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Technological Knowledge, Integration Practices, and Challenges of Primary School Teachers in Zone III, Division of Catanduanes: Insights from the TPACK Framework

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Abstract

This quantitative descriptive-correlational study, anchored from the Technological Pedagogical Content Knowledge (TPACK) Framework and Activity Theory, investigated the proficiency, integration behaviors, and contextual constraints faced by primary school teachers in Zone III, Division of Catanduanes. The central aim was to establish the level of Technological Knowledge, describe Integration Practices, and identify major Challenges of the primary school teachers to inform a strategic action plan. Utilizing stratified random sampling, data were collected from 122 teachers (out of N=176) via a validated survey instrument. Findings revealed that primary school teachers possess a Very High level of Technological Knowledge (Overall Weighted Mean [OWM]=3.68), with Technological Pedagogical Knowledge (OWM=3.76) ranking highest. Correspondingly, teachers demonstrated a high level of technology integration practices (OWM=3.53), showing the strongest application in lesson planning (OWM=3.76). However, the Use of Technology for Assessment and Evaluation (OWM=3.20) indicated the most significant area for improvement. The correlation analysis confirmed significant positive relationships across all variables: Technological Knowledge and Practices (r=0.934), Knowledge and Challenges (r=0.657), and Practices and Challenges (r=0.882). While the overall perception of Challenges was rated as Less Serious (WM=2.39), Technological Infrastructure and Accessibility was identified as the most pressing hindrance (WM=2.52). The results affirm the high technological readiness of the teaching workforce but underscore the critical need for systemic support. The study concludes with a proposed Strategic Action Plan targeting infrastructure upgrade and sustained TPACK-focused professional development to bridge the gap between high competency and the full realization of integration potential within this specific educational context.

Keywords: Technological Pedagogical Content Knowledge (TPACK), Technology Integration Practices, Primary School Teachers, Educational Challenges, Catanduanes Division (Zone III)

INTRODUCTION

In today's increasingly digital educational environment, the capacity of teachers to integrate technology effectively into instruction has become a critical component of professional practice (Paidican & Arredondo, 2022). This integration is essential for preparing students with the 21st-century skills necessary for a globally competitive and technologically advanced world (OECD, 2018). The Technological Pedagogical Content Knowledge (TPACK) Framework offers a robust lens for analyzing how teachers' technological knowledge (TK), pedagogical strategies (PK), and content knowledge (CK) intersect to support meaningful technology-enhanced learning (Mishra & Koehler, 2006; Abunda, 2020).

In the Philippines, the national drive toward 21st-century learning outcomes places greater demands on primary school teachers to adopt

technology integration practices that align with national standards and evolving curriculum expectations (Gonzales, 2021). This imperative requires teachers to move beyond mere tool usage to sophisticated integration that transforms pedagogy and assessment (Tirri, 2021). However, this ambitious goal faces persistent, often structural challenges, particularly in rural and resource-constrained contexts. Studies reveal significant hurdles, including infrastructural deficits, limited professional development opportunities, and sociocultural barriers that hinder effective technology use (Gou et al., 2024; Wang et al., 2025). For instance, issues like unreliable internet access and limited access to updated hardware fundamentally constrain the application of TPACK knowledge in daily classroom routines (Sweeney et al., 2020).

Teachers' knowledge of technology, pedagogical approaches, and content must therefore be investigated in concert with actual practices and the encountered obstacles (Dierendonck et al., 2024). Research consistently indicates that high awareness of TPACK alone does not guarantee consistent technology integration; institutional support, contextual factors, and basic infrastructure also play decisive roles (Plantado, 2020; Dabbagh et al., 2020). Accordingly, this study focuses on primary teachers in Zone III, Division of Catanduanes—a geographically specific rural setting—examining their levels of technological knowledge (TCK, TPK and TK), their actual practices in lesson-planning, instructional delivery, and assessment, and the challenges they face related to infrastructure, competencies, and institutional support. Building on the TPACK framework, this research explicitly explored: (1) how technological knowledge translates into instructional practice, (2) how contextual and infrastructural challenges constrain that translation, and (3) the interrelationships among knowledge, practice, and challenge. The outcomes are intended to inform a targeted action plan to strengthen teachers' technological integration capacity and professional development within this specific educational context.

Statement of the Problem. This study was aimed to examine the technological knowledge, integration practices, and challenges faced by primary school teachers in Zone III, Division of Catanduanes, Philippines, grounded in the TPACK framework. Specifically, it sought to address the following research questions:

1. What is the level of technological knowledge of primary school teachers in Zone III, Division of Catanduanes in terms of:
   1.1 Technological Content Knowledge (TCK);
   1.2 Technological Pedagogical Knowledge (TPK); and,
   1.3 Technological Knowledge (TK)?

