

Exploring the Impact of Technology Integration and Traditional Teaching Methods on Mathematics Learning Outcomes: Mixed-Methods Analysis

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Abstract. This study aimed to examine the impact of technology integration and traditional teaching methods on Mathematics learning outcomes among educators in Laak South District, Davao de Oro. Utilizing a convergent parallel mixed-methods design, the study combined quantitative data gathered through a structured Likert-scale survey and qualitative insights obtained via in-depth interviews. A total of 92 teacher-respondents participated. Quantitative findings revealed that both technology integration and traditional teaching methods were moderately implemented, while Mathematics learning outcomes—measured in terms of conceptual understanding, problem-solving skills, and engagement—were rated very extensive. Results from a Two-Way ANOVA showed that traditional teaching methods significantly influenced learning outcomes ($p = .018$), and a significant interaction effect ($p = .028$) was observed between technology integration and traditional methods, underscoring the importance of a blended approach. Qualitative findings further supported the value of combining both instructional strategies while also highlighting challenges such as limited resources, training, and institutional support. Integration of findings revealed that optimal student learning is achieved when traditional pedagogy is complemented with purposeful technology use.

KEY WORDS

1. technology integration 2. traditional teaching methods 3. Mathematics instruction

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1. Introduction

The integration of technology into education has revolutionized teaching and learning processes, particularly in Mathematics, where abstract concepts often challenge students' comprehension. Technology, such as dynamic software, virtual simulations, and interactive tools, provides opportunities to visualize and explore mathematical ideas more concretely. However, traditional teaching methods, emphasizing direct instruction, rote practice, and struc-

tured problem-solving, remain vital in building foundational skills and discipline. Despite the promising potential of technology, its integration into Mathematics education faces several challenges. These include unequal access to digital resources, varying levels of teacher preparedness to use technology effectively, and potential over-reliance on tools that may hinder critical thinking. Conversely, traditional methods sometimes struggle to engage learners in

today's digital age, leading to reduced motivation and participation. Hillmayr et al. (2020) explored the integration of technology in mathematics education and its impact on student performance and conducted a meta-analysis revealing that technology-based learning interventions, such as gamification and interactive software, significantly enhance students' mathematics performance. They found that immediate feedback provided by technology allows students to self-correct and adjust more quickly, leading to improved outcomes. However, the study also cautions that technology is not a universal remedy; challenges such as technical difficulties and the need for tailored interventions to individual learning styles must be addressed to maximize effectiveness. Kelley et al. (2020) suggest that incorporating technology in mathematics instruction can positively affect students' interest by helping them visualize abstract concepts and actively engage with the material. Interactive software applications and simulations provide visually rich experiences that make mathematics more engaging. Additionally, gamification, where mathematical concepts are presented as games, has been shown to increase student engagement and enjoyment. Despite these benefits, the study notes that technology-based interventions may not suit all students and should be tailored to individual learning styles and abilities. In Davao de Oro, technology integration in Mathematics education faces significant obstacles primarily due to limited infrastructure and access to digital resources. Davao de Oro Schools Division mentioned that many schools in the region struggle with inadequate internet connectivity, making it difficult for teachers to incorporate technology into their lessons effectively. Furthermore, the disparity in resource allocation means that while some urban schools have access to modern teaching tools, many rural schools lack even basic technological support. This inconsistency

results in a reliance on traditional teaching methods, which may not sufficiently engage students or meet the demands of the current curriculum. Consequently, students in Davao de Oro often find themselves disadvantaged, as they are not exposed to the interactive and dynamic learning experiences that technology can offer, hindering their overall Mathematics achievement.

1.1. Theoretical/Conceptual Framework of the Study —The theory of technology integration is grounded in the idea that effective use of technology in education requires a seamless blending of content, pedagogy, and technology to enhance teaching and learning outcomes. The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), is a widely recognized theory that addresses this integration. TPACK posits that successful technology integration occurs when educators possess expertise in three intersecting domains: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). The framework emphasizes the interconnectedness of these domains, arguing that technology must complement both the subject matter and the instructional strategies to create meaningful learning experiences. Another relevant theory is the Substitution Augmentation Modification Redefinition (SAMR) model, introduced by Puentedura (2006). The SAMR model outlines four levels of technology integration: substitution, where technology replaces traditional tools without functional change; augmentation, where technology provides functional improvements; modification, which allows for significant task redesign; and redefinition, where technology enables the creation of entirely new tasks previously inconceivable. This model helps educators evaluate and enhance their use of technology to move beyond basic substitution and toward transformative learning experiences.

