on academic performance, as their influence is often indirect or mediated by other variables rather than directly linked to achievement outcomes.

On the contrary, recent finding contradicts that attitudes toward technology-based learning can significantly relate to learning outcomes, as positive attitudes toward educational technology are associated with improved engagement, better learning behaviors, and stronger academic performance, including mathematics-related achievement (Navarro et al., 2023). Similarly, the current finding opposes the study showing that when students hold positive attitudes toward technology integration, these attitudes can enhance motivation and learning processes that contribute to better academic outcomes (Misirlis et al. 2023).

3.5. *Mathematics Self-Efficacy and Numeracy Skills Correlation*

The finding that mathematics self-efficacy has a low positive but non- significant correlation with numeracy skills supports the previous study of Street et al. (2024), which highlights that the connection between self-efficacy and actual mathematics achievement varies depending on instructional and contextual factors, suggesting that self-efficacy does not always translate into measurable numeracy performance. Similarly, large-scale empirical evidence from the National Assessment of Educational Progress (NAEP) analysis shows that while mathematics self-efficacy is related to achievement, the relationship may become weak depending on the analytical model and contextual variables considered (Yang et al. 2024).

On the other hand, this finding contrasted the assertion of Mustofa et al. (2025), suggesting that mathematics self-efficacy can significantly predict numeracy skills. Students who are more confident in their math abilities tend to perform better in numeracy tasks, especially when supported by effective teaching and learning activities. This means that even if the relationship is weak in some cases, it can become significant when students' confidence in math is improved.

3.6. *Attitudes toward Technology-based Learning and Numeracy Skills as Mediated by Mathematics Self-Efficacy*

The finding of this study asserting that mathematics self-efficacy does not mediate the correlation between attitudes toward technology-based learning and numeracy skills affirms the study of Tigbabao et al. (2023), which argues that mathematics self-efficacy does not mediate the relationship between technology utilization and mathematics literacy, as technology use directly influences mathematics literacy while self-efficacy serves only a supportive, non-mediating role. Moreover, the current finding supports Bright et al. (2024), who claimed that students' mathematics interest, rather than self-efficacy, mediated the effect of technology use on mathematics performance, highlighting that self-efficacy was not the explanatory pathway in this relationship.

In contrast, the current finding contradicts Zhao et al. (2024), who found that self-efficacy significantly mediates the relationship between students' self-management and academic achievement, indicating that better self-management enhances self-efficacy, which in turn leads to higher academic performance.

*4. **Conclusion***

Based on the findings, mathematics self-efficacy does not mediate the relationship between attitudes toward technology-based learning and numeracy skills. The result denies the Social Cognitive Theory, explaining that learning is shaped by the interaction of personal, behavioral, and environmental factors through reciprocal determinism.

*5. **Recommendations***

Based on the conclusion, the following are recommended:

1. Future researchers may explore other variables that could affect or explain the relationship between attitudes toward technology-based learning and numeracy skills, as mathematics self-efficacy was not found to mediate this relationship. They may also use qualitative studies to understand better other factors affecting students' numeracy skills.
2. Curriculum planners may design learning activities that support both technology use and the development of basic mathematics skills. Since mathematics self-efficacy did not mediate the relationship, programs may focus more on directly improving students' numeracy skills.

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