2. What are the technological integration practices of primary school teachers in Zone III, Division of Catanduanes regarding:
   2.1 Technology integration in lesson planning;
   2.2 Technology utilization in instructional delivery; and,
   2.3 Technology application in student assessment and evaluation?

3. What challenges do primary school teachers in Zone III, Division of Catanduanes encounter in terms of:
   3.1 Technological infrastructure and accessibility;
   3.2 Technological competency and professional skill development; and,
   3.3 Institutional support and opportunities for professional growth?

4. Is there a significant relationship between the technological knowledge of primary school teachers and their technological integration practices?

5. Is there a significant relationship between the technological knowledge of teachers and the challenges they encounter in integrating technology into teaching and learning?

6. Is there a significant relationship between teachers' technological integration practices and the challenges they face in implementing educational technology?

7. Based on the challenges identified, what strategic action plan can be proposed to enhance the technological knowledge, integration practices, and professional competencies of primary school teachers?

Hypotheses. At 0.05 level of significance, the following null hypotheses were tested:

H_{01}. There is no significant relationship between the technological knowledge of primary school teachers and their technological integration practices.

H_{02}. There is no significant relationship between the technological knowledge and the challenges encountered by primary teachers.

H_{03}. There is no significant relationship between the technological practices and the challenges encountered by primary teachers.

Scope of the Study. This study examines the TPACK-based technological knowledge (TCK, TPK, TK), technology integration practices (planning, delivery, assessment), and challenges (infrastructure, competency, support) of all primary school teachers in Zone III, Division of Catanduanes during the 2025-2026 school year. It establishes the relationships between these variables and proposes a Strategic Action Plan based on the findings. The study is delimited to this specific geographic area and teacher demographic.

Theoretical/Conceptual Framework. This study was anchored from the Technological Pedagogical Content Knowledge (TPACK) model and Activity Theory (AT) frameworks structured using the Input-Process-Output (IPO) paradigm.

The TPACK framework serves as the primary theoretical construct, defining the core teacher competencies—Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK)—and their crucial intersections (Abunda, 2020; Dierendonck et al., 2024). This directly informs the measurement of teachers' knowledge and technological integration practices (Research Questions [RQs] 1 & 2). The Activity Theory (AT) acts as the contextual anchor, interpreting technology integration as a systemic human activity (Gou et al., 2024; Wang et al., 2025).

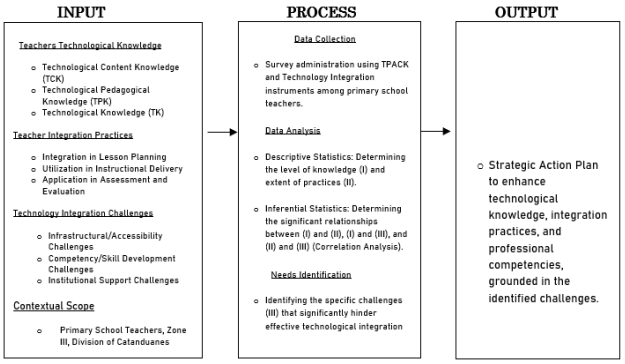

Figure 1
The Conceptual Paradigm of the Study

AT's strength lies in explaining the inevitable contradictions within the teaching system—such as the conflict between curriculum demands (Rules) and infrastructural deficits (Tools) in rural Catanduanes. This robust mechanism is essential for analyzing the challenges and their constraints on TPACK implementation (RQ 3). Conceptually, the IPO model synthesizes these theories: TPACK knowledge and integration challenges. These form the Input variables. The Process involves statistical analysis to determine the relationships between knowledge, practices, and challenges. The Output yields a data-driven Strategic Action Plan to enhance teacher competencies. This dual theoretical and conceptual approach ensures the study is both methodologically sound and contextually relevant.

LITERATURES

The contemporary landscape of education requires primary school teachers to move beyond passive technology use and instead function as designers of digitally enriched learning environments. This shift situates the present study within the Technological Pedagogical Content Knowledge (TPACK) framework—an established benchmark for 21st-century teacher competence (Mishra & Koehler, 2006; Voogt et al., 2020). TPACK

conceptualizes effective technology integration as the convergence of Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), together with their intersections—TCK and TPK—which shape teachers' instructional decision-making (Dabbagh et al., 2020; Khasawneh et al., 2021; Aksoy & Baskan, 2024). Recent studies affirm TPACK's utility as a diagnostic model for assessing teacher preparedness across diverse and rapidly evolving digital contexts (Dierendonck et al., 2024; Abunda, 2020; Ahmad & Mansor, 2021; Koh & Ching, 2024; Yurdakul et al., 2021; Guzey et al., 2022).