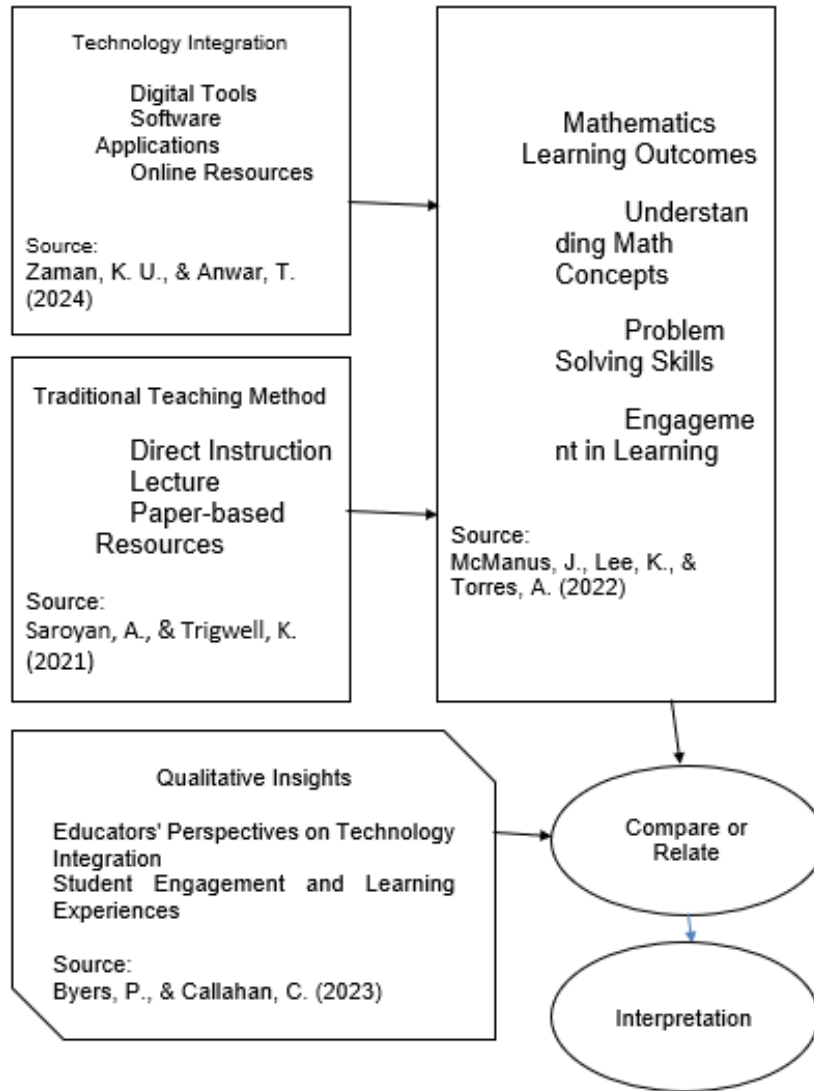


Fig. 1. Theoretical/Conceptual Framework

2. Methodology

The methodology section of this study outlines the research design, participants, data collection methods, and analytical procedures employed to investigate the impact of technology integration and traditional teaching methods on Mathematics learning outcomes. A mixed-methods approach combines quantitative measures such as pre- and post-assessments to evaluate student performance with qualitative insights gathered from interviews and focus groups with educators and students. This dual approach allows for a comprehensive analysis of how different instructional strategies influence student engagement and understanding in Mathematics. The study details the sampling techniques, the context in which the research is conducted, and the ethical considerations taken to ensure the integrity of the research process, ultimately providing a robust framework for addressing the research questions and objectives.

2.1. Research Design—The convergent parallel design is a widely used mixed-methods research approach in which both quantitative and qualitative data are collected simultaneously, analyzed independently, and then merged for interpretation (Weber, 2024). This design enables researchers to compare and integrate numerical data with detailed contextual insights, providing a more comprehensive understanding of the research problem. Combining both data types allows for cross-validation and a deeper exploration of the phenomenon under study, ensuring that the results are corroborated and well-rounded. Convergent parallel design is particularly useful when addressing complex research questions that require multiple perspectives to capture the full scope of the issue. In the quantitative phase of a convergent parallel design, researchers focus on gathering numerical data to test specific hypotheses or measure variables of interest. This phase typically involves structured methodologies, such as surveys, experiments, or standardized tests, which produce measurable and statistically analyzable results (Weber, 2024). The emphasis is on precision, objectivity, and generalizability, allowing researchers to identify patterns, correlations, or causal relationships within the data. The quantitative data collection is conducted simultaneously with the qualitative phase, but the analysis is handled independently to preserve the distinct nature of each method. Statistical tools are employed to analyze trends, test hypotheses, and draw inferences. When merged with the qualitative findings, the quantitative phase contributes numerical evidence to support or contrast the more nuanced, contextual insights from the qualitative phase. This integration strengthens the validity and reliability of the study's overall conclusions by offering complementary perspectives on the research question. In the qualitative phase of a convergent parallel design, researchers focus on exploring the underlying meanings, experiences, and perspec-

tives of participants through non-numerical data. This phase typically involves methods such as interviews, focus groups, observations, or analysis of textual or visual materials (Weber, 2024). The goal is to provide in-depth, contextual insights that complement the broader patterns revealed in the quantitative phase. Data collection is often open-ended, allowing participants to express their thoughts and experiences in their own words. The analysis is conducted independently of the quantitative phase, using thematic analysis, coding, or other qualitative techniques to identify patterns and narratives within the data. The qualitative findings offer rich, descriptive insights that help explain the "why" and "how" behind the trends or relationships observed in the quantitative results. When integrated with the quantitative phase, this approach ensures a more holistic understanding of the research problem, bridging numerical evidence with contextual depth. The convergent parallel design is particularly well-suited for a study exploring the impact of technology integration and traditional teaching methods on mathematics learning outcomes, as it allows for a comprehensive analysis by simultaneously collecting and analyzing both quantitative and qualitative data. In the quantitative phase, structured surveys or assessments can be administered to measure students' academic performance in mathematics under different teaching methods. This phase might involve comparing students' test scores exposed to technology-integrated teaching approaches versus those taught using traditional methods. Statistical analyses, such as t-tests or ANOVA, can be conducted to determine whether significant differences exist between the two groups, providing numerical evidence of the effectiveness of each method. The qualitative phase complements this by capturing the contextual and experiential aspects of the teaching methods. Researchers can gather insights into perceptions, challenges, and benefits of using technology or traditional methods in

mathematics instruction through interviews or focus groups with students and teachers. For instance, students might describe how interactive technology enhanced their engagement or how traditional methods helped clarify complex concepts. Similarly, teachers might provide narratives about their experiences adapting to technology or the constraints of traditional instruction. Applying the convergent parallel design, the study integrates the findings from both phases during the interpretation stage. This allows researchers to corroborate quantitative trends with qualitative narratives, ensuring a robust understanding of the research problem. For example, while quantitative results might show improved performance under technology-integrated methods, qualitative data could reveal contextual factors such as accessibility, teacher preparedness, or student preferences that influence these outcomes. This dual approach ensures that the study identifies the effectiveness of the teaching methods and explains the underlying reasons, offering actionable insights for educators and policymakers.

