

Implementation of Technology Integration and Teacher Engagement as Foundations for a Digital Leadership Framework

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Abstract

This study examined the implementation of technology integration and teacher engagement as foundations for developing a digital leadership framework in selected public elementary schools in the Surigao City Division. Specifically, it assessed the extent of technology integration in terms of instructional planning, classroom delivery, assessment practices, and use of digital tools and resources; determined the level of teacher engagement in terms of cognitive, behavioral, and emotional dimensions; tested the relationship between technology integration and teacher engagement; and identified the challenges encountered by teachers in implementing technology-enhanced instruction. The study employed a sequential explanatory mixed-methods design. Quantitative data were gathered from 265 elementary teachers selected from a population of 362 through stratified random sampling, while qualitative data were obtained from selected participants through semi-structured interviews. Descriptive statistics, correlation analysis, and regression analysis were used for quantitative data, while thematic analysis was applied to qualitative responses. Findings revealed that technology integration was generally implemented across instructional planning, classroom delivery, assessment practices, and digital resource use. Teacher engagement was also evident across cognitive, behavioral, and emotional dimensions. The results further showed a significant relationship between technology integration and teacher engagement, indicating that meaningful digital implementation contributes to teachers' professional involvement, instructional participation, and affective commitment to technology-supported teaching. Qualitative findings identified persistent challenges, including infrastructure limitations, uneven digital competence, instructional preparation constraints, time demands, and student access and readiness issues. The study concludes that technology integration becomes more sustainable when supported by engaged teachers and responsive school leadership. Based on the findings, a digital leadership framework was proposed to guide school leaders in strengthening teacher support, professional development, instructional innovation, and equitable technology implementation.

Keywords: Digital Leadership Framework, Elementary Education, Teacher Engagement, Technology Integration, Technology-Supported Instruction

1. Introduction

Digital transformation has become a defining feature of contemporary basic education, particularly after the global shift from emergency remote teaching to more sustained forms of technology-supported instruction. Educational technology is no longer viewed only as a supplementary resource but as an integral component of instructional planning, classroom delivery, assessment, professional collaboration, and school leadership. The *Global Education Monitoring Report 2023* emphasized that technology can support access, flexibility, teacher collaboration, and learning continuity, but its educational value depends on how appropriately, equitably, and pedagogically it is used (UNESCO, 2023a). Similarly, the Organisation for Economic Co-operation and Development (OECD, 2021) noted that digital technologies, including learning platforms, artificial intelligence, analytics, and other smart systems, are reshaping classroom instruction and the management of educational institutions. These developments suggest that technology integration must be understood not merely as the presence of devices or platforms, but as the purposeful alignment of digital tools with curriculum goals, pedagogy, assessment, and learner needs.

In the Philippine basic education context, technology integration has become increasingly important as schools continue to respond to learning disruptions, digital equity concerns, and the need to improve teaching quality. The Department of Education institutionalized flexible and technology-supported learning during the pandemic through the Basic Education Learning Continuity Plan, which required schools and teachers to adapt instruction through modular, online, blended, and other alternative delivery modalities (Department of Education [DepEd], 2020). This policy direction was later extended through the Basic Education Development Plan 2030, which identifies learning recovery, education resilience, digital transformation, and strengthened governance as major priorities for improving the quality of Philippine basic education (DepEd, 2022). In a country case study prepared for the 2023 Global Education Monitoring Report, Espinosa, Gomez, Miranda, and Santiago (2023) observed that the Philippines has made efforts to integrate digital skills in basic education; however, the effective use of educational technology remains shaped by persistent inequalities in infrastructure, connectivity, teacher capacity, and resource availability. These conditions demonstrate that technology integration in Philippine schools is both a pedagogical opportunity and an implementation challenge.

Technology integration is pedagogically meaningful only when teachers are able to connect digital tools with instructional purposes. The Technological Pedagogical Content Knowledge framework remains useful in explaining this process because it emphasizes that effective technology use requires the interaction of technological knowledge, pedagogical knowledge, and content knowledge rather than technical skill alone (Mishra & Koehler, 2006). Recent literature continues to affirm this position, noting that teachers' ability to design, deliver, and assess learning through digital technologies depends on their professional preparation, confidence, institutional support, and contextual conditions (Tondeur et al., 2020; Wagner et al., 2024). Thus, the central issue is not whether teachers use technology, but whether technology is integrated in ways that improve lesson planning, classroom interaction, assessment practices, feedback, student participation, and instructional decision-making.

Teacher engagement is equally critical in sustaining technology integration. In digital learning environments, teachers are not passive implementers of policy; they are active agents whose cognitive, behavioral, and emotional engagement influences whether technology use becomes meaningful, routine, and sustainable. Cognitive engagement is reflected in teachers' willingness to learn, reflect, plan, and solve instructional problems using digital tools. Behavioral engagement is shown through active participation in professional learning, collaboration, and consistent implementation of technology-enhanced practices. Emotional engagement is evident in teachers' confidence, motivation, satisfaction, and reduced anxiety in using technology for teaching. Studies on digital transformation in education show that teachers' professional agency, self-efficacy, and emotional readiness are important conditions for effective technology adoption, particularly when digital tools require changes in workload, instructional routines, and classroom management (Howard et al., 2021; Scherer et al., 2021). Therefore, examining technology integration without examining teacher engagement provides only a partial understanding of digital implementation.



