International Journal of Social Sciences and English Literature
Vol. 9, No. 4, 23-28, 2025
ISSN(E) 2576-683X
DOI: 10.55220/2576683x.v9.394

The Influence of Technology Integration on the Academic Performance of Upper Primary Education Learners in Mathematics

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Abstract

This study investigated the impact of technology integration on the academic performance of upper primary learners (Grades 4-6) in mathematics at Magsaysay Elementary School in Bohol, Philippines. The research employed a descriptive method. The findings revealed that while students initially struggled with competencies related to geometry and probability, the integration of Interactive PowerPoint and offline videos significantly improved their post-test scores across all assessed competencies. The study concluded that technology integration, specifically using these digital tools, significantly enhances the academic performance of upper primary learners in mathematics. The research recommends that Magsaysay Elementary School and similar institutions invest in comprehensive professional development programs for teachers to enhance their proficiency in integrating technology into their teaching practices. The study highlights the crucial role of technology in modern education and underscores the need for ongoing professional development for teachers to effectively leverage these resources. Adopting these recommendations, schools can better harness the potential of technology to improve educational outcomes and equip students with the skills necessary for academic success.

Keywords: Academic Performance, Interactive PowerPoint, Offline Videos, Teacher Professional Development, Technology Integration, Upper Elementary Mathematics.

1. Introduction

In modern educational institutions, technology has become a strong force for change, opening up a huge range of possibilities for how students learn and teachers teach (Haleem et al., 2022). In the area of mathematics education, this paradigm shift is especially clear. Using technology in the classroom has the potential to improve learning experiences and academic success (Ah-Labadi & Sant, 2021). Upper primary education is a very important time for students between the ages of 10 and 12 to improve their mathematics skills. During this important time, students move from knowing concrete to abstract math ideas, and technology can help them understand and get better at math during this time (Yuliandari & Anggraini, 2021). The intention of the study is to find out how using technology, especially digital tools and resources, affects the mathematics ability of upper primary school students (Akcay et al., 2021). The importance of this study lies in its potential to give solid evidence about how effectively incorporating technology into upper primary school mathematics instruction can boost students' academic success (Ran et al., 2022).

In the past, math education was mostly about memorizing facts and not thinking about them and this made many students bored and made it hard for them to understand general math ideas (Sari et al., 2024). Howeovwer, technology has made it possible for learning to be more engaging and immersive in new ways (Baxter & Hainey, 2024). Using digital tools, models, and educational software together can help teachers make flexible and unique learning spaces that meet the needs and teach in a way that fits each student's style (Sitthiworachart et al., 2022; Suson, 2024). When it comes to mathematics, the change from real to abstract thinking is very hard for students. Fo instance, things that used to be simple and easy to understand, like basic mathematical processes, are changing into more complicated and vague ideas, like algebraic equations and geometric proofs (Devlin, 2021). Moreover, technology, which can be used in many ways, is a great way to help with this. It provides engaging visuals, manipulatives, and virtual simulations that make abstract mathematical ideas more real and easy for young students to understand (Cirneanu & Moldoveanu, 2024).

Students in upper primary are at a very important point in their cognitive growth. They are most curious and want to learn more and using technology in mathematical classes, research, teachers can tap into students' natural interest and create hands-on, question-based learning opportunities (Horrace & Stone, 2023; Suson, 2020; Cebe & Suson, 2023). Interactive multimedia tools not only keep students interested, but they also give them the freedom to explore mathematics ideas at their own pace and this gives them a sense of control over their learning process (Amelia & Harahap, 2021). Incorporating technology into mathematics classes is a key way to teach important 21st-century skills while also helping students understand concepts better (Ingana et al., 20223). In this digital age,

these skills like working together to solve problems, thinking critically, and being able to use technology are becoming more and more important (Mahmud et al., 2022). Using technology-enhanced learning settings, students not only get ready to do well in school, but they also learn the skills they need to do well in a world that is always changing and this makes sure that mathematics education will always be useful (Yang et al., 2021).

The Department of Education (DepEd) in the Philippines has introduced the DepEd Commons, an online Learning Management System (LMS), to modernize education. This platform is a centralized hub for planning, delivering, managing, and evaluating educational content, providing teachers, students, and parents access to high-quality resources and facilitating collaboration. With features including online content delivery, assessment tools, and progress tracking, the DepEd Commons promotes technology-enhanced learning and the development of 21st-century skills (DepEd et al. Self-learning Modules," 2020). This initiative is designed to improve the efficiency, effectiveness, and accessibility of education delivery, offering a wide range of learning resources to meet diverse needs. The growing importance of effectively integrating digital technology into teaching and learning practices is underscored by global trends in education digitization. Many countries have accelerated their efforts through legislative measures and action plans to expedite digitalization. While the introduction briefly mentions previous studies by Al Schademan and initiatives like the DepEd Commons, the research will delve deeper into the existing literature on technology integration in mathematics education. This will involve synthesizing findings from various studies to provide a comprehensive understanding of the topic and identify gaps in the literature that the current research aims to address.

