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Mediating Effect of Mathematics Attitude on the Relationship between Technological Resources and Problem-Solving Abilities of Grade 12 Students

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Abstract
Low problem-solving abilities are a crucial issue. This study aimed to determine the mediating effect of mathematics attitude on the relationship between technological resources and problem-solving abilities. Using mediation analysis involving 500 grade 12 students selected through quota sampling, it is revealed that the interest variable significantly mediates the correlation between predictive and criterion variables, partially confirming the problem-solving theory. Consequently, the following are recommended: integrating technology in education, promoting positive mathematics attitudes, and developing metacognitive skills by reflecting on problem-solving strategies and approaches.

Keyword: *Mediating Effect of Mathematics Attitude, Technological Resources, Problem-Solving Abilities*

1. Introduction

The issue of low problem-solving abilities in mathematics among students is a significant concern (Simamora et al., 2018). In 2019, a study by the National Assessment of Educational Progress (NAEP) revealed that 66% of eighth-grade students in the United States did not achieve mathematics proficiency (NAEP, 2019). This result suggests that many students need to achieve the anticipated problem-solving standards. Research indicates that the difficulty in answering mathematical problems is not restricted to simple arithmetic but applies to more intricate and advanced cognitive tasks. A recent American Institutes for Research (AIR) poll indicated that 63% of high school students lacked confidence in problem-solving abilities in real-world situations (AIR, 2019).

Furthermore, there are noticeable discrepancies in the problem-solving abilities in mathematics among various demographic groups. This challenge is frequently evident in global evaluations like TIMSS and PISA, where students often demonstrate subpar proficiency in problem-solving activities, as highlighted by Son et al. (2020). Meanwhile, one study noted that Filipino students consistently perform poorly in international assessments, such as Trends in International Mathematics and Science Study (TIMSS). In mathematics, less than 20% of students demonstrated the minimum proficiency level (Level 2), while more than 50% showed very low proficiency (below Level 1) (Bernardo et al., 2022). A significant majority of Filipino students in this age range exhibit inadequate problem-solving skills, scoring below the minimum competency level on the PISA assessment, and this places them at a disadvantage compared to their counterparts in other regions (Lapinid et al., 2021).

Research indicates that students who lack proficient problem-solving abilities frequently encounter reduced academic achievement, heightened mathematics anxiety levels, and diminished mathematical aptitude self-assurance (Guo & Liao, 2022). Based on this, examining the causes of low problem-solving abilities is urgent. Amidst this urgency, more research needs to be conducted on this concern. Thus, this research was conducted.

1.1 Statement of the Problem

This study determined the mediating effect of mathematics attitude on the relationship between technological resources and problem-solving abilities. Specifically, it aimed to attain the following objectives:

1. To determine the level of technological resources in terms of:
    1.1. ownership and access to ICT;
    1.2. internet access;
    1.3. use of ICTs;
    1.4. social media, and
    1.5. perceptions of technology-enabled learning environment.
2. To determine the level of problem-solving abilities in terms of:
    2.1. problem-solving confidence;
    2.2. approach-avoidance style; and
    2.3. personal control.
3. To determine the level of mathematics attitude in terms of:
    3.1. anxiety;
    3.2. confidence;
    3.3. enjoyment; and
    3.4. benefits/values.
4. To determine the significant relationship between technological resources, problem-solving abilities, and mathematics attitude.
5. To determine the significant mediating effect of mathematics attitude on the relationship between technological resources and problem-solving abilities.

1.2 Hypotheses

The following hypotheses were tested at a 0.05 level of significance.

H01: There is no significant relationship between technological resources, problem-solving abilities, and mathematics attitude.

H02: Mathematics attitude has no significant mediating effect on the relationship between technological resources and problem-solving abilities.

1.3 Theoretical/Conceptual Framework

This study was grounded in Schoenfeld's Problem-Solving Theory (1985). The theory posits that problem-solving activity, which can be described as beliefs or attitudes towards mathematics, is necessary and sufficient to develop problem-solving abilities. Added to this, resources, which can be referred to as technology, are asserted to affect problem-solving abilities. This study examines the attitude towards mathematics to determine whether it mediated the correlation between technological resources and problem-solving abilities.

In this study, technological resources represent ownership and access to ICT, internet access, use of ICTs, social media, and perceptions of the technology-enabled learning environment (Das & Mishra, 2016). Problem-solving abilities include problem-solving confidence, approach-avoidance style, and personal control (Kasimu, 2017). Lastly, mathematics attitude includes anxiety, confidence, enjoyment, and benefits/value (Heppner, 1988).

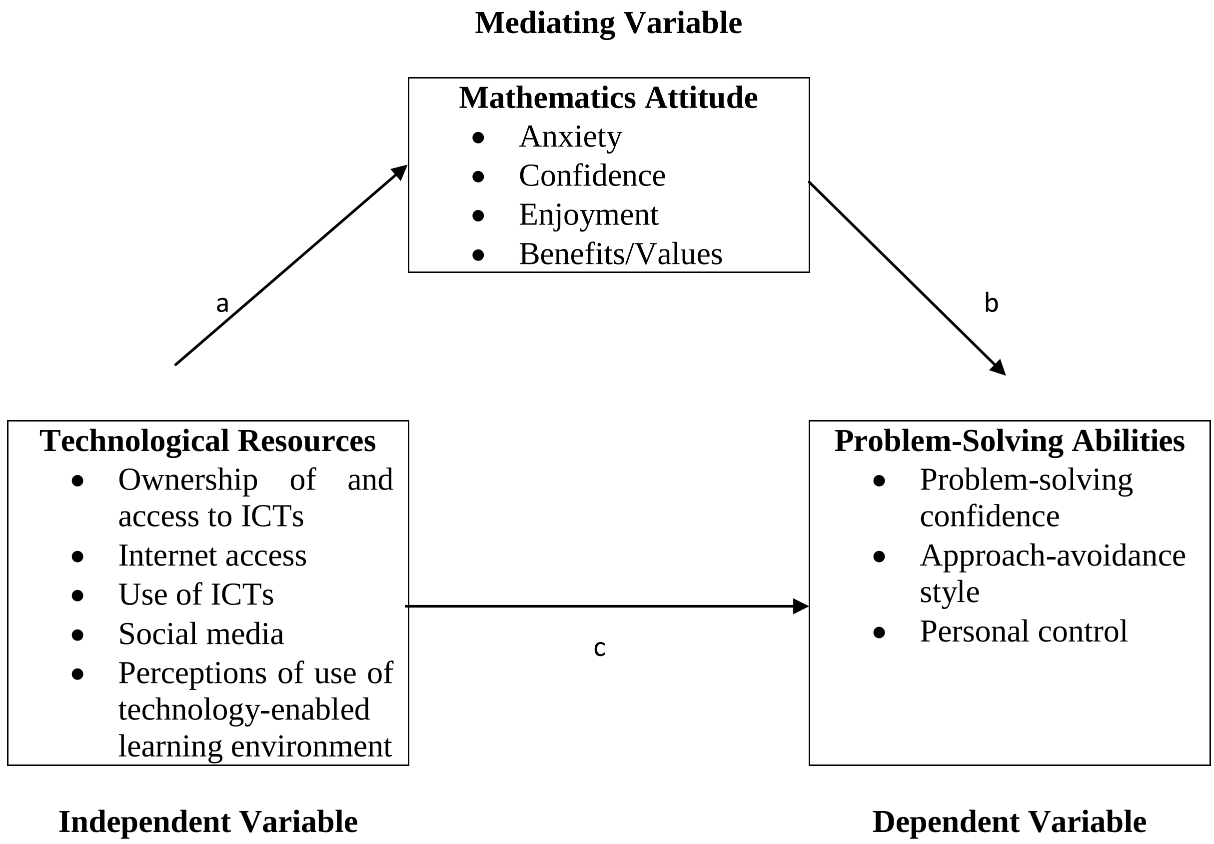


Figure 1: Conceptual Framework of the Study

2. Methodology

This study utilized a non-experimental quantitative research design employing a descriptive-correlational approach with mediation analysis. Cresswell and Cresswell (2018) described non-experimental research as quantitative research where the researcher does not manipulate any variables but observes and measures them as they naturally occur. Fraenkel et al. (2019) defined the descriptive-correlational approach as a research methodology that provides a detailed account of the present state of variables and investigates the connections between them. According to Leedy and Ormrod (2019), descriptive correlational research helps examine the relationship between factors and problem-solving skills. This type of research helps to understand current situations better and uncover trends. Meanwhile, mediation analysis is a statistical method employed to comprehend how an independent variable impacts a dependent variable through the involvement of a mediator (MacKinnon et al., 2017).