School leadership further shapes the success of technology integration because leaders influence vision-setting, professional development, resource allocation, technical support, and teacher motivation. Digital leadership refers to the capacity of school leaders to guide technology-enabled change through strategic planning, instructional support, collaborative culture, ethical technology use, and sustained organizational improvement. Empirical evidence indicates that digital leadership has a positive influence on teachers' technology integration, particularly when school leaders provide clear direction, professional support, and enabling conditions for digital instruction (AlAjmi, 2022). Other recent studies similarly suggest that principals' digital leadership and professional learning communities can strengthen teachers' innovation skills and promote more sustainable technology integration (Sunu et al., 2022; Wahid & Zulkifli, 2024). These findings indicate that digital leadership should be grounded not only in technological infrastructure but also in teacher engagement and school-level support systems.

Despite the increasing body of literature on educational technology, several gaps remain. First, many studies focus on technology access, digital competence, or frequency of technology use, while fewer studies examine how technology integration is implemented across specific instructional domains such as planning, classroom delivery, assessment practices, and use of digital tools and resources. Second, teacher engagement is often treated as a general professional attribute rather than as a multidimensional construct involving cognitive, behavioral, and emotional components. Third, Philippine studies on technology integration frequently emphasize learner access, online learning challenges, or digital literacy, but there remains a need for more localized evidence from public elementary schools, particularly in provincial and division-level contexts where infrastructure, teacher readiness, and school support vary considerably. Fourth, there is limited empirical work that connects technology integration, teacher engagement, and digital leadership into a single evidence-based framework for school improvement.

These gaps provide the rationale for the present study. In selected public elementary schools in the Surigao City Division, teachers are expected to implement technology-supported instruction while responding to practical constraints such as infrastructure limitations, digital competence gaps, instructional preparation demands, time constraints, and student access issues. Understanding the extent of technology integration and its relationship with teacher engagement can generate context-specific evidence for improving digital implementation at the school level. More importantly, the findings can inform the development of a digital leadership framework that responds to teachers' actual instructional experiences and support needs. Hence, this study examined the implementation of technology integration and teacher engagement as foundations for a digital leadership framework in selected public elementary schools in the Surigao City Division.

Theoretical Framework

This study is anchored on three complementary theories: the Technological Pedagogical Content Knowledge framework, Multidimensional Engagement Theory, and Digital Leadership Theory. The Technological Pedagogical Content Knowledge framework explains that effective technology integration occurs when teachers meaningfully connect technological knowledge, pedagogical knowledge, and content knowledge in instructional practice (Mishra & Koehler, 2006). This supports the study's examination of technology integration in terms of instructional planning, classroom delivery, assessment practices, and use of digital tools and resources. Multidimensional Engagement Theory explains teacher engagement as a construct composed of cognitive, behavioral, and emotional dimensions (Fredricks et al., 2004). This theory is relevant because the study treats engagement not merely as compliance with digital initiatives but as teachers' mental investment, active participation, and affective commitment to technology-supported teaching. Finally, Digital Leadership Theory provides the basis for developing the proposed framework by emphasizing that leadership in technology-mediated educational environments requires vision-setting, innovation support, professional guidance, and organizational adaptation (Avolio et al., 2000). Collectively, these theories establish the logic of the study: technology integration influences teacher engagement, and the resulting evidence may inform a digital leadership framework for sustaining meaningful and context-responsive technology implementation in public elementary schools.



