



Evaluating the Impact of Technological Infrastructure on Teaching, Learning, and Institutional Effectiveness in Technology Education Institutions

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ABSTRACT

Purpose of the study: The study evaluates the integration of technological infrastructure in schools, highlighting its positive impact on engagement, accessibility, and administration. Despite benefits like efficiency and improved communication, challenges remain in network connectivity, support, and the digital divide. Findings aim to inform policy for more effective, equitable technology use in education.

Methodology: The study uses a quantitative descriptive design to assess technological infrastructure integration in a rural elementary school. Complete enumeration of faculty and staff ensures accurate data. A validated self-made survey measures technology's impact on engagement, access, teaching efficiency, and performance. Descriptive statistics, including mean and standard deviation, analyze trends and the extent of technology's educational influence.

Main Findings: The study found high technological integration in elementary schools, with hardware availability scoring highest, reflecting strong institutional support. However, technical support services scored lowest, indicating a need for better troubleshooting assistance. Technology significantly enhanced student engagement but had a moderate impact on academic performance. Literature supports these findings, emphasizing that while digital tools boost interaction, improving outcomes requires strong technical support and teacher training. Mateo Elementary School should invest in both areas to maximize the effectiveness of its technological infrastructure.

Novelty/Originality of this study: The study advances existing knowledge by providing a holistic evaluation of technological infrastructure in elementary schools, focusing on both hardware/software integration and often-overlooked aspects like technical support and network connectivity. It highlights the disparity between high engagement and moderate performance gains, emphasizing the need for teacher training and equitable access. The findings offer actionable insights for policymakers and educators to optimize technology's role in education.

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1. INTRODUCTION

The landscape of education is undergoing a rapid transformation driven by the relentless advancement of technology. Technology Education (TE) institutions, specifically those focused on equipping students with the skills necessary to thrive in this evolving environment, face a critical challenge: ensuring their technological infrastructure keeps pace with industry demands [1]. This challenge is particularly pertinent considering the exponential growth of emerging technologies like Artificial Intelligence (AI), Cloud Computing, and the Internet of Things (IoT) [2]. These advancements not only influence the tools and techniques employed in various industries but also redefine the skillsets sought after by potential employers [3].

Despite the established importance of a robust technological infrastructure in TE institutions, a comprehensive understanding of its impact on various aspects of the educational experience remains elusive. While previous studies have explored the positive influence of technology on learning outcomes An and Park [4] and teacher effectiveness Sun et al. [5], the focus has primarily been on specific technologies or pedagogical approaches. However, a gap exists in understanding of how a holistic and up-to-date technological infrastructure within a TE institution shapes the overall learning environment [6].

Furthermore, existing literature often leans towards quantitative research methods, neglecting the subjective experiences of students and faculty regarding the impact of the institution's technological capabilities [5]. This research gap limits the ability to gain a nuanced understanding of how infrastructure influences perceptions, engagement, and ultimately, learning outcomes. By addressing these limitations, this research offers a valuable opportunity to inform strategic decision-making for TE institutions by providing data-driven insights into the optimal allocation of resources for technological infrastructure development, enhance curriculum design by aligning course content and delivery methods with the affordances of the available technology.

Improve faculty development by identifying specific training needs related to utilizing the institution's technological capabilities effectively, strengthen industry partnerships by demonstrating the institution's commitment to providing students with the technological skills and experiences relevant to current industry demands. This research has the potential to significantly contribute to the advancement of TE by offering a deeper understanding of the intricate relationship between technological infrastructure and the overall effectiveness of these institutions in preparing students for the technologically driven future.

The findings of this study can significantly inform the Department of Education (DepEd) in making policy decisions and resource allocation strategies related to technology integration in schools. For school administrators, the study provides valuable insights into optimizing technological infrastructure to enhance teaching, learning, and administrative efficiency. Teachers can benefit from this research as it highlights the importance of professional development in effectively utilizing technology for instruction. Likewise, students can gain from the study's emphasis on the benefits of technology in improving access to educational resources and enhancing learning outcomes.