2.2. Ethical Consideration—The ethical consideration section of this study will address the key principles that ensure the protection and well-being of the teacher-respondents involved. This includes adhering to confidentiality, informed consent, and the voluntary nature of participation, ensuring that the research is conducted with integrity and respect for the rights of all respondents. **Social Value** The social value of this study lies in its potential to enhance educational practices and improve student learning outcomes in Mathematics, particularly in a rapidly changing educational landscape where technology plays a pivotal role. By examining the effectiveness of both technology integration and traditional teaching methods, the study aims to provide insights that can inform educators, policymakers, and curriculum developers on best practices that foster student engagement and understanding. Additionally, this research

addresses the need for equitable access to effective instructional strategies, contributing to the broader goal of reducing educational disparities. As part of the ethical considerations, the study prioritizes the well-being and educational rights of participants, ensuring that findings are used to promote positive educational outcomes that benefit all students, regardless of their backgrounds.

Informed Consent and Assent Informed consent and assent are critical ethical considerations in this study, ensuring that all participants are fully aware of the research purpose, procedures, potential risks, and benefits before agreeing to take part. Informed consent will be obtained from parents or guardians of student participants, providing them with comprehensive information about the study and the voluntary nature of participation. Additionally, student assent will be sought from participants themselves, ensuring they understand the study's objectives and their right to withdraw at any time without penalty. This dual approach not only respects the autonomy of both parents and students but also fosters a transparent research environment where participants feel empowered and informed about their involvement in the study.

Vulnerability of Research Respondents In addressing the informed vulnerability of research respondents, this study recognizes that certain participants, particularly students, may possess varying degrees of understanding regarding the research process and its implications. To mitigate potential risks associated with their participation, the study emphasizes the importance of creating a safe and supportive environment where students feel comfortable expressing their thoughts and concerns. Researchers will ensure that all participants, especially those from vulnerable backgrounds, are provided with clear explanations of the study's purpose, procedures, and their rights throughout the research process. Additionally, appropriate

measures will be taken to protect the confidentiality and anonymity of all respondents, thereby minimizing any potential discomfort or anxiety related to their involvement. This commitment to ethical considerations underscores the study's dedication to fostering respectful and responsible research practices that prioritize the well-being of all participants.

Privacy and Confidentiality Privacy and confidentiality are paramount ethical considerations in this study, ensuring that all participant information is handled with the utmost care and respect. Researchers will implement strict protocols to safeguard the personal data of respondents, including assigning unique identification codes and securely storing data to prevent unauthorized access. All identifiable information will be removed from reports and publications, ensuring that individuals cannot be traced back to their responses. Participants will be informed of their rights regarding data confidentiality and will be assured that their involvement in the study will remain private. This commitment to protecting participant privacy not only fosters trust between researchers and respondents but also upholds ethical research standards, allowing for an open and honest exchange of information.

Risk, Benefits and Safety In conducting this study, careful consideration is given to the risks, benefits, and safety of all participants involved. The potential risks associated with participation, such as discomfort in discussing personal experiences related to teaching and learning, will be minimized through supportive measures and clear communication about the study's objectives. The anticipated benefits include the opportunity for participants to contribute to valuable insights that may enhance educational practices and improve Mathematics learning outcomes for future students. Additionally, the study aims to foster a safe environment where participants can express their thoughts openly without fear of negative consequences. By prioritizing par-

ticipant safety and well-being, the study ensures that ethical considerations are met while promoting a positive and constructive research experience for all involved.

Justice Justice, as an ethical consideration in this study, emphasizes the fair distribution of the benefits and burdens of research among all participants. The study is committed to ensuring that diverse groups of students and educators are included, allowing for equitable representation and access to the insights gained from the research. This approach seeks to avoid exploitation of vulnerable populations while providing them with opportunities to contribute to knowledge that could ultimately benefit their educational experiences. Additionally, the findings will be shared with all stakeholders, including participants and their communities, to ensure that the benefits of the research are accessible and that the voices of all contributors are acknowledged and valued. By prioritizing justice, the study aims to uphold ethical standards that promote inclusivity and fairness throughout the research process.

Transparency Transparency is a fundamental ethical consideration in this study, reflecting a commitment to openness and clarity in all aspects of the research process. Researchers will provide participants with comprehensive information regarding the study's purpose, methodologies, potential impacts, and their rights as respondents, ensuring that they fully understand the context and implications of their involvement. Regular updates will be communicated to participants throughout the study, and findings will be shared with them and the broader educational community to foster trust and accountability. By maintaining transparency, the study not only enhances the credibility of the research but also empowers participants by valuing their contributions and promoting an environment of mutual respect and collaboration.

Qualification of the Researcher The qualification of the researcher is a critical ethical

consideration in this study, as it ensures that the research is conducted with integrity, rigor, and professionalism. The researcher possesses a strong academic background in education, specifically in Mathematics pedagogy, coupled with practical experience in teaching and educational research. This expertise enables the researcher to design a robust study that adheres to ethical standards and employs appropriate methodologies for data collection and analysis. Furthermore, the researcher is committed to ongoing professional development and ethical training, ensuring familiarity with current ethical guidelines and best practices in research. This combination of qualifications enhances the credibility of the study and fosters trust among participants, thereby contributing to the overall ethical integrity of the research process.

Conflict of Interest Conflict of interest is a vital ethical consideration in this study, ensuring that personal or financial interests do not compromise the integrity of the research process. The researcher will disclose any potential conflicts, such as relationships with educational institutions, funding sources, or affiliations that could influence the study's outcomes or interpretations. To mitigate any perceived bias, the researcher will adhere to strict ethical guidelines and maintain objectivity throughout the research process, ensuring that the findings are based solely on empirical evidence and not on external influences. This commitment to transparency regarding conflicts of interest not only enhances the study's credibility but also safeguards the trust of participants and stakeholders in the research findings.