Figure 1. Conceptual Framework of the Study

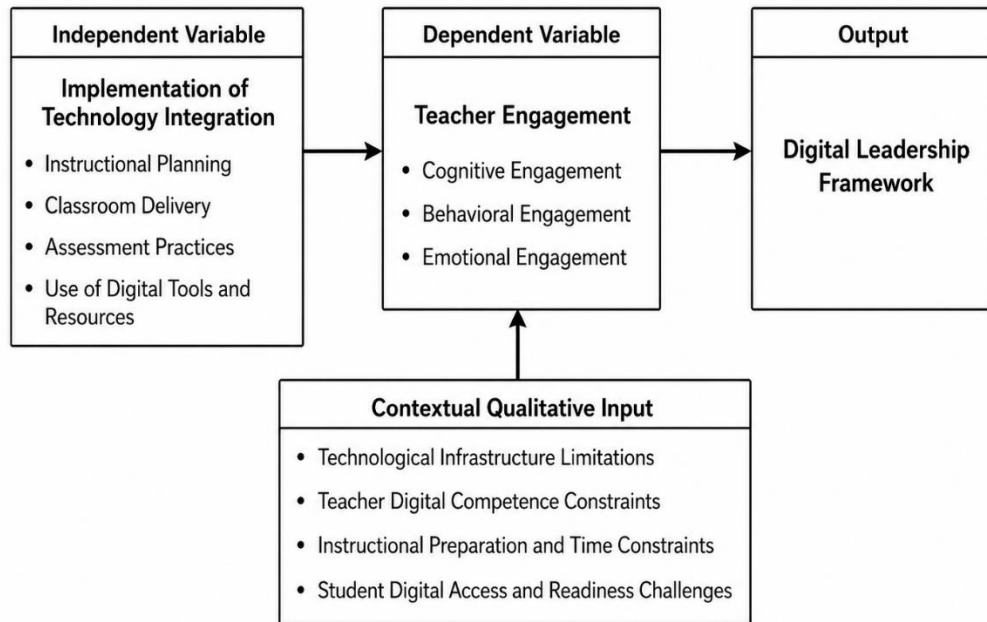


Figure 1. Diagram of Conceptual Framework

Figure 1 presents the conceptual framework of the study. It shows that the implementation of technology integration, measured through instructional planning, classroom delivery, assessment practices, and use of digital tools and resources, serves as the independent variable. This is expected to influence teacher engagement, which is examined in terms of cognitive, behavioral, and emotional engagement. The contextual qualitative input, consisting of infrastructure limitations, teacher digital competence constraints, instructional preparation and time constraints, and student access and readiness challenges, provides deeper explanation of the conditions that may strengthen or weaken teacher engagement. The framework further shows that the combined quantitative and qualitative findings serve as the basis for developing the proposed digital leadership framework for supporting sustainable and effective technology integration in public elementary schools.

Aim of the Study

This study aimed to examine the implementation of technology integration and teacher engagement as foundations for developing a digital leadership framework in selected public elementary schools in the Surigao City Division.

Statement of the Problem

Specifically, this study sought to answer the following questions:

1. What is the extent of implementation of technology integration among elementary teachers in terms of instructional planning, classroom delivery, assessment practices, and use of digital tools and resources?
2. What is the level of teacher engagement in terms of cognitive engagement, behavioral engagement, and emotional engagement?

3. Is there a significant relationship between the implementation of technology integration and teacher engagement?
4. What challenges do elementary teachers encounter in the implementation of technology integration?
5. Based on the quantitative and qualitative findings, what digital leadership framework may be developed?

2. Review of Related Literature

The literature on technology integration in education increasingly emphasizes that digital transformation is not achieved by the mere availability of devices, connectivity, or online platforms. Rather, meaningful integration occurs when technology is deliberately connected to instructional goals, pedagogical strategies, assessment practices, and learner needs. UNESCO (2023) emphasized that technology in education must be judged by its appropriateness, equity, scalability, and contribution to learning rather than by adoption alone. This position is consistent with the Technological Pedagogical Content Knowledge framework of Mishra and Koehler (2006), which explains that effective technology-supported instruction requires the interaction of technological, pedagogical, and content knowledge. For the present study, this means that the implementation of technology integration must be examined not only as tool use but as an instructional process reflected in planning, classroom delivery, assessment practices, and the use of digital tools and resources.

Instructional planning is a foundational dimension of technology integration because it determines whether digital tools are used purposefully or superficially. Recent studies suggest that teachers who possess stronger digital competence are more capable of aligning digital resources with curriculum standards, learning outcomes, and learner-centered activities (Falloon, 2020; Tondeur et al., 2020). However, the literature also indicates that digital competence alone is insufficient when teachers lack time, institutional support, or access to appropriate resources. Carpenter et al. (2024) found that access, leadership, and contextual conditions shape how educators develop professional digital competence and integrate technology into practice. This supports the present study's examination of instructional planning as one indicator of technology integration, since teachers' capacity to design technology-enhanced lessons depends on both individual competence and school-level enabling conditions.

Classroom delivery extends instructional planning into actual teaching practice. Digital tools can support interactive learning, multimodal instruction, collaboration, and student participation when they are used in ways that improve the learning process. Consoli et al. (2024) showed that the quality of technology integration explains student engagement and digital competence more strongly than the frequency of technology use. This finding is important because it challenges the assumption that more technology use automatically means better instruction. In relation to the present study, classroom delivery is therefore examined as a qualitative dimension of implementation: the issue is not simply whether teachers use digital tools during lessons, but whether these tools enhance explanation, interaction, participation, and learning engagement.

Assessment practices represent another important area where technology integration can improve instructional responsiveness. Digital assessment tools can support formative feedback, self-paced activities, online quizzes, digital portfolios, and data-informed instructional decisions. However, the literature also warns that digital assessment requires teachers to possess assessment literacy, platform familiarity, and the ability to maintain fairness, validity, and academic integrity. OECD (2021) noted that digital technologies, including artificial intelligence and learning analytics, can expand the capacity of education systems to personalize and monitor learning, but such benefits depend on responsible and pedagogically sound implementation. Thus, the present study's focus on assessment practices is justified because assessment is one of the main areas where technology can either strengthen instructional decision-making or create additional workload and inequity when implementation conditions are weak.

The use of digital tools and resources is closely connected to issues of access, infrastructure, and teacher readiness. In the Philippine context, the Department of Education has promoted technology-supported learning through policies such as the Basic Education Learning Continuity Plan and the Basic Education Development Plan



2030, both of which emphasize learning continuity, resilience, digitalization, and improved learning delivery (Department of Education [DepEd], 2020, 2022). However, national policy does not automatically translate into uniform school-level implementation. Espinosa et al. (2023) observed that Philippine educational technology initiatives continue to be shaped by unequal access to connectivity, digital resources, teacher training, and implementation capacity. This directly connects to the present study, which examines selected public elementary schools in the Surigao City Division, where teachers' experiences may reflect the continuing tension between digital policy expectations and school-level realities.