Despite broad recognition of TPACK's relevance, literature reveals a persistent gap between teachers' conceptual knowledge and their classroom-level technology integration. High levels of TK, TPK, and TCK do not necessarily result in transformative practices, with many teachers' applying technology in basic or substitution-level ways rather than using it to support innovative pedagogy (Chai et al., 2023; Scherer et al., 2021; Liu et al., 2021; Lü et al., 2020). This gap underscores the need to examine how teachers integrate technology across key instructional phases—planning, delivery, assessment, and evaluation—areas where inconsistencies remain evident (Abundis-Gutiérrez et al., 2023; Zhang et al., 2022; Tondeur et al., 2024; Deng et al., 2023). Determining whether technology use fosters genuine pedagogical improvement or merely replicates traditional methods is essential for evaluating the return on investment in school technology initiatives (Jang & Kim, 2024).

Knowledge–practice alignment is further shaped by contextual barriers. First-order barriers refer to external constraints such as lack of infrastructure, unreliable connectivity, and limited hardware access, while second-order barriers involve internal factors including teacher beliefs, self-efficacy, and institutional culture (Ertmer & Ottenbreit-Leftwich, 2010; Tshabalala & Mpungose, 2021; Ghavifekr & Roslan, 2020; Kopcha et al., 2021). Research in rural and developing contexts confirms that external, resource-related limitations often supersede teachers' willingness or capacity to implement their technological knowledge (Gou et al., 2024; Wang et al., 2025; Al-Fudail & Al-Sharji, 2020; Hew et al., 2020). Similarly, insufficient professional development opportunities, inadequate pedagogical coaching (Sun et al., 2020) and limited institutional pathways for continuous growth (Kim et al., 2022; Lü et al., 2020) hinder sustained technology integration.

The present investigation is further contextualized within Zone III of the Division of Catanduanes, an island locality with distinct socio-environmental characteristics that shape educational implementation. Previous studies indicate that teaching practices, policy enactment, and school-level innovations in Catanduanes are deeply influenced by local conditions (Cordial, 2025a), and that educational policy perceptions must account for community realities and institutional constraints (Cordial, 2025b). By examining the relationships among teachers' knowledge, their integration practices, and the contextual challenges unique to Catanduanes, the study advances evidence-based insights that move beyond generalized national trends. The ultimate aim is to translate these analytical results into a context-responsive Strategic Action Plan that enhances teachers' technological and pedagogical capacities while addressing distinct conditions of the island's primary schools (Cordial, 2025b).

METHODS

Research Design. This study employed a quantitative descriptive correlational research design, recognized as essential for initial explorations of complex educational phenomena (Deng et al., 2023). The design's descriptive component addresses RQs 1, 2, and 3 by systematically quantifying the levels of primary teachers' TPACK knowledge, integration practices, and contextual challenges in Catanduanes (Abundis-Gutiérrez et al., 2023). The correlational component, using statistical analysis, investigates the significant relationships among these key variables (RQs 4-6), establishing empirical evidence between

competency and practice mediated by external barriers (Scherer et al., 2021). Findings ultimately grounded the proposed strategic Action Plan (RQ 7), ensuring a data-driven approach to competency enhancement (Wang et al., 2025).

Population Samples and Sampling Technique. The methodological soundness of this quantitative study relies on a robust sampling procedure to ensure high external validity and accurate generalizability (Lee & Landers, 2022). The target population (N=176) is defined as all eligible respondents across the five distinct districts within Zone 3. Given the inherent differences in population size among these geographical areas, the optimal approach to achieve proportional representation and minimize sampling error is Stratified Random Sampling (SRS) combined with a Proportional Allocation strategy (Iqbal et al., 2024).

SRS is a probability sampling technique that mandates the partitioning of the heterogeneous overall population into non-overlapping, homogeneous strata—the five districts—to guarantee that all critical subgroups are represented (Rahman, 2023). This stratification enhances the precision of population parameter estimates compared to simple random sampling (Iqbal et al., 2024). The required overall sample size (n=122) from the known population (N=176) was first determined using Slovin's formula, a standard method for calculating sample size for finite populations (Andrade, 2020).

Table 1
Distribution of Population and Sample Respondents by District

Geographical Area (District) in Zone 3	Total Population (N)	Calculated Sample Size (n)
Bagamanoc North District	19	13
Bagamanoc South District	24	17
Panganiban District	41	28
Viga East District	33	23
Viga West District	59	41
GRAND TOTAL	**176**	**122**

Subsequently, the Proportional Allocation method was applied. This approach ensures that the number of sampled units selected from each district is directly proportional to that district's size in the total population (Rahman, 2023). For example, the largest district, Viga West (N=59), received the proportionally largest sample allocation (n=41), thus accurately preserving the demographic structure of the population in the final sample (Alsakkal et al., 2024). This rigorous, probability-based methodology ensures the sample maintains the same relative distribution as the population, thereby providing a strong foundation for the defensible generalization of findings to the entire Zone III area.