This methodology was chosen to explore the mediating effect of mathematics attitude on the relationship between technological resources and the problem-solving abilities of grade 12 students. The descriptive-correlational approach allows for examining relationships between variables without manipulating any factors, providing a clear picture of existing associations and potential mediators in a natural setting. Further, the mediation analysis can elucidate how technological resources affect problem-solving abilities through mathematics attitude, providing a deeper understanding of the indirect effects and the overall dynamics among the variables.

2.1 Research Locale

This study was carried out in the public senior high schools of Cluster 1 and 2, Division of Davao City, Region XI, which is regarded as the pilot school of Davao City and is located in the center of Region XI. These schools provided the respondents for this study since they are known as one of the leading schools in the community for offering quality education to students, notably in the field of special science education. Davao City has been chosen as the study location because of the many enrolled Science, Technology, Engineering, and Mathematics (STEM) students with technological resources, mathematics attitudes, and problem-solving abilities. In addition, Davao City is a first-class, highly urbanized city in the Davao Region.

It is also the largest city in the Philippines regarding land area. As Mindanao's most prominent economic center, the city is the primary local economy in the southern Philippines.

2.2 Research Respondents

This study included five hundred (500) grade 12 Senior High School Science, Technology, Engineering and Mathematics (STEM) students from the public high schools of Davao City, which is aligned with the desirable sample size suggested by Sim et al. (2021), ranging from 171 to 508, generally adequate for analyzing relationships and mediating effects in simple mediation models.

Moreover, the researcher employed Quota Sampling. This form of sampling does not rely on random selection but instead involves choosing a specific number or proportion of units in a planned manner, referred to as a quota (Nikolopoulou, 2023). The initial step involves partitioning the population into distinct and non-overlapping subgroups, known as strata. Subsequently, sample units are selected until the predetermined quota is attained.

As a result, 500 samples were collected from students in grade 12. The criteria for selecting respondents are as follows: (a) they must be students currently enrolled in the research locale for the school year 2023-2024; (b) they must be enrolled in the STEM class; and (c) whose age is 18 years old or older. If this requirement is met, the analysis will accept them. In addition, the researcher appreciated the respondents' eagerness to take part. Consequently, respondents had the option to discontinue their involvement if they encountered any psychological or emotional discomfort or were incapable of finishing the survey offered by the researcher. Their withdrawal would be duly considered.

2.3 Research Instruments

The three constructs of this study, technological resources, problem-solving abilities, and mathematics attitude, were assessed using three instruments: the technological resources questionnaire, adapted from Das and Mishra (2016), underwent restructuring to align with the specific technological tools and practices prevalent in the study's locale. Similarly, the problem-solving ability questionnaire, adapted from Heppner (1988), was adjusted to capture better the unique problem-solving challenges faced by students in the local educational system. The mathematics attitude questionnaire, adapted from Kasimu (2017), was modified to reflect cultural factors and educational priorities relevant to the study's context. The restructuring was done to make the instruments more applicable to the local educational context and is often necessary to improve their applicability to the local educational context. Thus, it was considered a modified-adapted survey questionnaire.

Technological Resources Questionnaire. To gather the data for the independent variable, technological resources, the researcher adapted the Technology Competence Survey instrument, the Questionnaire on Learner Use of Technology, developed by Das and Mishra (2016). It has five indicators: ownership of and access to ICTs, internet access, use of ICTs, social media, and perceptions of use of technology-enabled learning. In evaluating the technology competence of STEM students, the respondents will use the following scale:

Range of Means	Description	Interpretation
4.20-5.00	Very High	This means that technological resources were always manifested.
3.40-4.19	High	This means that technological resources were often manifested.
2.60-3.39	Moderate	This means that the technological resources were sometimes manifested.
1.80-2.59	Low	This means that the technological resources were rarely manifested.
1.00-1.79	Very Low	This means that the technological resources have yet to be manifested.

Problem-Solving Ability Questionnaire. To gather the data for the dependent variable, problem-solving abilities, the researcher utilized the Problem-Solving Inventory (PSI) (Heppner, 1988), which has three indicators: problem-solving, approach-avoidance style, and personal control. In evaluating the problem-solving abilities of STEM students, below are the rating scales:

Range of Means	Description	Interpretation
4.20-5.00	Very High	This means that problem-solving abilities were always manifested.
3.40-4.19	High	This means that problem-solving abilities were often manifested.
2.60-3.39	Moderate	This means that problem-solving abilities were sometimes manifested.
1.80-2.59	Low	This means that problem-solving abilities are rarely manifested.
1.00-1.79	Very Low	This means that problem-solving abilities are never manifested.

Mathematics Attitude Questionnaire. The researcher also adapted the Students' Attitudes toward Mathematics (SATM) questionnaire to gather the data for the mediating variable, mathematics attitude. The Students' Attitudes Toward Mathematics (SATM) questionnaire developed by Kasimu & Imoro (2017) had four indicators: anxiety, confidence, enjoyment, and benefits/values. In evaluating the mathematics attitude of STEM students, the rating scales are as follows:

Range of Means	Description	Interpretation
4.20-5.00	Very High	This means that the students' positive attitudes are always manifested.
3.40-4.19	High	This means that the students' positive attitudes are often manifested.
2.60-3.39	Moderate	This means that the students' positive attitudes are sometimes manifested.
1.80-2.59	Low	This means that the students' positive attitudes are rarely manifested.
1.00-1.79	Very Low	This means that the students' positive attitudes are never manifested.

In summary, the research instrument has a total of 93 items. Part 1 for the independent variable has 40 items. Part 2 for the dependent variable has 27 items. In part 3, the mediating variable has 26 items. The survey questionnaire underwent validation from three (3) experts. The three (3) experts used a validation sheet to rate the Survey Questionnaire. The questionnaire obtained an average rating of 4.61 from the validation. All the opinions and recommendations from the experts were followed. Cronbach alpha was used to assess its reliability. Items with more than 0.70 were considered reliable, whereas items with values less than 0.70 were revised (Mohamad et al., 2015). The Technology Competence Questionnaire scored 0.911, and the equivalent internal consistency is excellent. Problem-Solving Abilities Questionnaire scored 0.951, which means that the equivalent internal consistency is excellent. Mathematics Attitude Questionnaire obtained 0.949, which means that the equivalent internal consistency was excellent. Moreover, the instrument's reliability was tested using Cronbach's Alpha of 0.959, which denoted excellent consistency.

2.4 Data Analysis

The researcher used several statistical tools to analyze the respondents' responses, including the mean, Pearson product-moment correlation coefficient, and mediation analysis. Each tool provides unique insights into the data and helps to interpret the study variables' relationships comprehensively.

Mean. The mean was used to determine the respondents' levels of technological resources, problem-solving abilities, and mathematics attitude. By calculating the mean scores for these variables, the researcher could identify the general tendencies and average performance levels of the respondents, which aids in understanding the overall trends and patterns within the data.

Pearson Product Moment Correlation of Coefficient (Pearson's r). The Pearson correlation coefficient was used to analyze the relationships between technological resources, problem-solving abilities, and mathematics attitude. This helped determine the strength and direction of these relationships, offering insights into their interconnection.

Mediation Analysis. This study employed mediation analysis to investigate whether mathematics attitude mediates the relationship between technological resources and problem-solving abilities. This involved testing whether technological resources influence problem-solving abilities directly or indirectly through their effect on mathematics attitude. The mediation analysis provides a deeper understanding of how these variables interact, revealing whether improving mathematics attitude can enhance the impact of technological resources on problem-solving abilities (MacKinnon et al., 2017).

3. Results And Discussion

This chapter presents the findings and discussion based on the data gathered. The presentation is organized based on the sequence of the problem statement in the first chapter.

3.1 Level of Technological Resources

Presented in Table 1 is the level of technological resources in terms of ownership of and access to ICTs, internet access, use of ICTs, social media, and perceptions of the use of technology-enabled learning environment.