Teacher engagement is central to sustaining technology integration because teachers are the primary agents who translate policy, resources, and training into classroom practice. Engagement is commonly understood as multidimensional, consisting of cognitive, behavioral, and emotional components (Fredricks et al., 2004). In the context of technology integration, cognitive engagement refers to teachers' mental investment in learning, planning, and problem-solving with digital tools. Behavioral engagement refers to active participation in professional development, collaboration, and consistent use of technology-enhanced strategies. Emotional engagement refers to confidence, motivation, satisfaction, and reduced anxiety in using digital tools. Howard et al. (2021) found that teachers' readiness for online teaching is shaped not only by technical ability but also by professional beliefs, confidence, and perceived support. This literature supports the present study's treatment of teacher engagement as a major outcome of technology integration rather than as a peripheral variable.

The relationship between technology integration and teacher engagement is especially important because digital initiatives often fail when teachers experience technology use as compliance rather than meaningful professional practice. Scherer et al. (2021) argued that teachers' readiness for online teaching varies according to competence, attitudes, and contextual factors. Similarly, studies on digital competence show that teachers may feel generally capable of using technology but may still need support in adapting digital resources for meaningful pedagogical integration (Loureiro et al., 2024). These findings suggest that technology integration may strengthen engagement when teachers perceive digital tools as useful, manageable, and instructionally valuable. Conversely, it may weaken engagement when it increases workload, anxiety, or frustration. The present study addresses this issue by testing the relationship between technology integration and teacher engagement while also gathering qualitative data on the challenges that explain teachers' engagement levels.

Contextual barriers remain a recurring theme in technology integration literature. Infrastructure limitations, insufficient devices, unstable connectivity, inadequate training, limited technical support, and workload pressures can reduce the effectiveness of digital implementation. Atabek (2019) found that obstacles to technology integration are not limited to hardware; they also include insufficient training, content support, incentive systems, and psychological barriers. More recent studies similarly emphasize that access, leadership, and local context affect how teachers integrate technology in practice (Carpenter et al., 2024). These findings are directly relevant to the present study's qualitative component, which examines technological infrastructure limitations, teacher digital competence constraints, instructional preparation and time constraints, and student digital access and readiness challenges. By including these contextual inputs, the study moves beyond purely statistical measurement and provides a fuller explanation of why technology integration may or may not translate into teacher engagement.

Digital leadership has emerged as a necessary condition for sustaining technology integration. School leaders influence technology use by shaping vision, allocating resources, supporting professional development, building collaborative cultures, and reducing implementation barriers. AlAjmi (2022) found that principals' digital leadership significantly influenced teachers' technology integration during the COVID-19 pandemic. This finding suggests that school leadership is not merely administrative but instructional and transformational in digital environments. In addition, Wahid and Zulkifli (2024) reported that digital leadership supports teachers' innovation skills, particularly when mediated by professional learning communities. These studies indicate that technology integration is more sustainable when leaders support both the technical and human dimensions of digital change.



The synthesis of literature reveals that technology integration, teacher engagement, and digital leadership are interdependent rather than separate concerns. Technology integration provides the instructional mechanism; teacher engagement determines the depth and sustainability of implementation; and digital leadership creates the organizational conditions needed for continued improvement. However, existing studies often examine these constructs separately. Many studies focus on teachers' digital competence, technology access, or leadership practices, but fewer studies examine how technology integration across instructional planning, classroom delivery, assessment, and digital resource use relates to teachers' cognitive, behavioral, and emotional engagement. Moreover, there remains limited localized evidence from Philippine public elementary schools, particularly in division-level contexts where infrastructure, teacher readiness, and school leadership support vary.

The present study responds to these gaps by examining the implementation of technology integration and teacher engagement as foundations for a digital leadership framework in selected public elementary schools in the Surigao City Division. By integrating quantitative measurement with qualitative explanation, the study contributes context-specific evidence on how technology integration is implemented, how teachers engage with digital practices, what barriers shape implementation, and what leadership framework may guide more sustainable and equitable technology-supported instruction.

3. Methodology

This study employed a sequential explanatory mixed-methods design to examine the implementation of technology integration and teacher engagement as foundations for developing a digital leadership framework. The quantitative phase was conducted first to determine the extent of technology integration implementation, the level of teacher engagement, and the relationship between the two variables. The qualitative phase followed to explain, clarify, and deepen the quantitative results by exploring teachers' experiences and challenges in implementing technology-supported instruction. This design was appropriate because the study required both statistical evidence and contextual explanation to understand how technology integration relates to teacher engagement in public elementary schools.