Instrumentation. Data for this study were gathered using a modified, researcher-developed survey questionnaire divided into three major sections aligned with the Technological Pedagogical Content Knowledge (TPACK) framework. The first section measured teachers' Technological Knowledge, assessing self-reported proficiency across the TPACK domains: Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Knowledge (TK). The second section examined Technological Integration Practices, focusing on the frequency and consistency of technology use in lesson planning, instructional delivery, and assessment. The third section identified Challenges Encountered, which were grouped into infrastructure and accessibility constraints, competency and skill development issues, and also with institutional support limitations.

Table 2
Scoring Continuum and Verbal Interpretation Scale

Assigned Point	Numerical Range (Mean Score)	Interpretation for Knowledge	Interpretation for Practices	Interpretation for Challenges
4	3.25 - 4.00	Very High (Strongly Agree)	Always (Strongly Agree)	Very Serious (Strongly Agree)
3	2.50 - 3.24	High (Agree)	Often (Agree)	Serious (Agree)
2	1.75 - 2.49	Low (Disagree)	Sometimes (Disagree)	Less Serious (Disagree)
1	1.00 - 1.74	Very Low (Strongly Agree)	Never (Strongly Agree)	Least Serious (Strongly Agree)

A uniform 4-point Likert scale (Table 2), ranging from 1.00–1.74 (Strongly Disagree/Very Low) to 3.25–4.00 (Strongly Agree/Very High), was applied across all items to ensure consistency

in measurement and comparability of responses. To establish content validity, the draft instrument underwent expert evaluation by four (4) panel specialists, who reviewed the clarity, relevance, and alignment of each item with the study objectives.

Following revisions, the questionnaire was pilot-tested with ten (10) non-respondents to determine its reliability. Using Pearson r, the instrument produced a reliability coefficient of 0.918, indicating high reliability and confirming the internal consistency, stability, and dependability of the tool for the main data collection.

Data Analysis. For the descriptive component addressing the levels of TPACK knowledge, integration practices, and challenges (RQs 1, 2, and 3), the weighted mean and standard deviation (SD) were the primary statistical measures. The weighted mean provided a robust measure of central tendency for the aggregate responses across the 4-point Likert scale, with scores systematically interpreted using the established continuum (Table 2). Critically, the mean scores for all items and sub-variables were subsequently empirically ranked to pinpoint specific areas of strength and to prioritize the most acute challenges faced by teachers. To test the hypotheses of significant relationships (RQs 4, 5, and 6), the Pearson Product-Moment Correlation Coefficient (r) was employed. This inferential test assessed the strength and statistical significance of the linear relationships, evaluated at $p < .05$. The rigorous ranking of challenges (RQ 3) directly informed the structure and priority of the final proposed strategic Action Plan (RQ 7).

Ethical Considerations. This study strictly adhered to core ethical principles to safeguard human participants. Prior to data collection, institutional ethics approval was secured. Voluntary informed consent was obtained from all primary teacher participants, ensuring they fully understood the study's purpose, their right to withdraw at any time without prejudice (Bhandari, 2022), and any potential minimal risks (Resnik, 2020). To ensure participant autonomy, a confidentiality and anonymity protocol was enforced (Scribbr, 2021). All collected survey data were de-identified, processed numerically, and stored on password-protected devices, preventing any personally identifiable information from being linked to the reported findings, thereby upholding research integrity and professional ethical standards (BERA, 2024).

RESULTS

The findings presented across Tables 3 to 8 collectively illustrate the technological proficiency, integration practices, and corresponding challenges experienced by primary school teachers in Zone III, Division of Catanduanes. The results offer critical insights into how technological knowledge translates into classroom application and how these processes are shaped by existing institutional and infrastructural conditions.

Level of technological knowledge of primary school teachers. The results in Table 3 indicate that primary school teachers in Zone III possess a very high level of technological knowledge (overall WM = 3.68).

Table 3
Summary Mean Distribution of the Level of Technological Knowledge Among Primary School Teachers in Zone III, Division of Catanduanes

Variable	Weighted Mean	Descriptive Interpretation	Rank
Technological Pedagogical Knowledge	3.76	Very High (Strongly Agree)	1
Technological Content Knowledge	3.73	Very High (Strongly Agree)	2
Technological Knowledge	3.56	Very High (Strongly Agree)	3
Overall Weighted Mean	**3.68**	**Very High (Strongly Agree)**	

Legend: 4.00–3.25 = Very High (Strongly Agree); 3.24–2.50 = High (Agree); 2.49–1.75 = Low (Disagree); 1.74–1.00 = Very Low (Strongly Disagree)

Among the dimensions assessed, technological pedagogical knowledge obtained the highest mean (3.76), suggesting teachers' strong ability to integrate digital tools effectively within

instructional contexts. This was followed by technological content knowledge (3.73), reflecting teachers' confidence in using technology to enhance subject-specific learning. Technological knowledge (3.56) ranked third but still demonstrated a very high rating, implying well-developed general digital proficiency. Collectively, these results reveal that teachers are technologically competent and well-prepared to facilitate 21st-century learning, aligning with global standards that promote technology-enhanced pedagogy in education.