Table 1. Level of Technological Resources

Domains of Technological Resources	Mean	Descriptive Level
Ownership of and access to ICTs	4.16	High
Internet Access	4.13	High
Use of ICTs	4.08	High
Social Media	3.74	High
Perceptions of Use of Technology-enabled Learning Environment	4.29	Very High
Overall	**4.08**	**High**

As shown in Table 1, the average degree of technological resources of grade 12 students is 4.08, considered high. This means that technological resources are often manifested. Grade 12 students are highly proficient in utilizing and comprehending technology, which is crucial for their academic and future career achievements. The students' mean score indicates a high level of proficiency in a range of technical tools and applications. This is likely due to incorporating technology into the STEM curriculum and their exposure to advanced technological settings. Advanced technical proficiency can significantly improve educational experiences and results, equipping students with the ability to tackle intricate issues, participate in cooperative endeavors, and pursue inventive resolutions.

The findings are similar to recent studies emphasizing the importance of technological resources in STEM education. Li and Ma (2020) found that high levels of technological proficiency among high school students are connected to better performance in STEM subjects and greater preparedness for higher education and STEM careers. Similarly, research by Haleem et al. (2021) highlights that integrating technology into STEM education improves students' technological skills and enhances their critical thinking, creativity, and problem-solving abilities. The strong technological skills are consistent with contemporary educational trends and policies emphasizing digital literacy and technological resources in the 21st-century curriculum. Digital tools and resources are increasingly used in educational institutions, allowing students to develop vital technology skills (OECD, 2020).

Further, the domain perceptions of the use of technology-enabled learning environment obtained the highest mean value among the five domains, which is 4.29, which is described as very high; that is, the perceptions of the use of technology-enabled learning environment are always manifested. This is shown in the part where the grade 12 students use technology in their studies because it helps them better understand problem-solving in mathematics.

This aligns with Kimmons et al. (2015) when they found that students, especially in STEM disciplines, overwhelmingly regard technology as beneficial for understanding complex subjects due to the availability of interactive simulations and immediate feedback mechanisms, which facilitate learning and positively influence academic performance. Additionally, a meta-analysis by Zheng et al. (2022) strongly supports the use of technology in education, demonstrating that tailored learning experiences significantly enhance students' academic performance and positively shape their perceptions of the learning process. A study conducted by Peart et al. (2017) on the iSTART personalized learning system showed that integrating technology led to better student engagement and outcomes. This supports the high average values obtained in similar learning settings.

This is followed by the domain ownership of and access to ICTs obtaining a mean score of 4.16, which is described as high; ownership and access to ICTs are often manifested. This is seen particularly in the items where grade 12 students believe that ownership of personal ICT devices is essential for staying connected and engaged with educational resources in the modern learning environment of math classes. Access to a reliable and high-speed internet connection is crucial for maximizing the benefits of ICT tools and online educational resources in math.

A study conducted by Seenivasan (2024) emphasized that students who have more opportunities to use ICT resources demonstrate improved academic performance and problem-solving abilities, especially in STEM courses. However, Silva et al. (2023) found that while perceived ICT proficiency and independence positively influence educational achievements, overconfidence and using ICTs mainly for pleasure can negatively impact academic outcomes.

Meanwhile, social media obtained the lowest mean value among the five domains, obtaining a mean score of 3.74, which is described as high. This means that the social media of grade 12 students is often manifested. In this manner, education policymakers may consider leveraging social media platforms for educational purposes, given their high manifestation among grade 12 students, to enhance engagement and learning outcomes by integrating educational content into these platforms.

This is supported by Meier et al. (2019), who conducted a study that investigated the correlation between academic performance and social media use. The research indicates that, although social media can offer advantageous academic networking opportunities, its overall influence on academic performance is intricate. It may occasionally be less substantial than other technological tools. According to Kolhar et al. (2021), using social media excessively can cause distractions from schoolwork and possibly reduce academic attainment. However, Liu et al. (2022) suggest that social media can help learning and peer collaboration when utilized strategically. This means social media's impact on students depends on usage patterns and environment.

3.2 Level of Problem-Solving Abilities

Presented in Table 2 is the level of problem-solving abilities in terms of problem-solving confidence, approach-avoidance style, and personal control.

Table 2. Level of Problem-Solving Abilities

Domains of Problem-Solving Abilities	Mean	Descriptive Level
Problem-Solving Confidence	3.52	High
Approach-Avoidance Style	3.86	High
Personal Control	3.88	High
Overall	**3.76**	**High**

The table reveals that the overall mean value of problem-solving abilities is 3.76, which is described as high. This means that the problem-solving skills of the students are often manifested. This finding suggests that grade 12 students demonstrate strong problem-solving abilities, which is critical for success in STEM fields. The mean score indicates that these students possess the necessary skills to identify problems, analyze potential solutions, and successfully implement ways to overcome concerns. Proficient problem-solving abilities are crucial for addressing intricate issues in STEM fields, which frequently need analytical thinking, ingenuity, and deductive reasoning.

This is supported by Booc et al.'s study (2024), suggesting that if students demonstrate advanced computational abilities in addressing application issues through fundamental differentiation rules, they possess a high level of mathematical competency. However, this contradicts a study that observed that although students do well on standardized tests, they frequently struggle to comprehend concepts and apply critical thinking skills to solve real-world problems (Saadati & Reyes, 2019). The necessity for educational methodologies prioritizing problem-solving strategies and adaptable cognitive abilities is underscored by contemporary trends emphasizing critical thinking and problem-solving through experiential learning, project-based assignments, and collaborative activities that enhance these skills in grade 12 students (OECD, 2020).

Moreover, it shows that the domain personal control obtained the highest mean value among the three domains, gaining a mean score of 3.88, which is described as high; that is, personal control is often manifested in grade 12 students. This is seen particularly in the item where grade 12 students pause for a while and take time to deal with math problems. The results imply that educational policies further support and enhance students' autonomy and self-regulation skills, as these traits are already strongly manifested and can significantly contribute to their academic success and overall development.

This is supported by Zimmerman and Schunk (2011) in their study that examined the significance of personal control in self-regulated learning. It revealed that students who actively manage their learning by establishing objectives and self-reflecting on their problem-solving methods generally get better academic results, especially in mathematics. However, excessive emphasis on personal control can sometimes lead to stress and burnout in students, contradicting the assumption that it is uniformly beneficial (March-Amengual et al., 2022).

This is followed by the domain approach-avoidance style with a mean value of 3.86, descriptively interpreted as high; that is, approach-avoidance style is often manifested. This is observed mainly in the items where grade 12 students take time and compare the actual outcome to what they thought should have happened after solving a math problem and when they survey the situation and consider all the relevant pieces of information after getting confused with a math problem. Educational policy should consider students with a high approach-avoidance style, acknowledging their conflicted engagement with academic difficulties and goals.

The significance of reflection in the learning process is underscored in a study conducted by Hattie and Donoghue (2016). Engaging in reflective behaviors, such as evaluating actual outcomes in relation to anticipated results, enables students to comprehend their errors and enhance their future performance. Additionally, strong evidence was reported by Garcia-Guerrero et al. (2023) to indicate that people often display approach-avoidance behaviors when faced with uncertain outcomes in decision-making situations.

However, the domain problem-solving confidence had the lowest mean value among the three indicators, at 3.52, which is still described as high. This implies that while grade 12 students generally possess strong problem-solving abilities, their confidence in problem-solving skills is relatively lower than their actual capabilities. Although relatively strong, the result indicates that students may need more self-assurance when dealing with intricate difficulties. This suggests that although students can solve problems efficiently, they may have self-doubt or need more confidence in their problem-solving approach. With this, teachers may incorporate regular confidence-building exercises into their curriculum, including group problem-solving activities, peer-to-peer teaching opportunities, positive reinforcement strategies that emphasize effort and improvement, and correct solutions.

Studies have indicated that students often need more self-assurance to apply their problem-solving skills effectively, which impacts their ability to navigate complex academic and professional challenges (Knightsmith, 2016). Traditional teaching methods, which prioritize procedural knowledge over conceptual understanding, are seen as a significant contributor to this deficiency in students' critical thinking and cognitive abilities (Harding et al., 2017). To mitigate this, researchers advocate that promoting resilience and independent learning is crucial in enhancing students' problem-solving capacities (Nahdi et al., 2021).

3.3 Level of Mathematics Attitude

Presented in Table 3 is the level of mathematics attitude in terms of anxiety, confidence, enjoyment, and benefits/value.