The study was conducted among selected public elementary schools in the Surigao City Division. The population consisted of 362 elementary teachers who were directly involved in instructional planning, classroom delivery, assessment practices, and the use of digital tools and resources. For the quantitative phase, 265 teachers were selected using stratified random sampling to ensure proportional representation across the participating schools. The sample was distributed as follows: MEMCES, 23; Surigao City Pilot School, 67; Surigao West Central Elementary School, 44; CV Diez Memorial Central Elementary School, 40; Surigao City Central Elementary School, 30; B. Vazques Central Elementary School, 15; IPIL Elementary School, 11; Catadman Elementary School, 3; Canlanipa Central Elementary School, 13; and MAT-I Central Elementary School, 19. For the qualitative phase, selected teacher-participants were chosen purposively from the survey respondents to provide detailed explanations of the quantitative findings and describe the challenges encountered in technology integration.

The main quantitative instrument was a researcher-developed questionnaire designed to measure the implementation of technology integration and teacher engagement. The instrument was structured according to the variables and objectives of the study. The first part measured the extent of technology integration in terms of instructional planning, classroom delivery, assessment practices, and use of digital tools and resources. The second part measured teacher engagement in terms of cognitive, behavioral, and emotional engagement. The questionnaire used a five-point Likert scale to quantify teachers' perceptions and experiences. Prior to the actual administration, the instrument underwent content validation by experts in educational leadership, educational technology, and research. Their comments and suggestions were incorporated to improve the clarity, relevance, and alignment of the items with the research objectives.

Reliability testing was conducted through pilot testing with 15 respondents. The pilot-test data were analyzed using Cronbach's alpha through IBM SPSS Statistics Version 30. The reliability coefficient for the first part of the



instrument, which measured the extent of technology integration implementation, was 0.839, indicating strong internal consistency. The second part, which measured teacher engagement, obtained a Cronbach's alpha of 0.872, also indicating strong internal consistency. Since both values exceeded the acceptable threshold of 0.70, the questionnaire was considered reliable and suitable for actual data collection.

For the qualitative phase, a semi-structured interview guide was used to gather in-depth responses from selected participants. The guide contained open-ended questions aligned with the study's major constructs, particularly technology integration, teacher engagement, and implementation challenges. The interviews explored teachers' experiences in using digital tools for planning, instruction, assessment, and classroom engagement, as well as the contextual issues that affected their participation in technology-supported teaching. The semi-structured format allowed the researcher to ask common guiding questions while also giving participants the opportunity to elaborate on their views and experiences.

Data gathering followed the sequence required by the research design. Before data collection, formal permission was secured from the Surigao City Schools Division Office and from the heads of the selected public elementary schools. After approval, the researcher administered the survey questionnaire to the identified teacher-respondents through printed or online formats, depending on accessibility and school conditions. After the quantitative data were collected and reviewed, the qualitative phase was conducted through semi-structured interviews with selected participants. The interview responses were recorded, transcribed, organized, and analyzed to identify recurring ideas and themes that explained the quantitative results.

Ethical standards were observed throughout the study. Participation was voluntary, and informed consent was obtained from all respondents before data collection. The participants were informed of the purpose, scope, procedures, potential benefits, and their right to withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained by using codes or pseudonyms instead of real names. All data were treated with discretion and used only for academic and professional purposes. The study also ensured that the findings would not be used to evaluate or penalize individual teachers but to generate evidence for improving technology integration and digital leadership support.

Quantitative data were analyzed using descriptive and inferential statistics. Means and standard deviations were computed to describe the extent of technology integration implementation and the level of teacher engagement. Pearson product-moment correlation was used to determine the strength and direction of the relationship between technology integration and teacher engagement. Multiple linear regression analysis was used to determine which dimensions of technology integration significantly predicted teacher engagement when considered simultaneously. Regression diagnostics, including residual analysis and normality checks, were conducted to assess the adequacy of the regression model.

Qualitative data were analyzed using thematic analysis. The researcher first familiarized herself with the interview transcripts, then generated initial codes from significant statements. Similar codes were grouped into categories and refined into themes that represented the major challenges and contextual explanations related to technology integration and teacher engagement. The qualitative findings were integrated with the quantitative results to explain patterns in the data and provide a stronger basis for developing the proposed digital leadership framework.



4. Results

Quantitative Results

Extent of Technology Integration

Table 1
Summary of Technology Integration among Elementary Teachers

Dimension of Technology Integration	Mean	Standard Deviation	Verbal Description
Instructional Planning	4.7430	0.26989	Strongly Integrated
Classroom Delivery	4.8204	0.20385	Strongly Integrated
Assessment Practices	4.8196	0.20577	Strongly Integrated
Use of Digital Tools and Resources	4.7917	0.23630	Strongly Integrated
Grand Mean	4.7937	0.16187	Strongly Integrated

The results in Table 1 indicate that technology integration was strongly implemented among elementary teachers, as shown by the grand mean of 4.7937. Among the four domains, classroom delivery obtained the highest mean of 4.8204, followed closely by assessment practices with a mean of 4.8196. This suggests that teachers most actively integrated technology during actual instruction and assessment-related activities. The findings indicate that digital tools were not merely used as supplementary materials but were embedded in lesson delivery, student engagement, feedback, and learning monitoring. Instructional planning and the use of digital tools and resources were also strongly integrated, suggesting that teachers intentionally selected and aligned digital resources with instructional objectives, curriculum standards, and learners' needs.