Teachers at Magsaysay Elementary School in the Sevilla District of Bohol strive to incorporate technology into their teaching methods to enhance student learning, particularly in mathematics in upper primary education (Grade 4 to Grade 6). The research will include a component focused on professional development to address the challenge of teachers' lack of knowledge and training in technology integration. This may involve workshops, training sessions, or collaborative learning communities where teachers can share best practices and learn from experts in educational technology. While digital tools offer great potential for improving students' comprehension and engagement with mathematical concepts, their successful integration depends on teachers' classroom proficiency. Without adequate knowledge and training on leveraging technology for educational purposes, teachers may struggle to fully exploit its benefits, resulting in less interactive and impactful learning experiences for students. Therefore, addressing this challenge is crucial for advancing the goal of improving academic achievement in mathematics through the use of digital resources. The research will primarily focus on assessing the influence of technology integration on the academic performance of upper primary education learners in mathematics.

2. Methodology

This study employed a descriptive research design to investigate the impact of technology integration, specifically the use of a mobile virtual laboratory application, on improving students' achievement in mathematics among upper primary learners at Magsaysay Elementary School. The research utilized both quantitative and qualitative data collection methods to provide a comprehensive understanding of the integration of technology in the classroom. The participants consisted of Grade IV to Grade VI students, chosen based on observed academic challenges in mathematics at these levels. Data were collected through classroom observations, surveys, interviews, and pre-test/post-test assessments. Observations focused on teachers' use of technological tools and student engagement during instruction. The primary assessment tool was a questionnaire adapted from the Department of Education's Learning Modules and Mathematics Learning Materials, aligned with the Most Essential Learning Competencies (MELCs). The instrument included a 20-item multiple-choice test, with 10 items assessing each of the two selected competencies. This was administered as both a pre-test and post-test to evaluate learning gains following the intervention. The responses were scored and interpreted using a five-point rating scale ranging from "Poor" to "Outstanding." This methodological approach ensured alignment with national curriculum standards while allowing for the measurement of the effectiveness of technology integration in enhancing student learning outcomes in mathematics.

Table 1. Pre-Test Result on the Visualizes the volume of cube and rectangular prism.

Range of Score	f	%
15	0	0
14	0	0
13-Dec	0	0
0 - 11	77	100
Average	3.06	
Std. Deviation	0.9643	

3. Results and Discussion

Table 1 shows that all 77 students (100%) scored within the range of 0–11 out of 15 on the pretest for the competency "Visualizes the volume of cube and rectangular prism," with a standard deviation of 0.9643. This indicates a consistent struggle among learners with this concept, suggesting insufficient foundational understanding and difficulty applying volume-related geometric skills (Germuth, 2018; Sachdeva & Eggen, 2021). The results point to a need for more interactive, visual, and targeted instructional strategies to strengthen spatial reasoning and conceptual understanding (Tong et al., 2022; Carney et al., 2022). Studies by Ozan & Kıncal (2018) affirm that visual tools, focused support, and formative assessments can effectively address such learning gaps in geometry.

Table 2. Pre-Test Result on the Calculating and recording simple experimental probability.

Range of Score	f	%
15	0	0
14	0	0
13-Dec	0	0
0 - 11	77	100
Average	3.32	
Std. Deviation	0.9793	

Table 2 shows that all 77 upper primary learners scored between 0 and 11 on the pretest for the competency "Calculating and recording simple experimental probability," with an average score of 3.32 and a standard deviation of 0.9793. This consistently low performance suggests limited understanding of basic probability concepts, possibly due to inadequate teaching strategies or lack of exposure to hands-on learning (Hawthorne, 2023; Vale & Barbosa, 2023). To address this, educators should integrate interactive, real-life experiments and simulations to make probability concepts more engaging and understandable (Uyen et al., 2022; Siregar, 2024). Formative assessments and continuous feedback can also help identify learning gaps and adjust instruction accordingly (Carney et al., 2022; Ozan & Kıncal, 2018). Studies by Kumar and Ali (2022) confirm that experiential learning significantly improves student comprehension in probability.

Table 3. Pre-Test Result on the solving word problem involving simple probability.