Table 3. Level of Mathematics Attitude

Domains of Mathematics Attitude	Mean	Descriptive Level
Anxiety	3.23	Moderate
Confidence	3.10	Moderate
Enjoyment	3.47	Moderate
Benefits/Value	4.37	Very High
Overall	**3.54**	**High**

Table 3 reveals that the overall mean level of mathematics attitude is 3.54, which is described as high. This means that the students' positive attitudes are often manifested. This indicates that grade 12 students generally hold positive attitudes toward mathematics, crucial for their engagement and success in this subject. The mean score suggests that students possess a favorable disposition towards learning mathematics. This positive attitude can include a range of factors such as interest in the subject, perceived relevance of mathematics to their future goals, confidence in their mathematical abilities, and enjoyment of mathematical challenges.

This is supported by Ma and Kishor (2020) in their research, which stated that students with a positive attitude toward mathematics are more inclined to participate in educational tasks, seek assistance when necessary, and demonstrate perseverance when confronted with challenges. Furthermore, a recent investigation by Dowker et al. (2021) underscores the significance of having a favorable disposition towards mathematics, as it can result in enhanced problem-solving abilities and scholastic success in STEM fields. In recent years, there has been a growing emphasis on promoting favorable attitudes towards mathematics among students in educational trends. This encompasses integrating practical mathematical concepts, implementing engaging and learner-focused instructional approaches, and providing assistance to foster a strong sense of mathematical self-assurance (OECD, 2020). Through improving students' attitudes towards mathematics, educators strive to establish a more captivating and efficient learning atmosphere that fosters academic achievement in STEM disciplines (Cabuquin & Abocejo, 2023).

Meanwhile, the domain benefits/value obtained the highest mean score of 4.37, surpassing the rest of the three domains, which is interpreted as very high; that is, benefits/value as mathematics attitude is always manifested. This is observed mainly in the item where the grade 12 students wanted to develop their math skills. Given the results, educational policy may prioritize enhancing its perceived benefits and value. This indicates that students consistently demonstrate very high positive attitudes toward mathematics when they recognize its value, significantly supporting their overall learning and performance.

The result is consistent with the research conducted by Mazana et al. (2019), which emphasizes that students who acknowledge the value and advantages of mathematics frequently cultivate more optimistic attitudes, increasing their engagement and performance. This corroborates the notion that the advantages and values associated with mathematics attitudes are prominent and influential. Additionally, Subia et al. (2018) discovered that students who possess a high level of appreciation for the advantages of mathematics demonstrate superior performance and attitudes, underscoring the importance of perceived value in forming mathematical attitudes.

This is followed by the domain enjoyment, which has obtained a 3.47 mean value and is described as moderate, specifically in the part where grade 12 students enjoy learning math with friends. This indicates that enjoyment among grade 12 students is sometimes manifested. This implies that in order to improve the enjoyment of math education for grade 12 students, it is important for educational policy to focus on collaborative and peer-based learning methodologies.

This finding aligns with the study of Casinillo (2022), which aims to assess the degree of inventiveness and the amount of enjoyment in learning mathematics throughout the epidemic, and it showed that the level of creativity and fun experience in learning mathematics during the pandemic is limited. In this case, Posamentier (2017) recommended that teachers should create a dynamic and stimulating learning atmosphere for students by providing them with engaging and enjoyable mathematics learning activities.

The lowest mean value among the four domains of mathematics attitude is confidence, with a mean score of 3.10, described as moderate. This indicates that students' self-confidence in their mathematical abilities is the weakest aspect of their overall mathematics attitude. The educational policy may prioritize incorporating collaborative learning spaces, providing professional development opportunities for instructors to promote positive attitudes, and using captivating, technology-enhanced instructional approaches to boost students' confidence in mathematics.

Lack or low level of confidence might make students less inclined to work hard on complex mathematics problems, which can impact their classroom performance and overall persistence (Mazana et al., 2019). Additionally, self-confidence is a significant factor in acquiring mathematics skills, as it allows students to approach problems with a positive mentality, reduce anxiety, and cultivate persistence. These factors improve their capacity to comprehend and apply mathematical concepts effectively (Kunhertanti & Santosa, 2018).

3.4 Significance of the Relationship between Technological Resources, Problem-Solving Abilities, and Mathematics Attitude

Table 4 presents the relationship between technological resources, problem-solving abilities, and mathematics attitude.

Table 4. Significance of the Relationship between Technological Resources Problem-Solving Abilities and Mathematics Attitude

	r	p-value	Decision on H_0 @ 0.05 level of significance	Interpretation
	Problem-Solving Abilities			
Technological Resources	0.54	0.000	Reject H_0	Significant
Mathematics Attitude	0.64	0.000	Reject H_0	Significant
	Mathematics Attitude			
Technological Resources	0.40	0.000	Reject H_0	Significant

Table 4 reveals a significant relationship between technological resources and problem-solving abilities. The analysis obtained a p-value of 0.000 at a 0.05 level of significance. Thus, the null hypothesis was rejected. Therefore, a significant relationship exists between technological resources and problem-solving abilities. The r-value is 0.54, interpreted as a moderate positive correlation. The analysis further reveals that 29 percent of the variance (r^2=0.29) in the problem-solving abilities of grade 12 students can be attributed to their technological resources.

In comparison, other factors account for the remaining 71 percent. From the results, it is inferred that students would also have high problem-solving abilities when technological resources are high. Results observed between technological resources and problem-solving abilities of grade 12 students suggest that improving students' technological capabilities could significantly enhance their problem-solving abilities. This relationship highlights the significance of using technology-based learning tools and resources in STEM education since it enhances students' readiness for complicated problem-solving activities.

This finding aligns with González et al. (2020) when they found a substantial and favorable correlation between technological resources and problem-solving abilities among high school students, suggesting that those with higher technological resources are better equipped to confront and resolve obstacles, enhancing their problem-solving capabilities. Also, Kim and Kim (2021) demonstrated that integrating technology into the curriculum improves students' critical thinking and problem-solving abilities by enhancing comprehension of complex topics and facilitating more efficient knowledge application. However, Liu and Ko (2022) found that technological resources have a less significant impact on problem-solving abilities than cognitive skills and prior knowledge, suggesting that overemphasizing technology skills may hinder the development of crucial problem-solving techniques. Similarly, Carstens et al. (2021) demonstrated that excessive dependence on technology impairs independent problem-solving skills, as students relying too much on technology struggle with manual or non-technical scenarios, emphasizing the need for a comprehensive educational approach.

Table 4 also shows a significant relationship between mathematics attitude and problem-solving abilities. The analysis obtained a p-value of 0.000 at a 0.05 significance level, rejecting the null hypothesis. This shows a significant relationship between mathematics attitude and problem-solving abilities. The r-value is 0.64, which is interpreted as a moderate positive correlation. The analysis further reveals that 41 percent of the variance ($r^2=0.41$) in problem-solving abilities of grade 12 students can be attributed to their mathematics attitude.

In comparison, other factors account for the remaining 59 percent. This indicates that the mathematics attitude influences their problem-solving abilities. Their mathematics attitude is moderate, so they could also execute a moderate problem-solving ability. Further, it supports that mathematics attitude significantly contributes to their problem-solving abilities, although it is not the sole determinant. Consequently, educators should prioritize establishing nurturing and captivating learning settings that foster self-assurance and enthusiasm for mathematics. Furthermore, interventions targeting enhancing students' perspectives on mathematics, such as growth mindset initiatives and real-world application projects, may play a vital role in fostering their general problem-solving abilities.

This is supported by Li and Ma (2020), who found a positive correlation between high school students' problem-solving performance and their positive attitudes toward mathematics, indicating that students with a positive relationship with mathematics are more motivated and perseverant in problem-solving tasks. Smith and Johnson (2021) found that students who find mathematics relevant and enjoyable are more likely to participate in problem-solving activities actively. However, Brown and Jones (2022) discovered that cognitive ability and prior knowledge predict students' problem-solving approaches better than mathematics attitudes, as their findings stressed the need for a multifaceted approach to problem-solving. Further, Park et al. (2023) found that metacognitive skills and strategic methods are more important than mathematical attitude in sustained problem-solving effectiveness.

Also shown in Table 4 is a significant relationship between technological resources and mathematics attitude. The analysis obtained a p-value of 0.000 at the 0.05 level of significance. Thus, the null hypothesis is rejected. This means a significant relationship exists between technological resources and the mathematics attitude of grade 12 students. The r-value is 0.40, meaning a low positive correlation exists between variables. It shows that technological resources significantly influence attitudes towards mathematics.