Level of Teacher Engagement

Table 2
Summary of the Level of Teacher Engagement

Dimension of Teacher Engagement	Mean	Standard Deviation	Verbal Description
Learning Motivation	4.8445	0.19535	Highly Engaged
Active Participation	4.8174	0.18133	Highly Engaged
Learning Autonomy and Responsibility	4.8053	0.27159	Highly Engaged
Emotional Disposition toward Digital Learning	4.9638	0.09794	Highly Engaged
Grand Mean	4.8577	0.12404	Highly Engaged

The results in Table 2 show that teachers were highly engaged in technology-supported instruction, as reflected in the grand mean of 4.8577. Emotional disposition toward digital learning obtained the highest mean of 4.9638, indicating that teachers generally felt confident, comfortable, satisfied, and emotionally prepared in using digital tools. Learning motivation also obtained a high mean of 4.8445, suggesting that technology integration encouraged teachers to improve their instructional practices and explore new digital teaching strategies. Active participation and learning autonomy were likewise highly rated, indicating that teachers were not only willing to use digital tools but were also actively involved in professional learning, collaboration, and self-directed improvement. Overall, the findings suggest that technology integration was associated with strong cognitive, behavioral, and emotional engagement among teachers.



Relationship between Technology Integration and Teacher Engagement

Table 3

Relationship between Technology Integration and Teacher Engagement

Technology Integration Domain	Relationship with Teacher Engagement	Interpretation
Instructional Planning	Significant at $p < .001$	Positive relationship
Classroom Delivery	Significant at $p < .001$	Strongest positive relationship
Assessment Practices	Significant at $p < .001$	Positive relationship
Use of Digital Tools and Resources	$r = 0.546, p < .001$	Moderate positive relationship

The results in Table 3 indicate that higher levels of technology integration were associated with higher levels of teacher engagement. Classroom delivery emerged as the strongest relational domain, suggesting that teachers' engagement is most influenced when technology is actively used in the teaching-learning process rather than only during planning or preparation. The significant positive relationship between use of digital tools and teacher engagement also indicates that access to and purposeful use of digital resources can support teachers' motivation, participation, and innovation. Therefore, the null hypothesis stating that there is no significant relationship between technology integration and teacher engagement was rejected.

Table 4

Regression Model Summary for Technology Integration and Teacher Engagement

Model	R	R ²	Adjusted R ²	Standard Error of the Estimate	F Change	Sig.
1	0.672	0.452	0.444	0.09253	53.607	< .001

The regression model in Table 4 was statistically significant, $F(4, 260) = 53.607, p < .001$. The R^2 value of 0.452 indicates that technology integration explained 45.2% of the variance in teacher engagement. This shows that the combined dimensions of technology integration substantially contributed to teachers' engagement in digital instruction. The adjusted R^2 of 0.444 further indicates that the model remained stable after accounting for the number of predictors.

Table 5

Regression Coefficients for Predictors of Teacher Engagement

Predictor	B	Standard Error	Beta	t	Sig.
Constant	2.734	0.170	—	16.122	< .001
Instructional Planning / Curriculum	0.075	0.022	0.164	3.381	< .001
Classroom Delivery / Learning Delivery	0.372	0.052	0.611	7.114	< .001
Assessment Practices / Educational Assessment	-0.046	0.035	-0.077	-1.313	0.190
Use of Digital Tools and Resources / Collaboration	0.041	0.040	0.079	1.036	0.301

The regression coefficients in Table 5 show that classroom delivery was the strongest significant predictor of teacher engagement, $\beta = 0.611, p < .001$. This indicates that the actual use of technology during instruction had the greatest influence on teachers' engagement. Instructional planning also significantly predicted teacher engagement, $\beta = 0.164, p < .001$, although its predictive strength was lower than classroom delivery. In contrast, assessment practices and use of digital tools and resources did not independently predict teacher engagement when all predictors were entered into the model. These findings suggest that technology integration becomes most influential when it is translated into actual teaching practice and supported by purposeful planning.



Qualitative Findings

The qualitative findings were analyzed through thematic analysis. Interview data from selected teacher-participants were used to explain and contextualize the quantitative results. Four major themes emerged: technological infrastructure limitations, varying levels of digital competence, time constraints in digital lesson preparation, and student-related digital challenges.

Table 6
Qualitative Themes on Challenges Encountered in Technology Integration

Theme	Subthemes	Interpretation
Technological Infrastructure Limitations	Slow or unstable internet connection; limited digital devices; lack of technical support	Teachers experienced difficulty delivering digital lessons when internet access, devices, or technical support were inadequate.
Varying Levels of Digital Competence	Need for professional training; limited knowledge of advanced tools	Teachers differed in their ability to use digital platforms, indicating the need for continuous and differentiated professional development.
Time Constraints in Digital Lesson Preparation	Time-consuming digital lesson design; preparation of interactive materials	Teachers reported that technology-enhanced lessons required more preparation time than traditional lessons.
Student-Related Digital Challenges	Unequal access to devices and internet; varying student digital literacy; distractions during digital activities	Students' readiness and access influenced the effectiveness of technology-supported instruction.