20	0	0
18-19	0	0
16-17	0	0
0 - 15	77	100
Average	3.75	
Std. Deviation	1.3684	

Table 3 shows that upper primary learners scored between 0 and 11 on the pretest for "Solving word problems involving simple probability," with an average of 3.75 and a standard deviation of 1.3684. The low mean suggests students struggled with applying probability concepts to real-life problems, while the high variability indicates differing levels of understanding (Sarathy, 2018; Munna & Kalam, 2021). These results point to the need for more practice with contextualized word problems and step-by-step problem-solving strategies. Interactive tools, gamified learning, and real-world examples can make instruction more engaging and effective (Adipat, 2021; Carstens et al., 2021). Formative assessments should be used to track progress and adjust teaching to meet diverse learning needs (Carney et al., 2022; Kültür & Kutlu, 2021). Research supports that contextualized, differentiated, and tech-supported instruction enhances problem-solving in probability (Cambaya et al., 2022; Langelaan et al., 2024).

Table 4. Post-Test Result on the Visualizes the volume of cube and rectangular prism.

Range of Score	f	%
15	0	0
14	0	0
13-Dec	41	53.2468
0 - 11	36	46.7532
Average	11.29	
Std. Deviation	1.4497	

Table 4 shows a post-test average score of 11.29 (SD = 1.4497) for the competency "Visualizes the volume of cube and rectangular prism," with 53.24% of students scoring between 12–15—an improvement from the pretest where all scored 0–11. This indicates a notable gain in understanding following the use of interactive PowerPoint presentations and offline videos. The results suggest that multimedia tools effectively enhanced students' grasp of geometric volume by providing engaging, visual content (Jerika & Lestari, 2022; Roxas et al., 2020). Studies support that such tools improve comprehension, accommodate diverse learning styles, and foster better retention (Emralino & Nartea, 2020; Qasserras, 2024). Research by Abdulrahaman (2020), Shala & Shatri (2022), and Kassa et al. (2024) further confirms the effectiveness of visual aids in improving math learning outcomes. In summary, the improved post-test scores highlight the positive impact of integrating multimedia in math instruction, particularly for visualizing abstract geometric concepts.

Table 5. Post-Test Result on the Calculating and recording simple experimental probability.

15	0	0
14	1	1.2987
13-Dec	33	42.8571
0 - 11	43	55.8442
Average	11.42	
Std. Deviation	1.2912	

Table 5 shows that students achieved a post-test mean score of 11.42 (SD = 1.29) for "Calculating and recording simple experimental probability," with 55.84% scoring 0–11 and 42.86% scoring 12–13. This marks a clear improvement from the pretest, indicating the positive impact of interactive PowerPoint presentations and offline videos. The results suggest that multimedia tools effectively enhanced students' understanding of

experimental probability, although some still struggled with the concept (Rafiq et al., 2024). Visual and interactive content helped make abstract ideas more accessible, supporting engagement and retention (Gyeltshen, 2023; Abdulrahman et al., 2022). Research by Bukhatwa et al. (2022), Johnson & Lee (2022), and Kamran et al. (2023) further supports the use of multimedia in improving math performance and addressing diverse learning needs. In summary, the findings affirm that integrating multimedia resources enhances students' grasp of probability, making instruction more effective and inclusive.

Table 6. Post-Test Result on the solving word problem involving simple probability.

18-19	0	0
16-17	0	0
0 - 15	77	100
Average	3.75	
Std. Deviation	1.3684	

Table 6 reports a post-test mean score of 14.56 (SD = 1.6343) for "Solving word problems involving simple probability," with 71.43% of students scoring 0–15 and 28.57% scoring 16–17. This indicates a strong improvement in students' problem-solving abilities compared to the pretest. The high average and increased number of high scorers suggest that interactive PowerPoint presentations and offline videos effectively enhanced students' understanding and application of probability in word problems (Setiyani, 2020; Adipat et al., 2021). These tools provided engaging, context-rich learning experiences that improved comprehension and retention (Tuhuteru et al., 2023; Malik et al., 2024). Supporting studies by Siregar (2024), Fokuo et al. (2023), and others confirm that multimedia tools significantly boost problem-solving performance through visual, interactive instruction.

Table 7. Difference between Pre -Test and Post Test on Visualizes the volume of cube and rectangular prism.