This implies that when the technological resources are moderate, they would also have a moderate mathematics attitude. The analysis further reveals that 16 percent of the variance ($r^2=0.16$) in the mathematics attitude of grade 12 students can be attributed to their technological resources. In comparison, other factors account for the remaining 84 percent. This implies that while technological resources have some influence on the attitude toward mathematics, they are not the sole determinant. This also implies that although integrating technology in math education can enhance students' perceptions and engagement, it should be complemented with other strategies to foster a positive mathematics attitude more effectively. Therefore, educators should consider a holistic approach combining technological tools with motivational and pedagogical methods to improve technological resources and mathematics attitudes comprehensively.

This aligns with Wang and Wang's (2021) findings indicating that technology enhances students' math attitudes through enjoyable and dynamic activities, thereby potentially enhancing arithmetic learning by increasing engagement and enjoyment. However, Johnson and Smith (2022) discovered that while technical knowledge plays a crucial role, it is not the sole determinant of students' mathematical perspectives, revealing a complex interplay among individual, societal, and contextual factors influencing students' beliefs about mathematics. Although technology can potentially improve math instruction, Brown and Jones (2023) found that it does not consistently improve math attitudes. Instead, the significant impact of teacher-learner interactions, classroom environment, and the perceived significance of mathematics on students' attitudes is underscored.

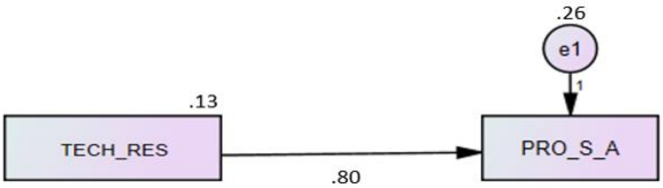


Figure 2. Regression Weight of the Technological Resources to Problem-Solving Abilities

			Estimate	S.E.	C.R.	p-value	interpretation
Technological Resources	→	Problem-Solving Abilities	0.80	0.08	10.38	.000	Significant

The regression weights are presented in the table of Figure 2, depicting the relationship between technological resources and problem-solving abilities. The regression weight for technological resources is 0.80, indicating a strong positive correlation. As technological resources increase, there is a significant improvement in problem-solving abilities in mathematics of grade 12 students. Further, the standard error (S.E) of 0.08 is deficient, indicating a precise and reliable estimate. Furthermore, the critical ratio (C.R.) of 10.38 indicates a substantial difference between the estimated regression weight and zero. The p-value of .000, lower than the 0.05 significance level, demonstrates a significant relationship between technological resources and problem-solving abilities. This implies that enhancing technological resources through advanced tools and training programs can significantly boost students' problem-solving skills, better preparing them for academic and professional challenges.

This is supported by Alsarayreh (2023) when he found that technological proficiency significantly enhances problem-solving abilities and that academic achievement moderates this influence, further supporting the positive impact of technological resources on developing these skills. Koyuncuoglu (2022) discovered a notable correlation between technological proficiency in digital tools and improved problem-solving skills in university students, arguing that such skills enable faster and more efficient problem-solving methods.

In relation to Schoenfeld's problem-solving theory, technological resources (resources), particularly in accessing and utilizing digital resources, significantly enhance problem-solving abilities, not solely by enriching the resources accessible for problem-solving but also by increasing the cognitive and metacognitive processes necessary for efficient problem-solving results in modern situations. Additionally, technology fosters metacognitive skills by encouraging students to plan, monitor, and evaluate their problem-solving strategies using digital platforms. This interactive and engaging learning environment, supported by technology, helps build confidence and resilience in tackling mathematical problems, positively influencing students' attitudes toward mathematics.

Table 5 shows the mediation analysis of the mediating effect of mathematics attitude on the relationship between technological resources and problem-solving abilities.

Table 5. Significance of the Mediating Effect of Mathematics Attitude on the Relationship between Technological Resources and Problem-Solving Abilities

			Estimate	S.E.	C.R.	p-value	Interpretation
Technological Resources	→	Problem-Solving Abilities	0.54	0.07	8.01	.000	Significant
Technological Resources	→	Mathematics Attitude	0.65	0.11	6.02	.000	Significant
Mathematics Attitude	→	Problem-Solving Abilities	0.41	0.03	12.54	.000	Significant

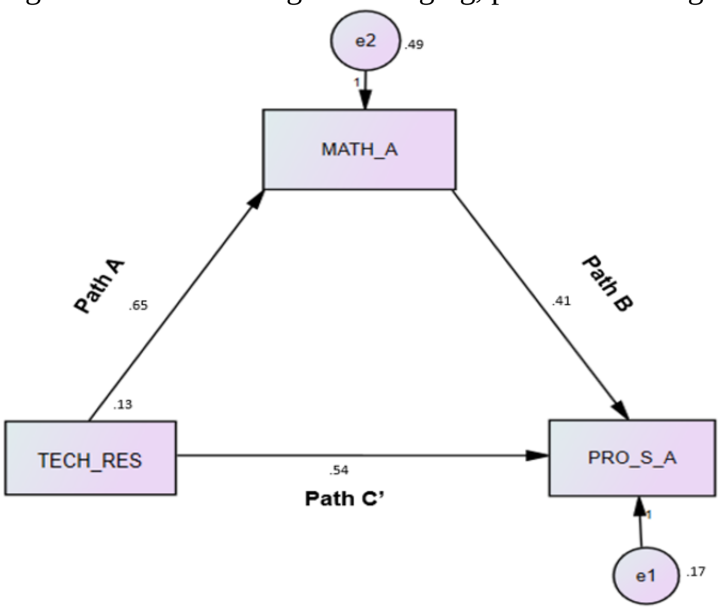
Presented in Table 5 are the relationships between the variables with their corresponding estimate, standard error, critical ratio, and p-value.

It shows that the association between technological resources and mathematics attitude (Path A) as a mediator has an estimated value of 0.65. This implies that if technological resources increase by 1 unit, mathematics attitude would also increase by 0.65 units. The probability value of 0.000 indicates that the regression weight for technological resources is significant at the 0.05 level, suggesting that the influence between technological resources and mathematics attitude is significant.

When examining the relationship between technological resources and mathematics attitude, within Schoenfeld's framework, individuals with solid technological resources and positive attitudes toward mathematics are more likely to effectively utilize available resources, enhancing their problem-solving capabilities through proactive engagement with mathematical challenges and informed use of technology. This also aligns with Higgins et al. (2019) as they emphasized that incorporating technology in mathematics education has been linked to several advantageous results, such as enhanced attitudes toward mathematics and increased comprehension of concepts. Technology facilitates the visualization of abstract mathematical concepts, fosters linkages between mathematical ideas, and encourages active engagement with the content (Rashidov, 2020). This can increase student involvement, interest, and motivation in mathematics. However, Emata (2023) conducted a study to examine how technology attitude influences the connection between mathematics self-efficacy and attitudes towards mathematics. The findings indicated no significant correlation between technology attitudes and attitudes toward mathematics.

Meanwhile, the estimate of the relationship between mathematics attitude as a mediator and problem-solving abilities (Path B) is 0.41, suggesting that as mathematics attitude increases by 1 unit, problem-solving abilities increase by 0.41. The probability value 0.000 implies that the regression weight for mathematics attitude is significant at 0.05.

In Schoenfeld's theory, how individuals approach and persist in solving mathematical problems is influenced by their beliefs, affecting their problem-solving abilities. Given that the mathematics attitude mediates the relationship between technological resources and problem-solving abilities, this emphasizes the substantial role of positive attitudes in improving problem-solving efficacy when accompanied by strong technological skills and resources. This is supported by Sturm and Bohndick (2021) in their study, which revealed that the problem-solving performance of students depends on their attitudes and beliefs. Further, the study conducted by Russo and Minas (2020) revealed that most students expressed unambiguously positive attitudes toward learning mathematics through challenging, problem-solving tasks.



Result: Partial Mediation

Figure 3. Path Diagram of the Mediating Effect of Mathematics Attitude on the Relationship Between Technological Resources and Problem-Solving Abilities

Furthermore, shown in Figure 3 is the mediating effect of mathematics attitude on the relationship between technological resources and problem-solving abilities. The data indicate that mathematics attitude plays a significant role in this relationship. As a mediating variable, mathematics attitude influences the association between technological resources and problem-solving abilities by lowering the beta coefficient value from 0.80 to 0.54. This change makes the relationship between the predictive and criterion variables (technological resources) (problem-solving abilities) even more significant. As a result, the null hypothesis is rejected. Accordingly, in Baron and Kenny's (1986) criteria, if there are significant associations in the three steps required to establish a third variable as a mediator, the analysis proceeds to the collective impact of both the technological resources and mathematics attitude on problem-solving abilities. Hence, it is significant. With this, the relationship between technological resources and problem-solving abilities is partially mediated by mathematics attitude, and the mediation effect is significant.