The primary objective of the study was to assess the impact of technological infrastructure technology education in elementary institutions. Specifically; the study answers the following questions;

1. To what extent is technological infrastructure integrated into the educational practices in Elementary School?
2. What is the level of influence of technological infrastructure on teaching and learning outcomes for:
 - a. Student engagement;
 - b. Access to learning materials;
 - c. Teaching efficiency; and
 - d. Student performance?

2. RESEARCH METHOD

2.1. Research Design

The study employs a quantitative research method using descriptive design. As mentioned by Ghanad [7] quantitative research is quantifying things and answering questions from "how long," "how many," and "the degree to which." Ghanad further cited that quantitative research was classified into two categories namely exploratory or formulative and descriptive research. Manjunatha [8] defines descriptive research as casting light on current issues or problems through a process of data collection that enables us to describe the situation more completely. This method describes the extent of technological infrastructure integrated into the educational practices in Elementary School and its influence on teaching and learning outcomes.

2.2. Respondents

The respondents were selected as complete enumeration. The entire faculty and staff employed in the rural elementary school. Complete enumeration is a data collection method where information is gathered from every unit within a population. This approach ensures that each individual or element is accounted for, providing comprehensive data about the entire group [9]. Kumar [10] stated that using complete enumeration, provides

highly accurate and comprehensive data since every individual in the population is included. Moreover, this eliminates sampling error and ensures that the data reflects the true characteristics of the population. The method was employed by the researcher to have detailed insights in assessing the extent of technological infrastructure integrated into the educational practices in Elementary School and its influence to teaching and learning outcome.

2.3. Research Instrument

This study utilizes the self-made survey questionnaire to determine the extent of technological infrastructure integrated into the educational practices in Elementary School and level of influence of technological infrastructure on teaching and learning outcomes for student engagement; access to learning materials; teaching efficiency; and student performance. As Creswell [11] explains, survey research is a quantitative method that provides a numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. Furthermore, a well-constructed questionnaire should include clear, concise questions aligned with the research objectives and should undergo validation and pilot testing to ensure reliability and accuracy [12].

2.4. Statistical Analysis

The study employed both quantitative data analysis methods to comprehensively assess the integration of technological infrastructure in education. The descriptive statistics including mean and standard deviation, were utilized to measure the extent of technological infrastructure integration and its influence on Student engagement; Access to learning materials; Teaching efficiency; and Student performance. Creswell [11] emphasized that survey research designs are particularly useful in describing trends and attitudes in a population, especially when paired with quantitative methods such as descriptive statistics to interpret the results.

3. RESULTS AND DISCUSSION

Table 1 shows the extent of technology infrastructure integration in elementary schools. The results indicate that technological infrastructure integration in Elementary School is generally high, particularly in terms of hardware and software availability. The highest mean score was observed in hardware availability (3.75), implying that the institution prioritizes providing devices for teaching and learning. However, the lowest mean score was in technical support services (3.10), suggesting that users may struggle with troubleshooting issues, potentially hindering effective technology use.

These findings align with existing literature, which suggests that while schools often focus on acquiring hardware and software, they may overlook the importance of technical support services. The high mean score for hardware availability reflects the institution's commitment to equipping classrooms, consistent with the findings of Zawawi et al. [13] and Jasinski et al. [14]. Conversely, the lower mean score for technical support services highlights a gap in troubleshooting and maintenance, similar to the observations of Hacifazlıoğlu et al. [15] and Cavanaugh et al. [16]. Literature suggests that strengthening technical support services is crucial for maximizing the benefits of technological infrastructure, as emphasized by Bebell and O'Dwyer [17] and Mohammadi et al. [1], who found that robust support systems reduce disruptions, increase teacher satisfaction, and enhance technology integration. Therefore, to address the challenges identified in the study, Mateo Elementary School should consider investing in technical support services to optimize the effectiveness of its technological infrastructure.