As shown in Table 6, the first theme, technological infrastructure limitations, explains why strong teacher engagement does not always result in seamless technology implementation. Teachers reported that slow internet connectivity, lack of devices, and limited technical support disrupted technology-based activities. These infrastructure concerns limited the full participation of students and required teachers to troubleshoot technical problems independently. Thus, even when teachers were motivated and competent, external technical barriers constrained the quality and continuity of digital instruction.

The second theme, varying levels of digital competence, highlights the unevenness of teachers' skills in using technology. Some teachers were able to use basic digital tools, while others found advanced platforms more challenging. This finding explains why technology integration may be strongly implemented overall but still requires continuous professional development. Teacher engagement is strengthened when teachers feel competent, but it may weaken when they experience uncertainty or difficulty in using unfamiliar tools.

The third theme, time constraints in digital lesson preparation, shows that technology integration adds preparation demands to teachers' workload. Participants indicated that preparing digital lessons, selecting appropriate tools, developing multimedia materials, and designing interactive activities required more time than conventional lesson preparation. This finding provides important context for the quantitative results: although teachers were highly engaged, sustaining such engagement requires institutional support, planning time, and collaborative preparation structures.

The fourth theme, student-related digital challenges, points to learner-side barriers that affect technology integration. Teachers observed that students differed in digital literacy, access to devices, internet availability, and ability to remain focused during digital activities. These challenges suggest that technology integration is not solely dependent on teacher readiness. It also requires attention to student access, digital equity, and readiness for technology-supported learning.

The qualitative findings support and deepen the quantitative findings. While the survey results show that technology integration was strongly implemented and that teacher engagement was high, the interview data reveal the contextual barriers that may affect the sustainability of implementation. Taken together, the quantitative and qualitative findings indicate that digital leadership should focus on strengthening classroom-based technology use, supporting instructional planning, improving infrastructure, providing continuous professional development, reducing preparation burdens, and addressing student access and readiness. These integrated findings serve as the empirical basis for the proposed digital leadership framework.

5. Integrated Results and Findings

The integration of quantitative and qualitative findings provides a more comprehensive understanding of how technology integration and teacher engagement function as foundations for a digital leadership framework. The quantitative results showed that technology integration was strongly implemented across instructional planning, classroom delivery, assessment practices, and the use of digital tools and resources. Among these domains, classroom delivery obtained the highest rating, followed closely by assessment practices, indicating that teachers were able to apply digital tools most visibly during actual instruction and learning evaluation. These results suggest that technology integration in the participating public elementary schools was not limited to the availability or use of digital devices but was reflected in teachers' instructional actions, classroom facilitation, and assessment-related practices.

The qualitative findings, however, provided a necessary contextual explanation for these high quantitative ratings. Although teachers reported strong implementation, their interview responses revealed that implementation was still affected by technological infrastructure limitations, uneven access to devices, unstable internet connectivity, and limited technical support. This means that while teachers demonstrated strong willingness and ability to use technology, the consistency and quality of implementation remained dependent on school-level resources and external conditions. Thus, the integrated finding shows that technology integration was strongly practiced but not uniformly supported by infrastructure. This highlights the need for digital leadership that addresses both instructional use and enabling conditions.

The quantitative results also revealed a high level of teacher engagement across cognitive, behavioral, and emotional dimensions. Teachers showed strong motivation, active participation, autonomy, responsibility, and positive emotional disposition toward digital learning. This indicates that teachers were generally willing to learn, adapt, collaborate, and sustain technology-supported teaching practices. The high engagement scores suggest that technology integration may have strengthened teachers' professional involvement by encouraging them to explore digital strategies, participate in instructional innovation, and improve their teaching practices.

The qualitative findings deepened this result by showing that teacher engagement was shaped by both confidence and challenge. Teachers expressed willingness to integrate technology, but they also encountered constraints related to varying levels of digital competence, preparation time, workload demands, and student readiness. Some teachers were confident in using basic platforms but required further support in using more advanced digital tools for interactive instruction, assessment, and learner monitoring. This indicates that engagement was present, but it required continuous professional development and differentiated technical assistance. The integrated finding therefore suggests that teacher engagement is strengthened when teachers perceive technology as useful and manageable, but it may be weakened when technology use increases anxiety, workload, or uncertainty.

The correlation results demonstrated a significant positive relationship between technology integration and teacher engagement. This means that higher levels of technology integration were associated with higher levels of teacher engagement. Classroom delivery appeared to be the strongest relational domain, implying that teacher engagement is most strongly activated when technology is used directly in the teaching-learning process. When digital tools are meaningfully used to present lessons, facilitate interaction, encourage participation, and support learning tasks, teachers become more cognitively, behaviorally, and emotionally engaged. This finding confirms



that engagement is not only an internal teacher attribute but also a professional response to meaningful instructional practice.

The regression results further showed that technology integration significantly predicted teacher engagement, explaining a substantial proportion of the variance in engagement. Classroom delivery emerged as the strongest significant predictor, while instructional planning also contributed significantly. This indicates that teacher engagement is most strongly influenced when technology integration moves from planning to actual classroom implementation. Assessment practices and use of digital tools and resources were positively related to engagement but did not independently predict engagement when all dimensions were considered together. This suggests that digital tools and assessments become more influential when embedded in coherent lesson delivery rather than used as isolated technical activities.