Schoenfeld's theoretical framework for problem-solving underscores the significance of beliefs, control, heuristics, and resources in effective problem-solving. In this framework, mathematics attitude can partially mediate the relationship between technological resources and problem-solving abilities. This suggests that, despite the importance of technological resources, their impact on problem-solving is significantly influenced by the students' attitudes towards mathematics. This mediation effect emphasizes that positive mathematics attitudes improve the control over problem-solving processes by enhancing the utilization of technological resources and heuristics. Schoenfeld's original factors emphasize that a learner's beliefs about mathematics influence their engagement with problem-solving tasks. This implies that the full potential of problem-solving is only realized when a positive attitude toward mathematics is present, even with high technological resources (Lang et al., 2018). This substantial mediation effect underscores the significance of cultivating positive mathematical attitudes to optimize the advantages of technological resources in problem-solving contexts.

3.5 Summary of Findings

The study found different findings regarding grade 12 students. The research findings indicated that technological resources are consistently high, which means that the technology resources are often manifested. The study found that problem-solving abilities are consistently manifested. The consistent manifestation of a positive mathematics attitude among grade 12 students is validated by research indicating that attitudes towards mathematics, once developed, tend to persist and influence ongoing learning and performance. This is supported by studies showing that regular engagement with technology enhances students' confidence and proficiency, a persistent trait in STEM education. Furthermore, it reveals that the relationship between technological resources and problem-solving abilities is partially mediated by mathematics attitude.

4. Conclusions And Recommendations

Based on the data, it is concluded that mathematics attitude significantly partially mediates the correlation between technological resources and problem-solving abilities. Thus, problem-solving theory was affirmed partially, stating that problem-solving activity, described as beliefs or attitudes towards mathematics, is necessary and sufficient to develop problem-solving abilities, which correlate with technological resources.

Schools should integrate technological resources into the curriculum to enhance learners' problem-solving abilities, ensuring equitable access to quality education. Educational programs should focus on fostering positive attitudes towards mathematics among learners to improve their problem-solving abilities. Additionally, it is essential to teach learners metacognitive strategies to help them reflect on their problem-solving processes and improve their approaches over time.

5. References

1. Alsarayreh, R. S. (2023). The effect of technological skills on developing problem solving skills: The moderating role of academic achievement. *International Journal of Instruction*, *16*(2), 369–388. https://doi.org/10.29333/iji.2023.16221a
2. American Institutes for Research. (2019). *High school students' views on mathematics and science*. https://www.air.org/resource/high-school-students-views-mathematics-and-science
3. Arellano, L., Alcubilla, P., & Leguízamo, L. (2023). Ethical considerations in informed consent. *IntechOpen*. https://doi.org/10.5772/intechopen.1001319

4. Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173
5. Bernardo, A. B. I., Cordel, M. O., II, Lapinid, M. R. C., Teves, J. M. M., Yap, S. A., & Chua, U. C. (2022). Contrasting Profiles of Low-Performing Mathematics Students in Public and Private Schools in the Philippines: Insights from Machine Learning. *Journal of Intelligence*, *10*(3), 61. https://doi.org/10.3390/jintelligence10030061
6. Booc, N. B. B., Ringcunada, E. J. D., Justiniani, A. M. Q., Arevalo, J. M. N., Nui, J. P. C., Mora, R. C., Semblante, A. P., & Subingsubing, E. T. (2024). Computational skills in solving application problems involving basic differentiation rules in differential calculus: an explanatory sequential study. *European Journal of Theoretical and Applied Sciences*, 2(1), 367–374. https://doi.org/10.59324/ejtas.2024.2(1).31
7. Brown, A., & Jones, B. (2023). *Beyond technology: Factors influencing learners' attitudes towards mathematics*. Mathematics Education Research Journal, 35(1), 45–60.
8. Brown, L., & Jones, P. (2022). *The relative influence of mathematics attitude, cognitive abilities, and prior knowledge on problem-solving abilities*. Journal of Educational Psychology, 114(2), 217–231.
9. Cabuquin, J., & Abocejo, F. (2023). Mathematics learners' performance and academic achievement at a public high school institution in Leyte, Philippines. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 13*(2), 123–136. https://doi.org/10.30998/formatif.v13i2.17235
10. Carstens, K. J., Mallon, J. M., Bataineh, M., & Al-Bataineh, A. (2021). Effects of technology on student learning. *The Turkish Online Journal of Educational Technology*, *20*(1), 105–113. http://files.eric.ed.gov/fulltext/EJ1290791.pdf
11. Casinillo, L. F. (2022). Is learning mathematics still creative and enjoyable during the COVID-19 pandemic? *Indonesian Journal of Social Research* (IJSR), 4(2), 124-138. https://doi.org/10.30997/ijsr.v4i2.208
12. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.).* SAGE Publications.
13. Das, A. K., & Mishra, S. (2016). Questionnaire on learner use of technology. In A. Kirkwood & L. Price (Eds.), *Technology-enabled learning implementation handbook* (pp. 59–68). Commonwealth of Learning.
14. Dowker, A., Sarkar, A., & Looi, C. Y. (2021). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology, 12,* 639. https://doi.org/10.3389/fpsyg.2021.639
15. Emata, C. (2023). The Moderating Effect of Technology Attitude on the Relationship between Math Self-Efficacy and Attitudes towards Mathematics. *Unnes Journal of Mathematics Education*, *12*(1), 1–12. https://doi.org/10.15294/ujme.v12i1.62791
16. Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). *How to design and evaluate education research (10th ed.).* McGraw-Hill Education.
17. Garcia-Guerrero, S., O'Hora, D., Zgonnikov, A., & Scherbaum, S. (2023). The action dynamics of approach-avoidance conflict during decision-making. *Quarterly Journal of Experimental Psychology*, *76*(1), 160-179. https://doi.org/10.1177/17470218221087625
18. González, C., Campos, F., & Castillo, M. (2020). *The impact of technological proficiency on problem-solving skills among high school learners*. Journal of Educational Technology & Society, 23(2), 45-57.
19. Guo, S., & Liao, S. (2022). The role of opportunity to learn on student mathematics anxiety, problem-solving performance, and mathematics performance. *Frontiers in Psychology, 13,* 829032. https://doi.org/10.3389/fpsyg.2022.829032
20. Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004
21. Harding, S. E., Griffin, P. E., Awwal, N., Alom, B. M., & Scoular, C. (2017). Measuring collaborative problem solving using Mathematics-Based tasks. *AERA Open,* 3(3), 233285841772804. https://doi.org/10.1177/2332858417728046
22. Hattie, J., & Donoghue, G. M. (2016). Learning strategies: A synthesis and conceptual model. *NPJ Science of Learning*, *1,* 16013. https://doi.org/10.1038/npjscilearn.2016.13