Technological integration practices of the primary school teachers. The findings in Table 4 reveal that primary school teachers demonstrate a high level of technological integration in their teaching practices (overall WM = 3.53). Among the indicators, technology integration in lesson planning ranked first (WM = 3.76), showing that teachers consistently embed digital tools in instructional design. Technology utilization in teaching delivery followed (WM = 3.63), indicating frequent use of technology to enhance classroom engagement and instructional efficiency. Meanwhile, technology application in assessment and evaluation (WM = 3.20) was rated slightly lower, suggesting room for improvement in leveraging technology for learner assessment. Overall, these findings underscore teachers' strong commitment to digital transformation and the institutionalization of technology in daily pedagogical practices.

Table 4
Summary Mean Distribution of the Technological Integration Practices of Primary School Teachers in Zone III, Division of Catanduanes

Variable	Weighted Mean	Descriptive Interpretation	Rank
Technology Integration in Lesson Planning	3.76	Always (Strongly Agree)	1
Technology Utilization in Teaching Delivery	3.63	Always (Strongly Agree)	2
Technology Application in Assessment and Evaluation	3.20	Often (Agree)	3
Overall Weighted Mean	3.53	Always (Strongly Agree)	

Legend: 4.00–3.25 = Very High (Strongly Agree); 3.24–2.50 = High (Agree); 2.49–1.75 = Low (Disagree); 1.74–1.00 = Very Low (Strongly Disagree)

Challenges encountered by primary school teachers. The results in Table 5 indicate that the challenges encountered by teachers are generally less serious (overall WM = 2.39). Among the identified concerns, technological infrastructure and accessibility emerged as the most pressing issue (WM = 2.52), suggesting that connectivity limitations and inadequate digital resources hinder seamless technology integration. Meanwhile, technological competency and skills development (WM = 2.36) and institutional support and professional development opportunities (WM = 2.28) were perceived as less serious, implying that teachers possess satisfactory digital literacy and benefit from adequate institutional support. Overall, the results highlight a positive technological climate, despite residual infrastructural barriers.

Table 5
Summary of Challenges Encountered by Primary School Teachers in Zone III, Division of Catanduanes

Variable	Weighted Mean	Descriptive Interpretation	Rank
Technological Infrastructure and Accessibility	2.52	Serious (Agree)	1
Technological Competency and Skills Development	2.36	Less Serious (Disagree)	2
Institutional Support and Professional Development Opportunities	2.28	Less Serious (Disagree)	3
Overall Weighted Mean	2.39	Less Serious (Disagree)	

Legend: 4.00–3.25 = Very High (Strongly Agree); 3.24–2.50 = High (Agree); 2.49–1.75 = Low (Disagree); 1.74–1.00 = Very Low (Strongly Disagree)

Relationship between technological knowledge and technological integration practices of the primary school teachers. Table 6 reveals a strong positive correlation (r = 0.934) between technological knowledge and technological practices, exceeding the critical value (0.514) at 0.05 level of significance. This leads to the rejection of the null hypothesis, affirming a significant relationship between the two variables. The result suggests that teachers with higher levels of technological knowledge are more effective in integrating digital tools into instruction. This finding supports the TPACK model, which posits that teachers' integration of technology is contingent upon their mastery of interrelated knowledge domains.

Table 6
Pearson r Test Analysis Between Technological Knowledge and Technological Practices of Primary School Teachers in Zone III, Division of Catanduanes

Variables	Statistical Test	Computed Value (r)	Critical Value (α = 0.05)	Decision	Interpretation
Technological Knowledge of Primary Teachers and Their Technological Practices	Pearson *r*	0.934	0.514	Reject H_0	Significant Relationship

Relationship between technological knowledge of teachers and the challenges encountered in integrating technology into teaching and learning. Table 7 presents a moderate positive correlation (r = 0.657) between technological knowledge and the challenges encountered. Since the computed value surpasses the critical value (0.514), the null hypothesis is rejected, indicating a significant relationship. The finding implies that teachers with greater technological knowledge are more perceptive of the barriers and complexities associated with technology integration. Increased competence may enhance critical awareness of infrastructural and pedagogical constraints, emphasizing the need for sustained capacity building.

Table 7
Pearson r Test Analysis Between Technological Knowledge and Challenges Encountered by Primary School Teachers in Zone III, Division of Catanduanes

Variables	Statistical Test	Computed Value (r)	Critical Value (α = 0.05)	Decision	Interpretation
Technological Knowledge and Challenges Encountered by Primary Teachers	Pearson *r*	0.934	0.514	Reject H_0	Significant Relationship

Relationship between teachers' technological integration practices and the challenges faced in implementing educational technology. Finally, Table 8 reveals a strong positive correlation (r = 0.882) between technological practices and challenges encountered, exceeding the critical value at the 0.05 significance level. This finding suggests that as teachers engage more actively in technology-driven instruction, they also confront more tangible challenges, such as limited infrastructure, inadequate technical support, and insufficient training. The result highlights the dynamic interplay between adoption and constraint, calling for responsive institutional mechanisms that balance innovation with capacity enhancement.