Table 1. Extent of Technological Infrastructure Integration

Component	Mean	Standard Deviation	Interpretation
Availability of hardware	3.75	0.45	High
Availability of software	3.60	0.50	High
Network connectivity	3.20	0.70	Moderate
Technical support services	3.10	0.75	Moderate

Table 2 shows the level of influence of technological infrastructure on teaching and learning outcomes in elementary school. The data suggests that technological infrastructure significantly contributes to student engagement, which received the highest mean score (4.00), highlighting how digital tools enhance interaction and participation in learning. However, student performance had the lowest mean score (3.50), indicating that while students engage with technology, its direct impact on academic achievement may require further investigation.

These findings align with existing literature, which suggests that technology effectively enhances student engagement but has a less direct influence on academic performance. The high mean score for engagement reflects the effectiveness of digital tools in fostering interaction, consistent with the findings of

Ferguson [18] and Yildiz [19]. Conversely, the lower mean score for student performance suggests that engagement alone may not directly improve academic outcomes, as noted by Means et al. [20] and An and Park [4]. Research emphasizes that additional factors, such as teacher training and personalized learning strategies, are essential for maximizing the benefits of technology in education. Studies by Hutchison and Woodward [21] and Chen et al. [22] highlight the importance of professional development in enabling teachers to use technology effectively for differentiated instruction and addressing individual student needs. Therefore, to bridge the gap between engagement and performance, Mateo Elementary School should consider investing in teacher training and personalized learning approaches to optimize the impact of technological infrastructure on academic achievement.

Table 2. The influence of technological infrastructure on Teaching and Learning Outcomes in elementary school

	Mean	Standard Deviation	Interpretation
Student engagement	4.00	0.30	High
Access to learning materials	3.80	0.50	High
Teaching efficiency	3.70	0.60	High
Student performance	3.50	0.55	Moderate

The findings of this study have important implications for school administrators and educational policymakers in planning and managing technological infrastructure in elementary schools. The high level of hardware and software availability demonstrates that investments in digital resources can successfully support teaching and learning activities [23]-[25]. However, the relatively lower ratings for technical support services indicate that infrastructure development should not focus solely on equipment acquisition but also on maintenance and user assistance. Establishing dedicated technical support systems can reduce disruptions during instructional activities and improve the overall effectiveness of technology integration [26]-[28]. Consequently, educational institutions should adopt a more comprehensive approach that balances technological resources, technical support, and sustainability strategies to maximize educational benefits.

The study also provides valuable implications for instructional practices and professional development programs. Although technological infrastructure significantly enhances student engagement and access to learning materials, its influence on student performance remains moderate. This finding suggests that technology alone is insufficient to improve academic achievement without effective pedagogical implementation. Teachers should be equipped with continuous professional development opportunities that focus on technology-enhanced instruction, personalized learning, and digital pedagogies [29]-[31]. Furthermore, educational leaders should encourage the integration of technology into curriculum design and assessment practices to ensure that increased engagement translates into meaningful learning outcomes and improved student achievement.

4. CONCLUSION

The study confirms that technological infrastructure plays a crucial role in enhancing education and institutional effectiveness by improving access to learning resources, streamlining administrative processes, and increasing efficiency. However, challenges such as limited technical support, inconsistent network connectivity, and the digital divide hinder its full potential. To maximize its impact, institutions should prioritize investments in robust internet infrastructure, continuous professional development for educators, and strategies to ensure equitable access to technology. Additionally, addressing software compatibility issues and enhancing decision-making tools can lead to a more seamless integration of technology in both academic and administrative functions. Ultimately, a well-structured and well-maintained technological infrastructure can significantly contribute to educational advancements, fostering a more efficient and effective learning environment for all stakeholders.

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