23. Heppner, P. P. (2008). Expanding the conceptualization and measurement of applied problem-solving and coping: From stages to dimensions to the almost forgotten cultural context. *American Psychologist*, *63*(8), 805–816. https://doi.org/10.1037/0003-066X.63.8.805
24. Higgins, K., Huscroft-D'Angelo, J., & Crawford, L. (2019). Effects of Technology in Mathematics on Achievement, Motivation, and Attitude: A Meta-Analysis. *Journal of Educational Computing Research*, 57(2), 283–319. https://doi.org/10.1177/0735633117748416
25. Johnson, E., & Smith, K. (2022). *Exploring the multifaceted nature of mathematics attitude: The role of technological resources*. International Journal of STEM Education, 9(1), 67–82.
26. Kasimu, O., & Imoro, M. (2017). Students' attitudes towards mathematics: The case of private and public junior high schools in the East Mamprusi District, Ghana. *IOSR Journal of Research & Method in Education*, *7*(5), 38–43. https://doi.org/10.9790/7388-0705033843
27. Kim, J., & Kim, H. (2021). *Enhancing critical thinking and problem-solving skills through technology integration in STEM education*. Journal of Science Education and Technology, 30(3), 392-407.
28. Kimmons, R., Miller, B. G., Amador, J., Desjardins, C. D., & Hall, C. (2015). *Technology integration coursework and finding meaning in pre-service teachers' reflective practice*. Educational Technology Research and Development, 63, 809-829. doi:10.1007/s11423-015-9394-5
29. Knightsmith, P. (2016). Developing skills of resilience in your pupils. *Headteacher Update*, 2016(4), 20–21. https://doi.org/10.12968/htup.2016.4.20
30. Kolhar, M., Kazi, R. N. A., & Alameen, A. (2021). Effect of social media use on learning, social interactions, and sleep duration among university students. Saudi journal of biological sciences, 28(4), 2216–2222. https://doi.org/10.1016/j.sjbs.2021.01.010
31. Koyuncuoglu, D. (2022). Analysis of digital and technological competencies of university students. International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10(4), 971-988. https://doi.org/10.46328/ijemst.2583
32. Kunhertanti, K., & Santosa, R. (2018). The influence of students' self-confidence on mathematics learning achievement. *Journal of Physics: Conference Series, 1097,* 012126. https://doi.org/10.1088/1742-6596/1097/1/012126
33. Lang, C., Bae, S., Battista, C., Qin, S., Chen, T., Evans, T., & Menon, V. (2018). Positive attitude toward math supports early academic success: Behavioral evidence and neurocognitive mechanisms. *Psychological Science*, *29*(3), 390–402. https://doi.org/10.1177/0956797617735528
34. Lapinid, M., Cordel II, M., Teves, J., Yap, S., Chua, U., & Bernardo, A. (2021). *Which Filipino students are being left behind in Mathematics? Testing machine learning models to differentiate lowest-performing Filipino students in public and private schools in the 2018 PISA Mathematics test.* Retrieved from https://www.dlsu-aki.com/uploads/1/0/2/2/102266760/dlsu_aki_working_paper_series_2022-09-085.pdf
35. Leedy, P. D., & Ormrod, J. E. (2019). *Practical research: Planning and design* (12th ed.). Pearson Education Limited.
    a. Retrieved from https://www.pearsonglobaleditions.com
36. Li, Q., & Ma, X. (2020). *The impact of digital literacy on academic achievement among high school learners in STEM education*. Journal of Educational Technology Development and Exchange, 13(1), 23-38.
37. Liu, Y., & Ko, H. (2022). The relative influence of technological resources, cognitive skills, and prior knowledge on problem-solving abilities. *Educational Psychology Review*, 34(1), 89-105.
38. Liu, S., Zaigham, H., Muhammad, R., Rashid, & Bilal, A. (2022). Social media-based collaborative learning effects on student performance/learner performance with moderating role of academic self-efficacy. *Frontiers in Psychology*, *13*, 903919. https://doi.org/10.3389/fpsyg.2022.903919
39. Ma, X., & Kishor, N. (2020). *Assessing the relationship between attitude towards mathematics and achievement in mathematics: A meta-analysis*. Journal for Research in Mathematics Education, 51(3), 246–264.
40. MacKinnon, D., Fairchild, A., & Fritz, M. (2017). Mediation analysis. *Annual Review of Psychology*, *58*, 593–614. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2819368/

41. March-Amengual, J. M., Cambra Badii, I., Casas-Baroy, J. C., Altarriba, C., Comella Company, A., Pujol-Farriols, R., Baños, J. E., Galbany-Estragués, P., & Comella Cayuela, A. (2022). Psychological distress, burnout, and academic performance in first year college students. *International Journal of Environmental Research and Public Health, 19*(6), 3356. https://doi.org/10.3390/ijerph19063356
42. Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2019). Investigating students’ attitude towards learning mathematics. *International Electronic Journal of Mathematics Education, 14*(1), 207-231. https://doi.org/10.29333/iejme/3997
43. Meier, A., Reinecke, L., & Meltzer, C. E. (2019). “Facebocrastination”? Predictors of using Facebook for procrastination and its effects on students' well-being. *Computers in Human Behavior, 100,* 85–94. https://doi.org/10.1016/j.chb.2018.09.023
44. Nahdi, D. S., Jatisunda, M. G., & Suciawati, V. (2021). Pre-service teachers' ability to solve mathematics problems is viewed from the perspective of self-resilience. *Malikussaleh Journal of Mathematics Learning,* 4(2), 117. https://doi.org/10.29103/mjml.v4i2.2916
45. National Assessment of Educational Progress. (2019). *The Nation's Report Card: Mathematics*. https://www.nationsreportcard.gov
46. Nikolopoulou, K. (2023). What is quota sampling? *Scribbr*. https://www.scribbr.com/methodology/quota-sampling
47. OECD. (2020). *Education in the digital age: Healthy and happy children.* OECD Publishing. https://www.oecd-ilibrary.org/education/education-in-the-digital-age_9789264915535-en
48. Park, S., Lee, J., & Kim, H. (2023). *The role of metacognitive skills in the relationship between mathematics attitude and problem-solving success*. Educational Psychology, 38(1), 89-104.
49. Peart, D., Rumbold, P., Keane, K., & Allin, L. (2017). Student use and perception of technology-enhanced learning in a mass lecture knowledge-rich domain first-year undergraduate module. *International Journal of Educational Technology in Higher Education, 14,* 60. https://doi.org/10.1186/s41239-017-0078-6
50. Posamentier, A. (2017). 9 strategies for motivating students in mathematics. *Edutopia.* https://www.edutopia.org/blog/9-strategies-motivating-students-mathematics-alfred-posamentier
51. Rashidov, A. (2020). Use of differentiation technology in teaching mathematics. European Journal of Research and Reflection in Educational Sciences, 8(7), 163–167.
52. Russo, J., & Minas, M. (2020). Student attitudes towards learning mathematics through challenging, problem-solving tasks: “It’s so hard—in a good way.” *Mathematics Education Research Journal, 33,* 277–299. https://files.eric.ed.gov/fulltext/EJ1285338.pdf
53. Saadati, F., & Reyes, C. (2019). Collaborative learning to improve problem-solving skills: A relation affecting through attitude toward mathematics. In P. Felmer, P. Liljedahl, & B. Koichu (Eds.), *Problem solving in mathematics instruction and teacher professional development* (pp. 193–206). Springer. https://doi.org/10.1007/978-3-030-29215-7_10
54. Seenivasan, R. (2024). ICT in education: A critical literature review and its implications. *International Journal of Finance, Insurance and Risk Management, 14*(1), 12-27. https://doi.org/10.35808/ijfirm/378
55. Schoenfeld, A. H. (1985). Mathematical problem solving. *Elsevier Science Publishers*.
56. Silva, João & Rodrigues, José & Miguéis, V.L.. (2023). Factors influencing students' use of information and communication technologies for educational purposes. Education and Information Technologies. 29. 1-41. 10.1007/s10639-023-12132-6.
57. Sim, M., Kim, S.-Y., & Suh, Y. (2021). Sample size requirements for simple and Complex mediation models. Educational and Psychological Measurement, 82(1), 76–106. doi: 10.1177/00131644211003261
58. Simamora, R., Saragih, S., & Hasratuddin. (2018). Improving students’ mathematical problem solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education, 13*(3), 188–200. https://doi.org/10.12973/iejme/3966
59. Smith, R., Jones, P., & Roberts, L. (2021). Enhancing STEM education through technology integration: Impacts on learner learning and engagement. *International Journal of STEM Education*, 8(3), 112–125.

60. Smith, R., & Johnson, L. (2021). Enhancing problem-solving abilities through fostering positive attitudes towards mathematics. *Journal of Mathematics Education*, 42(4), 567–582.
61. Son, A.L., Darhim, & Fatimah, S. (2020). Students' Mathematical Problem-Solving Ability Based on Teaching Models Intervention and Cognitive Style. *Journal on Mathematics Education*, 11(2), 209-222. http://doi.org/10.22342/jme.11.2.10744.209-222.
62. Sturm, N., & Bohndick, C. (2021). The influence of attitudes and beliefs on problem-solving performance. *Frontiers in Education, 6*. https://doi.org/10.3389/feduc.2021.525923
63. Subia, G. S., Salangsang, L. G., & Medrano, H. B. (2018). Attitude and performance in Mathematics I of Bachelor of Elementary Education students: A correlational analysis. *American Scientific Research Journal for Engineering, Technology, and Sciences, 39*(1), 206–213. Retrieved from https://asrjetsjournal.org/index.php/American_Scientific_Journal/article/download/3821/1378
64. Wang, Y., & Wang, L. (2021). The impact of technology integration on mathematics attitude among high school learners. *Journal of Computers in Mathematics and Science Teaching*, 40(2), 143-158.
65. Zheng, Lanqin & Long, Miaolang & Zhong, Lu & Gyasi, Juliana. (2022). The effectiveness of technology-facilitated personalized learning on learning achievements and learning perceptions: a meta-analysis. Education and Information Technologies. 27. 10.1007/s10639-022-11092-7.
66. Zimmerman, B. J., & Schunk, D. H. (Eds.). (2011). *Handbook of self-regulation of learning and performance*. Routledge. https://doi.org/10.4324/9780203839010

6. APPENDIX

Survey Questionnaire

"The Mediating Effect of Mathematics Attitude on the Relationship between Technological Resources and Problem – Solving Abilities"

General Instruction: Please check the corresponding numbers of each item in accordance with your personal observation. Part I deals on technological resources whether they are highly observed by STEM students. Part II deals on problem-solving abilities of the STEM students. Part III deals on the mathematics attitude of the STEM students. If you volunteer to participate in this study, you are asked to answer the survey questionnaire which you can finish in less than 30 minutes. Use the scale below to objectively assess. Be truthful with your response.