Table 8
Pearson r Test Analysis Between Technological Integration Practices and Challenges Encountered by Primary Teachers in Zone III, Division of Catanduanes

Variables	Statistical Test	Computed Value (r)	Critical Value (α = 0.05)	Decision	Interpretation
Technological Practices and Challenges Encountered by Primary Teachers	Pearson *r*	0.934	0.514	Reject H_0	Significant Relationship

In synthesis, the results portray a teaching force that is technologically proficient, highly engaged in integrating technology into pedagogy, yet still constrained by infrastructural and institutional challenges. The significant relationships among technological knowledge, practice, and challenges affirm the need for a holistic approach to digital transformation in education—one that not only strengthens teacher competencies but also reinforces systemic and infrastructural support. This aligns with contemporary global education agendas advocating sustainable, inclusive, and resilient digital learning ecosystems in basic education.

Proposed Strategic Action Plan. Technological Knowledge Enhancement and Digital Integration Among Primary School Teachers in Zone III, Division Of Catanduanes

Vision: A digitally empowered teaching workforce in Zone III, Division of Catanduanes that effectively integrates technology to enhance learning outcomes, promote innovation, and ensure equitable access to 21st-century education.

Mission: To strengthen teachers' technological knowledge, integration practices, and digital resilience through sustained professional development, improved infrastructure, and institutional support systems fostering technology-driven pedagogy.

Objectives:

1. Enhance teachers' technological knowledge and pedagogical integration competencies.
2. Strengthen digital infrastructure and accessibility in primary schools.

3. Foster institutional support and continuous professional development in educational technology.

4. Address challenges encountered in technology integration through responsive strategies.

5. Institutionalize monitoring, evaluation, and policy alignment to sustain technology integration.

2020). Similarly, the high Technological Content Knowledge (3.73) underscores confidence in applying technology to enhance subject-specific learning (Dabbagh et al., 2020; Khasawneh et al., 2021; Aksoy & Baskan, 2024). These results align with studies confirming that TPACK competence predicts teacher adaptability and instructional quality in digital classrooms (Yurdakul et al., 2021; Guzey et al., 2022).

Table 9
Matrix of Proposed Technological Knowledge Enhancement and Digital Integration Program for Primary School Teachers in Zone III, Division Of Catanduanes

Objectives	Key Result Areas (KRAs)	Performance Indicators (PIs)	Strategies	Projects and Activities	Time Frame	Personnel Involved	Resources
Objective 1: Enhance teachers' technological knowledge and pedagogical integration competencies	Capacity building on TPACK and digital pedagogy	- Percentage of teachers trained in ICT integration- Improvement in post-training evaluation scores	Conduct comprehensive digital literacy and TPACK-based workshops	- Organize division-level ICT competency seminars- Implement school-based mentoring and peer-learning sessions	Annual	Schools Division Office (SDO), ICT Coordinators, School Heads	Training budget, ICT modules, digital tools
Objective 2: Strengthen digital infrastructure and accessibility	Improved ICT facilities and connectivity	- Number of schools with upgraded infrastructure- Teacher access to reliable internet and devices	Advocate and partner with LGUs and DepEd central office for infrastructure enhancement	- Procure digital equipment (e.g., laptops, projectors)- Upgrade internet connectivity in schools	1–3 years	DepEd Division Office, LGUs, School ICT Committees	DepEd funds, LGU support, public–private partnerships
Objective 3: Foster institutional support and continuous professional development	Enhanced institutional mechanisms for ICT support	- Number of active ICT support programs- Inclusion of ICT targets in School Improvement Plans (SIPs)	Institutionalize ICT development in performance and school planning systems	- Integrate ICT goals in SIPs- Conduct annual digital literacy assessments	Annual	School Heads, ICT Coordinators, HR Development	Institutional budget, training resources
Objective 4: Address challenges in technology integration	Minimized barriers to digital implementation	- Reduced teacher-reported challenges- Increased ICT integration across curriculum areas	Develop responsive feedback and support mechanisms	- Establish an ICT Help Desk and teacher feedback portal- Create a repository of digital teaching resources	Continuous	Division ICT Office, Teachers' Associations	ICT tools, feedback systems
Objective 5: Institutionalize monitoring, evaluation, and policy alignment	Sustained improvement and policy coherence	- Annual evaluation of ICT integration- Policy updates aligned with DepEd ICT frameworks	Establish a division-level monitoring and evaluation framework	- Conduct annual technology integration audits- Regular policy review and alignment with DepEd initiatives	Annual	Division Research Office, School Heads, ICT Committees	Evaluation tools, documentation system