Adequacy of Facilities The adequacy of facilities is an essential ethical consideration in this study, as it ensures that the research environment is conducive to effective data collection and participant engagement. The study will be conducted in well-equipped educational settings that provide necessary resources, such as access to technology and comfortable spaces

for interviews and group discussions. Adequate facilities will also include ensuring a safe and supportive environment for participants, promoting open communication and collaboration. By maintaining high standards for the research setting, the study aims to foster a positive experience for all participants, thereby enhancing the quality of the data collected and ensuring that ethical standards are upheld throughout the research process.

Community Involvement Community involvement is a crucial ethical consideration in this study, as it emphasizes the importance of engaging with local stakeholders and fostering collaborative relationships. The research will actively seek input and participation from community members, educators, and parents to ensure that their perspectives and needs are reflected in the study's objectives and methodologies. By incorporating community feedback, the study aims to create relevant and contextually appropriate interventions that directly address the educational challenges faced by the local population. This collaborative approach not only enhances the validity of the research findings but also promotes a sense of ownership among community members, ensuring that the outcomes of the study are beneficial and accessible to those directly impacted by the educational practices being examined.

2.3. Research Respondents—Using Slovin's formula, which is expressed as $n = \frac{N}{1 + Ne^2}$, the appropriate sample size for a population of 120 Mathematics teachers in Laak South District, given a 5% margin of error, is calculated as follows: $n = \frac{120}{1 + 120(0.05)^2} = \frac{120}{1 + 3} = \frac{120}{4} = 30$. Simplifying the equation results in a sample size of 30. This means that 30 respondents should be selected from the district's total population of Mathematics teachers to obtain statistically reliable findings while maintaining a reasonable margin of error. Three essential inclusion criteria guide the selection of respondents for

this study to ensure the reliability and relevance of the findings. First, the respondents must be licensed Mathematics teachers currently employed in the Laak South District. This qualification ensures that they possess the necessary academic credentials, professional training, and subject-matter expertise to provide informed perspectives on Mathematics instruction. Second, they must have at least one year of teaching experience in Mathematics within the district. This criterion is set to guarantee that the participants have acquired adequate exposure to the instructional methodologies, curricular frameworks, and classroom dynamics specific to their teaching context. Teachers with at least a year of experience are more likely to provide substantive insights into mathematics education challenges and best practices. The respondents must be actively engaged in teaching Mathematics at the time of data collection. This requirement ensures that the study captures real-time, practical experiences rather than retrospective or second-hand accounts. Establishing these rigorous inclusion criteria, the study ensures that the data collected is credible, reflective of current instructional realities, and aligned with the overarching research objectives.

2.4. Research Instrument—This study employed a convergent parallel mixed-methods approach, which involved the collection and analysis of both quantitative and qualitative data to comprehensively examine the impact of technology integration and traditional teaching methods on mathematics learning outcomes.

Quantitative Instrument The quantitative phase employed a structured survey questionnaire targeting mathematics teachers. The instrument included Likert-scale items designed to measure the two independent variables Technology Integration and Traditional Teaching Methods as well as the dependent variable Mathematics Learning Outcomes, which covered three domains: conceptual understanding, problem-solving ability, and learner engagement. Utilizing these validated instruments, the study capitalizes on well-established metrics, enhancing the credibility and accuracy of the collected quantitative data. These adapted survey tools align with the theoretical framework and provide actionable insights into the role of teacher. The questionnaire was developed by adapting validated instruments sourced from existing literature and empirical studies, ensuring content validity and construct alignment with the study objectives. The instrument underwent reliability testing using Cronbach's alpha at the 0.05 confidence level. Reliability coefficients were interpreted as follows: 0.70 (acceptable), 0.80 (good), and 0.90 (excellent) (George Mallery, 2003; Tavakol Dennick, 2011). To facilitate inferential analysis through Two-Way ANOVA, composite mean scores for each construct were computed and transformed into categorical variables. The transformation was based on the following schema for both Technology Integration and Traditional Teaching Methods:

Composite Mean Range, Category, and Interpretation

Composite Mean Range	Category	Interpretation
1.00 – 2.49	Low	Minimal application
2.50 – 3.49	Moderate	Occasional or partial use
3.50 – 5.00	High	Consistent and extensive use

Scale Descriptive Ratings and Interpretation of Learning Outcome

Scale	Descriptive Rating	Interpretation
4.20 – 5.00	Strongly Agree	Learning outcome is highly manifested
3.40 – 4.19	Agree	Learning outcome is manifested
2.60 – 3.39	Neutral	Learning outcome is moderately manifested
1.80 – 2.59	Disagree	Learning outcome is rarely manifested
1.00 – 1.79	Strongly Disagree	Learning outcome is not manifested

2.4.1. Qualitative Instrument—The qualitative component used semi-structured interviews to explore the lived experiences, instructional perceptions, and pedagogical challenges encountered by teachers in implementing technology-enhanced and traditional methods in teaching mathematics. These interviews were conducted with a purposive sub-sample of survey participants to allow data triangulation. Facilitating and probing questions were aligned with the constructs of the quantitative phase to ensure consistency and integrative interpretation.

Examples include: How do educators perceive the effectiveness and challenges of integrating technology into mathematics instruction alongside traditional methods? Do technology integration and traditional teaching methods differ in their perceived impact on student learning outcomes? How do the quantitative findings reflect or contrast with your experiences in applying both approaches to teaching mathematics? The qualitative data provided depth and contextual understanding, which were analyzed alongside the quantitative results during the integration phase of the convergent design.

2.5. Data Gathering Procedure—The guidelines for this process adhere to the policies of The Rizal Memorial Colleges, Inc. as part of the formal request, researchers delineate their intentions regarding data collection, analysis, and dissemination, aligning these with the overarching research goals. Anticipated concerns or questions from recipients are proactively addressed in this communication, providing assurances on ethical safeguards, confidentiality measures, and the potential benefits of the study. The formal permission request explicitly seeks authorization to proceed, emphasizing the pivotal role of their support in ensuring the research's success.