5 = strongly agree
4 = agree
3 = moderately agree
2 = disagree
1= strongly disagree
N/A = not applicable

Part 1. Technology Resources Instrument

1.1	**Ownership of and Access to ICTs** *I …*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	have consistent access to a variety of Information and Communication Technology (ICT) devices for educational purposes, including computers, tablets, and smartphones during our math class.						
2	feel confident in utilizing ICT tools to enhance my educational experience, such as online research, collaborative projects, and digital learning platforms in math.						
3	benefit significantly from the availability of up-to-date						

	ICT devices for my math operations, solutions, and problem-solving skills.						
4	believe that ownership of personal ICT devices is essential for staying connected and engaged with educational resources in the modern learning environment of math classes.						
5	recognize that access to a reliable and high-speed internet connection is crucial for maximizing the benefits of ICT tools and online educational resources in math.						
6	prioritize investing in the latest ICT devices to ensure that I have access to cutting-edge educational technologies and resources for math operations, solutions, and problem-solving.						
7	find that ownership of personal ICT devices positively influences my ability to adapt to various learning environments and requirements in math class.						
8	believe that continuous improvement and upgrading of ICT laboratory in educational institutions are necessary for upskilling math operations, solutions, and problem-solving.						
9	acknowledge that having access to a variety of ICT resources significantly impacts my overall educational success and keeps me technologically empowered as a learner, especially during math classes.						
10	understand that owning and having access to a diverse set of ICT resources is fundamental for preparing me for the demands of math classes in terms of math operations, solutions, and problem-solving.						

1.2	**Internet Access** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	have reliable and high-speed internet access for math operations, solutions, and problem-solving.						
2	find that internet access is crucial for my ability to develop and maintain technological resources in my math operations, solutions, and problem-solving.						
3	recognize that the quality of my internet connection significantly impacts my effectiveness in utilizing technological tools for my math operations, solutions, and problem-solving.						
4	acknowledge that having consistent internet access enhances my overall technological resources in various educational tasks, such as my math operations, solutions, and problem-solving.						
5	consider reliable internet access as essential for staying updated with technological advancements relevant to solving math problems.						
6	understand that access to high-speed internet positively influences my ability to engage in online learning and collaborative problem-solving in math.						
7	acknowledge that internet access is a key factor in my proficiency in using online resources and platforms for math problem-solving.						

8	believe that improving and expanding internet access is critical for fostering technological resources among learners in math operations, solutions, and problem-solving.						

1.3	**Use of ICTs** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	am proficient in using Word Processor. (e.g. Word)						
2	am proficient in making Spreadsheets. (e.g. Excel)						
3	am proficient in making Presentation. (e.g. PowerPoint)						
4	know how to make and use emails.						
5	know the uses of search engines.						
6	am proficient in graphic editing, multimedia authoring, video editing, and web-page design.						
7	can navigate and efficiently utilize various software applications with my computer skills.						
8	feel confident in using ICT tools for communication, both academically and personally.						
9	actively seek opportunities to enhance and update my computer skills to stay updated with technological advancements.						
10	believe that my proficiency in computer skills positively influences my ability to solve problems and address challenges in diverse contexts.						

1.4	**Social Media** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	spend my time mostly on social media platforms. (e.g. Facebook, Twitter, Instagram, etc.) to learn math problem solving.						
2	update my social media status on a daily basis.						
3	actively use social media platforms for various academic and personal purposes, especially in learning math problems.						
4	engage with social media and selectively use it for specific needs, such as learning math problem-solving.						
5	use social media to learn from other people's techniques in solving math problems.						

1.5	**Perceptions of Use of Technology-Enabled Learning** *I want to use technology in my studies because …*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	it will help me get better results in my math subject.						
2	it will help me better understand problem-solving in math.						
3	it makes completing work in math more convenient.						
4	it motivates me to explore many topics I may not have seen before, especially in math problems.						
5	it allows me to collaborate with others easily, both in and off campus.						
6	it will improve my IT/information management skills in general.						
7	it will improve my career or employment prospects in the						

	long term.						

Part 2. Problem-Solving Inventory Scale

2.1	Problem-Solving Confidence	5	4	3	2	1	N/A
1	I am able to think up creative and effective alternatives to solve a math problem.						
2	I have the ability to solve math problems even though initially no solution is immediately apparent.						
3	I make solutions in math problems and I am happy with them later.						
4	I find that after making a decision, the expected outcome usually matches the actual outcome.						
5	I trust my ability to solve new and difficult math problems.						
6	I, when making a decision, weigh the consequences of each alternative and compare them against each other.						
7	I try to predict the overall result of carrying out a particular course of action.						
8	I find many math problems to be too easy for me to solve.						
9	When I become aware of a math problem, one of the first things I do is to try to find out exactly what is asked.						
10	When I make plans to solve a math problem, I am almost certain that I can make them work.						
11	Given enough time and effort, I believe I can solve math problems that confront me.						
12	When faced with a new situation, I have confidence that I can handle math problems that may arise.						
13	When confronted with a math problem, I am sure that I can handle the situation.						
14	When confronted with a math problem, I constantly examine my feelings to find out what is going on in a problem situation.						

2.2	Approach-Avoidance Style	5	4	3	2	1	N/A
1	After I have attempted to solve a math problem, I take time and compare the actual outcome to what I thought should have happened.						
2	When I am confronted with a math problem, I devise a plan and develop a strategy to collect information so I can define exactly what the problem is.						
3	When I am confused by a math problem, one of the first things I do is survey the situation and consider all the relevant pieces of information.						
4	When I have a math problem, I think up as many possible ways to handle it as I can, until I can come up with more ideas.						
5	I take time to consider deciding on a solution to a math problem.						
6	When confronted with a math problem, I examine what sort of external things my environment may be						

	contributing to the problem.						
7	Most of the time, I work with my problems decisively.						

2.3	**Personal Control**	**5**	**4**	**3**	**2**	**1**	**N/A**
1	I have a systematic method for comparing alternatives and making decisions.						
2	When my first efforts to solve a problem fail, I am certain about my ability to handle the situation.						
3	I pause for a while and take time to deal with math problems.						
4	I make judgments and later accept what will be the result of it.						
5	When confronted with a math problem, I stop and think about it before deciding on the next step.						
6	Sometimes I get so charged up emotionally that I am able to consider many ways of dealing with math problems.						

Part 3. Students' Attitudes Toward Mathematics Questionnaire

3.1	**Anxiety** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	feel energetic when working on math.						
2	get a good feeling when I think of learning math.						
3	find learning math to be very fun.						
4	feel confident about asking math questions in class.						
5	get excited when the math teacher is in class.						

3.2	**Confidence** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	am not scared of math at all.						
2	have self-confidence in learning math.						
3	have confidence in taking a math test.						
4	can solve math problems within a given time.						
5	am able to solve math problems without difficulty.						
6	have confidence in asking math questions in class.						
7	am able to answer math questions in class.						

3.3	**Enjoyment** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**
1	enjoy doing math.						
2	find math word problems fascinating.						
3	look forward to a math class.						
4	find math very interesting.						
5	enjoy learning math with my friends.						
6	feel comfortable working math problems.						

3.4	**Benefits/Value** *I…*	**5**	**4**	**3**	**2**	**1**	**N/A**

1	believe math is important in everyday life.						
2	want to develop my math skills.						
3	consider math a very necessary subject.						
4	believe knowing math will help me earn a living.						
5	need math for my future work.						
6	appreciate that math helps people make good decisions.						
7	notice that math improves my thinking capacity.						
8	understand that math is important for other subjects.						