DISCUSSION

The results in Table 3 reveal that primary school teachers in Zone III, Division of Catanduanes, demonstrate a very high level of technological knowledge (WM = 3.68), reflecting strong digital readiness for 21st-century instruction. The highest rating in Technological Pedagogical Knowledge (3.76) suggests teachers' capability to meaningfully integrate digital tools into instruction, consistent with the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Voogt et al.,

Field observations revealed that teachers actively design interactive lesson slides, use subject-specific simulations, and integrate multimedia resources to facilitate student engagement, reflecting practical application of their technological knowledge. However, literature cautions that theoretical mastery does not always ensure transformative pedagogical use, especially in contexts constrained by infrastructural and institutional limitations (Ertmer & Ottenbreit-Leftwich, 2010; Tshabalala & Mpungose, 2021; Gou et al., 2024). In Catanduanes, where connectivity and

resource challenges persist (Cordial, 2025a), these barriers may mediate knowledge-to-practice translation. Conclusively, while teachers exhibit commendable technological proficiency, strategic interventions are recommended—such as sustained professional development, enhanced ICT infrastructure, and context-sensitive policy support—to reinforce the translation of technological knowledge into innovative teaching practices and ensure sustainable digital transformation in primary education (Cordial, 2025b; Kim et al., 2022).

The findings in Table 4 demonstrate that primary school teachers in Zone III exhibit a high level of technological integration (WM = 3.53), reflecting the growing normalization of digital tools in pedagogical practice. The highest mean for technology integration in lesson planning (WM = 3.76) underscores teachers' proactive approach in embedding digital resources in instructional design—a key dimension of Technological Pedagogical Knowledge (TPK) within the TPACK framework (Mishra & Koehler, 2006; Voogt et al., 2020). Similarly, the high rating of technology utilization in teaching delivery (WM = 3.63) indicates effective classroom application of technology to enhance engagement, consistent with findings by Khasawneh et al. (2021) and Aksoy & Baskan (2024) that strong TPACK competencies promote pedagogical innovation. However, the relatively lower score in technology use for assessment (WM = 3.20) aligns with global observations that evaluation remains the least digitized component of instruction (Abundis-Gutiérrez et al., 2023; Tondeur et al., 2024). Contextual barriers—such as limited infrastructure, connectivity, and insufficient training—often constrain this domain (Ertmer & Ottenbreit-Leftwich, 2010; Gou et al., 2024; Wang et al., 2025). Conclusively, teachers' strong integration capacity signifies readiness for digital transformation, yet sustained improvement requires institutional investment in ICT tools, targeted digital assessment training, and continuous pedagogical support. It is thus recommended that localized capacity-building programs and resource development plans be institutionalized to strengthen holistic technology integration and ensure equitable digital learning advancement in the Division of Catanduanes (Cordial, 2025a; Cordial, 2025b).

The findings in Table 5 indicate that while primary school teachers in Zone III face certain technological challenges, these are generally less serious (WM = 2.39)—a promising indicator of a positive digital learning climate. The most significant concern, technological infrastructure and accessibility (WM = 2.52), highlights persistent connectivity issues and limited access to digital tools, consistent with findings from Gou et al. (2024) and Wang et al. (2025), who note that infrastructural deficits remain primary barriers to digital integration in rural contexts. Meanwhile, the lower ratings for technological competency (WM = 2.36) and institutional support (WM = 2.28) suggest that teachers possess adequate digital skills and benefit from ongoing professional development—a trend aligned with the TPACK framework's emphasis on competency-based digital preparedness (Mishra & Koehler, 2006; Voogt et al., 2020). Nevertheless, Ertmer and Ottenbreit-Leftwich (2010) caution that "first-order barriers" such as inadequate infrastructure can still undermine sustained technology adoption despite strong teacher capability. Thus, while the overall findings reveal readiness for technology-enhanced pedagogy, the study concludes that addressing resource limitations is crucial for equitable access and sustainability. It is recommended that the Division of Catanduanes prioritize digital infrastructure investment, expand ICT access in schools, and institutionalize localized training programs that enhance teachers' adaptive capacity to evolving technologies, ensuring a resilient and inclusive digital education ecosystem (Cordial, 2025a; Cordial, 2025b).