The qualitative findings clarified why classroom delivery emerged as the strongest predictor. Teachers' narratives showed that digital instruction directly affected their interaction with learners, their sense of instructional effectiveness, and their motivation to improve teaching practice. However, classroom delivery was also the area most vulnerable to technical disruptions, student access problems, and varying digital readiness. These findings indicate that classroom-based technology use is both the strongest driver of teacher engagement and the area requiring the most leadership support. Effective digital leadership must therefore prioritize classroom-level implementation by ensuring access to tools, technical assistance, training, and realistic workload arrangements.

The integrated findings also showed that student-related digital challenges influenced the effectiveness of technology integration. Teachers reported that some learners had limited access to devices, weak internet connectivity, insufficient digital literacy, or difficulty maintaining attention during technology-supported activities. These learner-side barriers affected teachers' ability to sustain digital instruction and contributed to additional instructional adjustments. This finding suggests that teacher engagement cannot be separated from student digital readiness. A digital leadership framework must therefore include strategies for learner access, digital literacy support, and inclusive technology use.

Overall, the integrated results indicate that technology integration and teacher engagement are mutually reinforcing. Strong implementation of technology integration supports teacher engagement by encouraging motivation, participation, innovation, and professional commitment. At the same time, engaged teachers are more likely to sustain technology integration despite contextual challenges. However, this relationship depends on enabling conditions such as infrastructure, professional development, leadership support, preparation time, and student access. The mixed-methods findings therefore provide a strong empirical basis for developing a digital leadership framework that is responsive to instructional realities, teacher needs, and contextual barriers in public elementary schools.

Based on the integration of quantitative and qualitative results, the proposed digital leadership framework should focus on five major areas: strengthening instructional technology integration, sustaining teacher engagement, improving infrastructure and technical support, institutionalizing continuous professional development, and addressing student access and readiness. These areas reflect the combined evidence that technology integration becomes sustainable only when school leaders support both the technical and human dimensions of digital transformation.

6. Conclusion and Recommendations

The study concludes that technology integration was strongly implemented among elementary teachers in selected public schools in the Surigao City Division and was significantly associated with teacher engagement. The findings show that teachers were highly engaged cognitively, behaviorally, and emotionally when technology was meaningfully integrated into instructional planning, classroom delivery, assessment practices, and the use of digital tools and resources. Among the domains of technology integration, classroom delivery emerged as the strongest



contributor to teacher engagement, indicating that digital implementation becomes most influential when it directly supports teaching-learning interaction. However, the qualitative findings revealed that strong implementation and high engagement were still affected by infrastructure limitations, varying levels of teacher digital competence, time constraints, and student access and readiness issues. Therefore, technology integration and teacher engagement should be understood as interdependent foundations for digital leadership, requiring school leaders to provide instructional guidance, professional development, technical support, and equitable digital learning conditions.

Based on the findings, it is recommended that school leaders institutionalize a digital leadership framework that strengthens technology integration while sustaining teacher engagement. School administrators should prioritize reliable infrastructure, adequate digital tools, technical assistance, and scheduled time for technology-enhanced lesson preparation. Continuous professional development should be provided to address differences in teachers' digital competence, with emphasis on pedagogically meaningful use of technology in lesson delivery, assessment, collaboration, and learner support. Teachers should also be encouraged to participate in peer mentoring, professional learning communities, and reflective practice to sustain cognitive, behavioral, and emotional engagement in digital instruction. At the policy and division levels, support mechanisms should address student digital access, connectivity gaps, and readiness for technology-supported learning. Future researchers may validate and test the proposed digital leadership framework in other school divisions, grade levels, and educational contexts to determine its broader applicability and effectiveness.

Declarations

Ethics Approval and Consent to Participate

This study observed the ethical standards required for research involving human participants. Permission to conduct the study was secured from the appropriate school authorities, and informed consent was obtained from the teacher-participants before data collection. Participation was voluntary, and respondents were informed of the purpose of the study, the procedures involved, their right to withdraw, and the confidentiality of their responses.

Consent for Publication

The authors give consent for the publication of this manuscript in the journal. No personally identifiable information of the respondents is disclosed in the article.

Availability of Data and Materials

The data used in this study are available from the corresponding author upon reasonable request, subject to institutional approval, ethical restrictions, and confidentiality requirements.

Competing Interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any public, commercial, or not-for-profit funding agency.

Authors' Contributions

Grace Dumanjog Nahial served as the principal researcher and was responsible for the original dissertation study, data gathering, analysis, and initial interpretation of findings. Don Anton R. Balida, PhD contributed to the conceptual refinement, manuscript development, scholarly restructuring, and preparation of the article for journal publication. Both authors reviewed and approved the final manuscript.

Acknowledgments

The authors acknowledge the support of the Schools Division of Surigao City, the participating public elementary schools, the teacher-respondents, and all individuals who contributed to the completion of the study.



Conflict of Interest Statement

The authors declare that there is no conflict of interest related to the conduct, authorship, or publication of this study.

Originality Statement

The authors affirm that this manuscript is original, has not been published elsewhere, and is not under consideration for publication in another journal. Proper acknowledgment has been given to all sources used in the study.

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