Source of Difference	**Mean**	**Std. Dev.**	**t - value**	**P - value**	
Pretest	3.06	*0.9643*	42.089	<0.000	Highly Significant
Post-Test	11.29	1.4497			
Decision: Reject the null hypothesis					

Table 7 shows a significant improvement in scores for "Visualizes the volume of cube and rectangular prism," with the mean rising from 3.06 (SD = 0.9643) in the pretest to 11.29 (SD = 1.4497) in the post-test. This marked gain allows rejection of the null hypothesis, confirming that the intervention had a positive effect. The results suggest that interactive PowerPoint presentations and offline videos significantly enhanced students' understanding of geometric volumes. While most students improved, some variability remains, indicating the need for further individualized support (Walck-Shannon et al., 2021). Studies by Etyarisky & Marsigit (2022) and Abdulrahman et al. (2020) support the effectiveness of multimedia in improving spatial reasoning and conceptual understanding.

Table 8. Difference between Pre -Test and Post Test on Calculating and recording simple experimental probability.

Source of Difference	**Mean**	**Standard Deviation**	**t - value**	**p - value**	
Pre-Test	3.32	0.9793	42.274	<0.000	Highly Significant
Post-Test	11.42	1.2912			
Decision: Reject the null hypothesis					

Table 8. shows a significant increase in scores for "Calculating and recording simple experimental probability," with the mean rising from 3.32 (SD = 0.9793) in the pretest to 11.42 (SD = 1.2912) in the post-test, allowing the rejection of the null hypothesis. This improvement indicates that interactive PowerPoint presentations and offline videos effectively enhanced students' understanding of experimental probability. While some variability remains, most students showed substantial gains, suggesting strong instructional impact with room for additional support (Lodge, 2018). Supporting studies by Bukhatwa et al. (2022) and Rafiq et al. (2024) confirm that multimedia tools improve engagement and mastery of complex math concepts. In conclusion, the findings validate the use of multimedia resources to boost student achievement in probability and support their continued integration in math instruction.

Table 9. Difference between Pre -Test and Post Test on Solving word problems involving simple probability.

Source of Difference	**Mean**	**Standard Deviation**	**t - value**	**p - value**	
Pre-Test	3.75	1.3684	51.856	<0.000	Highly Significant
Post-Test	14.56	1.6343			
Decision: Reject the null hypothesis					

Table 9. shows a significant increase in scores for "Solving word problems involving simple probability," with the mean rising from 3.75 (SD = 1.3684) in the pretest to 14.56 (SD = 1.6343) in the post-test, supporting the rejection of the null hypothesis. This sharp improvement indicates that interactive PowerPoint presentations and offline videos effectively enhanced students' problem-solving abilities in probability. Although some variability remains, the overall gain reflects deeper understanding and better application of concepts (Steinmayr et al., 2019). Studies by Amir et al. (2018) and others confirm that multimedia tools significantly improve mathematical problem-solving. In summary, the findings validate the use of multimedia instruction in boosting students' performance in probability word problems.

4. Discussion

The analysis of the tables reveals several key findings regarding the influence of technology integration on mathematics education Elementary School. The teacher respondents are predominantly female and mostly aged 56 years and above, with many holding MA/MS units as their highest educational attainment. A significant number of teachers have attended numerous professional development seminars, reflecting their commitment to ongoing learning. The student respondents are mainly female, with the most common age being 10 years old, which provides a demographic context for the study. In terms of academic performance, students initially struggled with competencies such as visualizing volumes of geometric shapes, calculating simple probabilities, and solving probability-related word problems, as indicated by their pretest scores. However, following the integration of Interactive PowerPoint and offline videos, there was a marked improvement in their post-test scores across all competencies. For competency 1, students' mean scores rose from 3.06 to 11.29, while for competency 2, the mean score increased from 3.32 to 11.42. Competency 3 saw an impressive rise from 3.75 to 14.56. These improvements highlight the effectiveness of technology in enhancing students' mathematical skills. The significant differences between pretest and post-test scores across these competencies suggest that technology integration has positively impacted students' learning outcomes. This underscores the need for continued professional development for teachers to maximize the benefits of digital tools. The findings emphasize the importance of technology in improving educational performance and suggest that further research and investment in technology integration could continue to benefit mathematics education.

5. Conclusion

The findings from the study conclusively demonstrate that technology integration, specifically using Interactive PowerPoint and offline videos, significantly enhances the academic performance of upper primary learners in mathematics. The substantial improvements observed in post-test scores across various competencies such as visualizing volumes, calculating probabilities, and solving probability-related problems indicate that digital tools positively influence student learning outcomes. These results highlight the crucial role of technology in modern education and underscore the need for ongoing professional development for teachers to leverage these resources effectively. The study supports the notion that well-implemented technology can substantially improve student comprehension and engagement, thus reinforcing the value of integrating digital tools into the educational curriculum.

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