The results in Table 6 indicate a strong and statistically significant positive correlation ($r = 0.934$, $p < 0.05$) between technological knowledge and technological practices among primary teachers in Zone III, Division of Catanduanes, suggesting that those with

greater technological competence are more effective in integrating digital tools into teaching. This finding reinforces the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Voogt et al., 2020), which posits that successful technology integration depends on teachers' cohesive mastery of technological, pedagogical, and content knowledge. Consistent with Khasawneh et al. (2021) and Aksoy and Baskan (2024), the study underscores that enhanced technological proficiency fosters pedagogical innovation and improves learning outcomes. Nonetheless, as Ertmer and Ottenbreit-Leftwich (2010) emphasize, sustained technology use depends on adequate institutional and infrastructural support—conditions that remain challenging in parts of Catanduanes (Cordial, 2025a). Hence, it is recommended that the Division of Catanduanes institutionalize TPACK-based capacity-building programs, strengthen digital infrastructure in remote schools, and establish localized mentorship and monitoring systems to promote consistent and innovative technology integration across classrooms.

Table 7 indicates a moderate positive correlation ($r = 0.657$, $p < 0.05$) between technological knowledge and the challenges encountered by primary teachers in Zone III, Division of Catanduanes, suggesting that those with higher technological competence are more perceptive of the infrastructural and pedagogical barriers affecting technology integration. This finding reinforces the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Voogt et al., 2020), which emphasizes that effective digital pedagogy depends not only on technological, pedagogical, and content expertise but also on the ability to recognize and navigate contextual limitations. Consistent with Ertmer and Ottenbreit-Leftwich (2010) and Kopcha et al. (2021), teachers with advanced digital literacy often exhibit greater awareness of both "first-order barriers" (infrastructure, connectivity) and "second-order barriers" (self-efficacy, institutional support). The results highlight the importance of strengthening teachers' resilience and adaptive capacity in digitally constrained settings. Conclusion: Greater technological knowledge enhances teachers' awareness of integration challenges. Recommendations: The Division of Catanduanes should invest in ICT infrastructure, institutionalize TPACK-based training, and establish localized technical and pedagogical support systems to ensure sustained digital transformation in primary education.

Table 8 reveals a strong positive correlation ($r = 0.882$, $p < 0.05$) between technological practices and the challenges encountered by primary school teachers in Zone III, Division of Catanduanes, indicating that as teachers intensify their engagement in technology-driven instruction, they simultaneously face increased infrastructural, pedagogical, and technical challenges. This finding reinforces the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Voogt et al., 2020), which asserts that meaningful digital integration demands both advanced competence and adaptive institutional ecosystems. Similar studies (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha et al., 2021) affirm that greater implementation often exposes educators to "first-order barriers" such as inadequate connectivity and "second-order barriers" including limited institutional support and confidence gaps. The result underscores the paradox that innovation and constraint often coexist in digitally evolving school systems (Tondeur et al., 2024; Wang et al., 2025). Conclusion: Greater engagement in technological practices heightens teachers' exposure to systemic and operational challenges. Recommendations: The Division of Catanduanes should strengthen ICT infrastructure, expand localized technical support, and institutionalize continuous, TPACK-based professional development to ensure that digital adoption translates into sustainable and transformative classroom practices.

The proposed Strategic Action Plan for Technological Knowledge Enhancement and Digital Integration among Primary School

Teachers in Zone III, Division of Catanduanes operationalizes the study's findings, translating statistical relationships into concrete interventions. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Voogt et al., 2020), the plan recognizes that technological competence, pedagogical innovation, and contextual awareness are interdependent. Empirical evidence revealed that while teachers demonstrate commendable technological literacy, infrastructural and institutional challenges persist (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha et al., 2021). Consistent with Chai et al. (2023) and Tondeur et al. (2024), the plan emphasizes capacity building, infrastructure development, and institutional support as synergistic drivers of sustained digital integration. Its five objectives—ranging from TPACK-based training to ICT policy alignment—mirror global best practices for technology-enhanced education while addressing local constraints, such as limited connectivity and resource inequity (Wang et al., 2025; Cordial, 2025b). Conclusion: Strengthening teachers' technological and pedagogical competencies requires systemic reform integrating professional development, infrastructure, and policy. Recommendations: Institutionalize TPACK-based capacity-building programs, enhance ICT infrastructure through multi-sectoral partnerships, and implement continuous monitoring and evaluation frameworks to ensure adaptive, sustainable digital transformation in primary education.

Collectively, the findings from Tables 1 to 8 and the proposed strategic plan underscore that technological knowledge, integration, and practice are deeply intertwined with contextual realities and institutional readiness. Teachers in Zone III, Division of Catanduanes, display commendable digital competence and pedagogical innovation; however, their efforts are constrained by persistent infrastructural and policy-related challenges. The significant correlations among knowledge, practices, and challenges highlight the systemic nature of digital transformation—where capacity building, infrastructure, and institutional culture must evolve simultaneously. For policy and practice, the results advocate a holistic digital education agenda that prioritizes equitable resource distribution, sustained professional development grounded in the TPACK model, and adaptive governance mechanisms. Ultimately, advancing digital learning in Catanduanes requires both teacher empowerment and systemic reform to foster inclusive, future-ready, and resilient educational ecosystems.

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