Permission to Conduct the Study In October 2024, before data collection, the researcher obtained necessary permissions from the relevant authorities, including the research adviser, the

Dean of The Rizal Memorial Colleges, Inc., and the top management of DepEd Davao de Oro, through the appropriate channels. This involved submitting a comprehensive research proposal outlining study design, procedures, and potential risks and benefits. The researcher provided detailed information about the study's purpose, goals, and methods for data collection, analysis, and reporting. Furthermore, in December 2024, immediately after the conducted colloquium, the researcher took steps to ensure that all participants were fully informed about the study, their rights, and the nature of their involvement. Informed consent was obtained from each participant before they participated in the study. The researcher committed to data accuracy and completeness during the last week of January 2025. The distribution and retrieval of questionnaires were conducted using a standardized

and systematic approach, ensuring reliability in collecting responses from participants. Collation and Statistical Treatment of Data. The researcher took time in data management. She ensured that accurate data gathered were sorted accordingly through Microsoft Excel and later

transferred to JASP. All necessary information was collected. Consistency was also considered to make it relevant to the problem's statement. Reliability and validity were reviewed to lessen the degree of error in the analysis.

2.6. Data Analysis—The study, which consists of a two-way ANOVA and qualitative analysis, is purposely conducted to explore the impact of music and arts integration on secondary school teachers' approaches to catechetics. To answer statement problems 1, 2, 3, 4, and 5 the Two-Way ANOVA will test for the interaction effects between teacher coordinator leadership styles and stakeholder engagement on program implementation success in the adopt a school program. A two-way ANOVA study would analyze the effect of teacher coordinator leadership styles and stakeholder engagement on program implementation success in the adopt a school program. This approach allows the researcher to explore the main effects of each independent variable and any potential interaction effects between them. Post-hoc tests are essential in this study, particularly after conducting Two-Way ANOVA, to further investigate the differences among group means when significant effects are found. To answer 5, 6, and 7, the thematic analysis will be used to identify common themes and patterns in the interview and focus group data. Quantitating the frequency of themes or sentiments provided a broader understanding of qualitative findings. Combined quantitative and qualitative data to provide a comprehensive view. All data processing and analysis

were performed using Jeffrey's Statistics Amazing Program (JASP) version 0.12.20. When results were yielded, discussions and interpretations followed. The analytical framework of this study on music and arts integration in Catechetics is designed to comprehensively evaluate both quantitative and qualitative data, allowing for a multifaceted understanding of the research problem. For the quantitative component, statistical analysis will be employed to identify patterns and correlations between music and arts integration and various outcomes, such as student engagement and teacher effectiveness. This may involve using descriptive statistics, inferential statistics, and techniques like t-tests or ANOVA to assess differences among groups. On the qualitative side, thematic analysis will be utilized to analyze interview and focus group data, enabling the identification of key themes and insights regarding teachers' experiences and students' perceptions of arts integration. This dual analytical approach allows for triangulation of findings, enhancing the study's overall validity. By combining statistical evidence with rich qualitative insights, the analytical framework provides a holistic view of the impact of music and arts integration on teaching methodologies in Catechetics, ultimately informing best practices and educational policies.

3. Results and Discussion

This chapter presents the results of the study on the impact of technology integration and traditional teaching methods on mathematics learning outcomes, using a convergent parallel mixed-methods design. Quantitative data were analyzed using descriptive statistics and Two-Way ANOVA to determine the main and interaction effects of the independent variables. Concurrently, qualitative data gathered through interviews were thematically analyzed to enrich the interpretation of

statistical findings.

3.1. Technology Integration in Mathematics Instruction—Technology integration in mathematics instruction refers to the strategic incorporation of digital tools and resources to enhance teaching and learning processes. This approach aims to foster deeper conceptual understanding, improve problem-solving skills, and increase student engagement by leveraging technological advancements. Recent studies have highlighted the positive impact of technology integration on mathematics education. For instance, Bright et al. (2024) found that the use of technology in teaching mathematics significantly improved students' performance, with students' interest in mathematics mediating this relationship. Similarly, Patel (2024) reported that incorporating interactive software and educational applications in middle school classrooms enhanced students' engagement and motivation, leading to better conceptual understanding and problem-solving abilities. However, effective technology integration requires careful planning and consideration. Cadley (2024) emphasized that while technology can

enhance teaching outcomes, challenges such as limited resources, time constraints, and the need for continuous professional development must be addressed to ensure successful implementation. Furthermore, the National Council of Supervisors of Mathematics (NCSM) highlighted the importance of selecting appropriate technologies that align with instructional goals and support students in making meaningful mathematical connections (NCSM, 2024). Summary of the Level of Technology Integration in Mathematics Instruction Table 1 provides a summary of the mean scores across the three major indicators of technology integration in mathematics instruction: the type of digital tools used, the variety of software applications utilized, and the availability and accessibility of online resources. Each of these indicators received a moderate descriptive interpretation, with mean values ranging from $M = 1.92$ to $M = 1.98$. The overall composite mean is $M = 1.94$, which also falls under the moderate category, suggesting that technology integration in mathematics instruction is occasionally or partially implemented.

Table 1. Summary of the Level of Technology Integration in Mathematics Instruction

No	Technology Integration in Mathematics Instruction	N	Mean	Descriptive Interpretation
1	Type of digital tools used	92	1.93	Minimal Application
2	Variety of software applications utilized	92	1.98	Minimal Application
3	Availability and accessibility of online resources	92	1.92	Minimal Application
Mean Average		92	1.94	Minimal Application

According to the interpretation scale adopted in this study, a mean score from 2.50 to 3.49 is classified as moderate, which implies that teachers are integrating technological tools

inconsistently and are not yet employing them as a regular or integral component of their instructional practices. While teachers acknowledge the instructional value of digital tools, soft-

ware applications, and online resources, their actual implementation remains limited due to various systemic and contextual factors. Recent scholarly studies support these findings. For instance, Raja and Qadri (2023) found that while digital tools are increasingly present in schools, their usage is often sporadic due to insufficient infrastructure, lack of training, and weak alignment with curriculum goals. Similarly, Garcia and Molina (2022) noted that many educators possess a positive attitude toward using software and online resources in mathematics, but report moderate integration due to constraints such as limited time for planning and a lack of confidence in using digital platforms. Additionally, Ndlovu and Wadesango (2021) emphasized that institutional support, teacher readiness, and consistent professional development are key enablers for technology integration, which are often lacking in many educational contexts, especially in public and rural schools. These studies affirm the findings of this research, emphasizing that while there is foundational awareness and partial use of technology in mathematics classrooms, full integration requires structural support, policy commitment, and capacity-building efforts to transform occasional use into consistent pedagogical practice.

3.2. Traditional Teaching Methods—Traditional teaching methods in mathematics instruction refer to teacher-centered approaches that emphasize direct instruction, structured lectures, textbook use, and repetitive practice. In this model, the teacher serves as the primary source of knowledge, and students are expected to absorb and apply procedures through drills and paper-based tasks. While such methods support procedural fluency and are practical in managing large classes, they often limit student engagement and conceptual understanding (Patil Nayak, 2022). However, in many settings, particularly where technological resources are scarce, traditional methods remain essential. Recent studies affirm that their effectiveness depends largely on how well teachers balance content delivery with opportunities for active learning (Yen Li, 2023). As such, educators are encouraged to integrate traditional methods with more interactive strategies to foster deeper learning outcomes in mathematics.

Summary of the Level of Traditional Teaching Methods Table 2 presents a consolidated summary of the levels of traditional teaching methods employed by mathematics teachers, as reflected in three core domains: direct instruction strategies, lecture delivery, and paper-based instructional resources.

Table 2. Summary of Traditional Teaching Methods

No	Paper-Based Instructional Resources	N	Mean	Descriptive Interpretation
1	Type of direct instruction strategies employed	92	2.10	Minimal Application
2	Mode of lecture delivery	92	2.23	Minimal Application
3	Utilization of paper-based instructional resources	92	2.12	Minimal Application
Mean Average		92	2.15	Minimal Application

The results yielded a composite mean of $M = 2.15$, with all three domains falling within the moderate descriptive category, indicating occasional or partial use in mathematics instruction. Among the domains, lecture delivery received the highest mean ($M = 2.23$), suggesting that teachers view lectures as the most consistently applied traditional strategy. This is followed by the utilization of paper-based instructional materials ($M = 2.12$) and the employment of direct instruction strategies ($M = 2.10$). These findings suggest that while traditional teaching methods remain present in contemporary classroom practice, their use is generally balanced rather than dominant. Teachers continue to rely on structured lectures and printed materials, particularly when addressing foundational skills, delivering large volumes of content, or managing large classes. However, the moderate ratings also reflect a shift toward integrating more student-centered or blended strategies, especially in contexts where digital tools are increasingly accessible. Recent studies corroborate these observations. Yen and Li (2023) emphasized that traditional methods remain effective when appropriately integrated within a modern pedagogical framework, enhancing clarity and procedural fluency. Patil and Nayak (2022) also found that moderate use of lectures and print-based instruction supports concept delivery, particularly in resource-constrained settings, but cautioned against their exclusive use. Additionally, Akram and Ghazal (2023) stressed that while traditional resources like textbooks and worksheets contribute to consistency in instruction, they must be aligned with student engagement strategies to maintain learning relevance. Collectively, these findings affirm that traditional teaching methods in mathematics instruction

retain pedagogical value, especially when selectively applied and complemented by interactive and technology-enhanced approaches.

3.3. *Extent of Mathematics Learning Outcomes*—Mathematics learning outcomes refer to the specific knowledge, skills, and attitudes that students are expected to develop through mathematics instruction. These outcomes typically encompass conceptual understanding, problem-solving skills, and active participation in learning tasks. They serve as key indicators of both instructional effectiveness and student progress. According to Sarabi and Ututalum (2023), effective teaching methods that emphasize clarity and relevance significantly enhance mathematics achievement. Similarly, Guerra Ayala et al. (2024) stressed that student enjoyment and engagement are crucial factors in achieving positive learning outcomes. As such, mathematics learning outcomes go beyond test scores and reflect a learner's ability to think critically, apply concepts, and sustain interest in mathematical problem-solving. Summary of the Extent of Mathematics Learning Outcomes Table 3 provides a comprehensive summary of mathematics learning outcomes as perceived by teachers across three key domains: conceptual understanding, problem-solving skills, and engagement and participation in learning activities. The results reveal a very extensive level of learning outcomes, with a composite mean of $M = 4.46$. Among the domains, conceptual understanding received the highest mean ($M = 4.48$), followed closely by problem-solving skills ($M = 4.47$) and engagement ($M = 4.44$). These consistently high ratings indicate strong instructional effectiveness and affirm that students demonstrate high levels of mastery and participation when appropriate strategies are implemented.

These findings suggest that a multidimensional approach to mathematics teaching, incorporating technology, interactive learning, real-

world application, and formative feedback, can significantly enhance student learning outcomes. Supporting this, Sarabi and Ututalum (2023)

Table 3. Summary of the Extent of Mathematics Learning Outcomes

No	Extent of Mathematics Learning Outcomes	N	Mean	Descriptive Interpretation
1	Conceptual understanding of mathematical concepts	92	4.48	Strongly Agree
2	Problem-solving skills	92	4.47	Strongly Agree
3	Engagement and participation in learning activities	92	4.44	Strongly Agree
Mean Average		92	4.46	Strongly Agree

noted that effective instructional methods positively influence both skill development and student confidence in mathematics. Likewise, Guerra Ayala et al. (2024) emphasized that student engagement and enjoyment significantly contribute to academic performance, particularly in complex subject areas like mathematics. These results validate the current findings, indicating that targeted instructional practices are highly effective in fostering meaningful and comprehensive mathematics learning outcomes.

3.4. Interaction Effect Between Technology Integration and Traditional Teaching Methods on Mathematics Learning Outcomes—The results of the two-way ANOVA (see Table 12) indicate a statistically significant main effect of traditional teaching methods on mathematics learning outcomes, $F(2, 85) = 4.233$, $p = .018$. Thus, the null hypothesis (H_0), stating that there is no significant difference in mathematics learning outcomes when grouped according to types of traditional teaching methods, is rejected.

Table 4. Two-Way ANOVA Summary Table (DV: Mathematics Learning Outcomes)

Source	Sum of Squares	Df	Mean Square	F	p
Technology Integration Level (IV1)	0.845	2	0.422	1.942	0.150
Traditional Teaching Methods (IV2)	1.842	2	0.921	4.233	0.018
Interaction (IV1 $\times$ IV2)	1.617	2	0.808	3.715	0.028
Residual	18.496	85	0.218	—	—

3.5. Main Effects of Technology Integration and Traditional Teaching Methods on Mathematics Learning Outcomes—As shown in Table 5, the main effect of traditional teaching methods on mathematics learning outcomes was found to be statistically significant, $F(2, 85) =$

4.233 , $p = .018$. This result indicates that variations in traditional teaching strategies—such as direct instruction, structured lectures, and the use of paper-based materials—significantly influence students' mathematics performance. This finding aligns with the results of Rah-

man and Mohd Yusof (2022), who reported that direct instruction and structured classroom strategies contribute positively to students' foundational mathematics skills and achievement. Likewise, Suarez and Tan (2023) found that the

consistent use of lectures, guided practice, and structured assessments led to improved conceptual understanding and test performance among high school learners.

Table 5. Main Effects Summary Table (DV: Mathematics Learning Outcomes)

Source	Sum of Squares	df	Mean Square	F	p
Technology Integration Level (IV1)	0.845	2	0.422	1.942	0.150
Traditional Teaching Methods (IV2)	1.842	2	0.921	4.233	0.018
Residual	18.496	85	0.218	—	—

The findings presented in Table 13 are well supported by several recent empirical studies that examined the effects of traditional teaching methods and technology integration on mathematics learning outcomes. The significant main effect of traditional teaching methods aligns with the study by Khamis and Amos (2024), which found that structured instructional approaches such as direct instruction and guided lectures significantly improved mathematics achievement among Tanzanian secondary students. Similarly, Oluwudayo (2023) concluded that traditional pedagogical strategies have a strong predictive influence on students' success in mathematics, underscoring the value of clarity, structure, and routine in conventional teaching. Further, a report by the Grattan Institute (2025) showcased how high-performing Australian schools that implemented consistent, school-wide teaching routines—including timetabled math periods, aligned assessments, and collaborative planning saw marked improvements in students' mathematics outcomes. In contrast, the non-significant main effect of technology integration in this study is also supported by contemporary literature. Bright et al. (2024) revealed that while technology posi-

tively influenced students' mathematics performance in Ghana, its effectiveness was mediated by student interest, suggesting that technology alone is not sufficient. Similarly, Fatima et al. (2025) emphasized that technology integration in Pakistan improved learning outcomes only when accompanied by sufficient infrastructure and teacher training. Patel (2024) echoed this view, noting that educational software and digital tools fostered greater engagement and conceptual understanding among Indian students, but only when used as part of a broader, interactive instructional strategy. These studies reinforce the interpretation that while traditional teaching methods continue to play a significant role in enhancing mathematics achievement, the impact of technology depends heavily on the context and quality of its integration. As such, educational outcomes are best maximized when digital innovations are thoughtfully embedded within structured and pedagogically sound instructional frameworks. Taken together, these findings suggest that traditional teaching methods continue to have a measurable impact on student outcomes, likely due to their structure, predictability, and alignment with assessment standards. Conversely, technology integration,

while promising, requires strategic application, such as in blended learning models or interactive formats, to effectively support and elevate mathematics learning.

3.6. Educators' Perceptions Regarding the Effectiveness and Challenges of Integrating Technology with Traditional Teaching Methods in Mathematics Instruction—The qualitative strand of this convergent parallel mixed-methods study explored educators' perceptions of integrating technology with traditional teaching methods in Mathematics instruction. The responses revealed five key themes: Improved Conceptual Understanding, Increased Engagement and Motivation, Enhanced Real-World Connection, Technology-Driven Visualization, and Challenges in Access or Infrastructure.

The most prevalent theme, mentioned by 10 educators, emphasized how the combination of traditional instruction and technology improves students' conceptual understanding. Teachers noted that platforms such as Desmos and GeoGebra enabled learners to explore and visualize abstract concepts, thus deepening their comprehension. One participant shared, "Technology makes it easier for students to grasp challenging ideas when they see them in dynamic form." This aligns with Guerra Ayala et al. (2024), who observed that the use of engaging digital tools enhances the clarity of complex subject matter. The second theme, Increased Engagement and Motivation, was sup-

ported by statements indicating that interactive activities and the visual appeal of digital platforms helped sustain student interest. These findings corroborate the work of Sarabi and Ututalum (2023), who argued that learner motivation increases when digital resources are combined with conventional teaching. A smaller subset of responses highlighted the enhanced real-world connection brought by online simulations and contextualized digital tasks. Participants noted that integrating technology helped students relate mathematical problems to practical scenarios, thereby fostering deeper cognitive engagement. However, several educators raised concerns under the theme Challenges in Access or Infrastructure, noting issues such as inconsistent internet connectivity and lack of devices in certain schools. This limitation echoes Nyoni and Bhebhe (2023), who emphasized that infrastructural constraints hinder equitable access to technology-based learning in multilingual and rural contexts.

Merging both qualitative and quantitative findings, it becomes evident that educators value blended strategies, where technology enriches traditional methods. These perspectives reinforce the notion that instructional synergy, rather than substitution, drives effectiveness in mathematics learning. Thus, successful integration is not just dependent on tools but also on pedagogical intention, teacher readiness, and infrastructure support.

Table 6. Emerging Themes on Educator Perceptions

Theme	Number of Respondents
Improved Conceptual Understanding	10
Increased Engagement and Motivation	4
Enhanced Real-World Connection	3
Technology-Driven Visualization	2
Challenges in Access or Infrastructure	2

4. Conclusions and Recommendations

This chapter presents the concluding statements and practical recommendations derived from the key findings of the study entitled “The Impact of Technology Integration and Traditional Teaching Methods on Mathematics Learning Outcomes: A Two-Way ANOVA and Mixed-Methods Analysis.” Grounded in the results of both quantitative and qualitative analyses, this chapter synthesizes the outcomes of hypothesis testing and educators’ insights to draw meaningful conclusions. Furthermore, it offers research-based recommendations to inform instructional practice, educational policy, and future research directions in the field of Mathematics education.

4.1. Findings—Technology integration in Mathematics instruction was classified as moderate across all three domains. The use of digital tools, variety of software applications, and access to online resources all received mean scores reflecting occasional or partial use. This suggests that while digital tools are incorporated into instruction, their usage is not yet extensive or fully optimized in the schools surveyed. Traditional teaching methods were also rated as moderate in extent. Teachers consistently employed direct instruction, lectures, and paper-based materials with average mean scores. This implies that conventional approaches remain central to mathematics teaching but are not implemented with high consistency or innovation. Mathematics learning outcomes were found to be very extensive. Across the domains of conceptual understanding, problem-solving skills, and engagement and participation, students displayed high levels of achievement, suggesting that instructional strategies regardless of being traditional or technology-enhanced were effective in supporting learning. A significant interaction effect was identified between technology integration and traditional teaching methods on mathematics learning outcomes. This means the impact of one instructional method was influenced by the level of the other, supporting the complementary use of both strategies in improving student performance. There was a significant difference in mathematics learning outcomes when grouped by traditional teaching methods, but not by levels of technology integration. Traditional methods had a more pronounced impact, while technology alone did not produce significant differences in outcomes. Educators perceived that integrating technology with traditional methods enhanced conceptual understanding and student engagement. However, they also cited challenges such as inconsistent access to digital infrastructure, lack of training, and time constraints. They emphasized the need for balanced application and professional development. The quantitative findings corresponded well with qualitative insights. While technology integration was rated moderate, educators affirmed its value when used alongside traditional methods. The extensive mathematics outcomes validated the perception that effective teaching, regardless of method, hinges on strategic and context-sensitive implementation.

4.2. Conclusions—The classification of technology integration in Mathematics instruction reveals a moderate level of implementation across digital tools, software applications, and online resource accessibility. This suggests that while efforts are being made to incorporate technology, its usage remains inconsistent and limited in impact. Traditional teaching methods are also applied at a moderate level, reflecting the ongoing reliance on conventional instructional approaches such as direct instruction, lectures, and paper-based resources. This demonstrates the persistent value of these methods, particularly in foundational skill development. Students’ mathematics learning outcomes in terms of conceptual understanding, problem-

solving, and engagement were rated very extensive, indicating that the current teaching strategies whether technology-based or traditional are effective in enhancing academic achievement. A statistically significant interaction effect exists between technology integration and traditional teaching methods, highlighting that their combined use can synergistically enhance mathematics learning outcomes. Traditional teaching methods have a significant main effect on student achievement, while technology integration alone does not yield a statistically significant difference. This indicates that foundational instructional strategies remain crucial and that technology should support rather than replace them. Educators' qualitative responses affirm the benefits of integrating technology with traditional teaching. However, they also reveal practical challenges such as inadequate resources, limited training, and the need for institutional support. The alignment of quantitative results with educators' insights reinforces the importance of a blended instructional approach, wherein effective teaching requires both innovation through technology and the reliability of traditional strategies.

4.3. Recommendations—Public School District Supervisor. Public school district supervisors will benefit from a comprehensive understanding of the challenges and opportunities in Mathematics education. The study's findings can guide policy development and implementation, promoting innovative teaching approaches that address the needs of both educators and students within the district. DepEd Officials. For Department of Education (DepEd) officials, the study provides valuable data and insights to inform curriculum development and teacher training programs. It emphasizes the importance of integrating technology into educational

practices, helping to shape policies that enhance the quality of Mathematics education nationwide. Future Researchers. Future researchers will find a solid foundation for further exploration of the impact of teaching methodologies on student learning. The study contributes to the ongoing discourse in educational research, offering avenues for future investigations into effective practices in Mathematics education and the broader implications of technology integration in teaching. This study defined the terms conceptually and operationally to understand better and reference them when discussing results in the preceding chapters. Schools may strengthen professional development programs that equip teachers with both pedagogical and technical skills to maximize technology integration in Mathematics instruction. Educational leaders may allocate resources to improve the availability and accessibility of digital tools and online learning materials in classrooms. While advancing digital efforts, institutions may also preserve and enhance traditional teaching practices, ensuring these methods are updated and aligned with learner needs. School systems may consider implementing a balanced instructional framework that formally integrates technology-supported learning with proven traditional methods to boost academic performance. Further studies are encouraged to explore how different student demographics respond to varying combinations of instructional strategies for more targeted interventions. Policymakers may consider developing guidelines for blended instruction models that draw on the strengths of both digital innovation and classical pedagogy. Institutional support systems may be established to address logistical challenges faced by teachers, including technological infrastructure, time for instructional planning, and peer collaboration.

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