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ICT Integration and Technological Competence of Elementary Mathematics Teachers

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Abstract

Optimizing digital mathematics education relies on harmonizing technological infrastructure, active instructional delivery, and ethical standards within daily teaching practices. This study examined the availability of Information and Communication Technology (ICT) resources, levels of ICT integration regarding instructional practices and ethical awareness, and ICT competence among 95 elementary mathematics teachers across nine public elementary schools in West Butuan District. Employing a descriptive-correlational research design, empirical data were gathered using a validated survey questionnaire and analyzed using weighted means and Spearman's rank-order correlation analysis (ρ). Results revealed that school ICT resources were Highly Available providing an accessible infrastructural foundation. Regarding ICT integration, teachers demonstrated that digital tools were Always Practiced in daily instructional delivery and exhibited a Very High Level of Awareness regarding digital citizenship and student data privacy. Teacher ICT competence was evaluated as Very Good, reflecting strong independent operational and pedagogical proficiency. Correlation analysis established statistically significant, direct positive associations between ICT competence and resource availability instructional practices and ethical awareness. Ethical awareness demonstrated the strongest link with overall technological competence. Based on these outcomes, a proposed DepEd Lesson Exemplar addresses identified domain gaps by expanding educational software access, strengthening teacher adaptability during disruptions, reinforcing student data privacy, and embedding visual problem-solving tools in elementary mathematics instruction.

Keywords: ICT Competence and Integration, Instructional Practices, Ethical Awareness, Lesson Exemplar

Introduction

The rapid evolution of digital technologies has reshaped educational practices across the globe, bringing significant changes to the delivery of instruction and the teaching and learning of mathematics at the elementary level. Digital tools such as visualization software, learning management systems, interactive presentations, and online assessment platforms strengthen conceptual understanding, learner engagement, and formative assessment (OECD, 2023). Consequently, teachers require comprehensive ICT competence to select, apply, adapt, and manage digital tools in alignment with instructional objectives and diverse learner

needs. In teaching elementary mathematics, effective ICT competence moves beyond basic technical literacy to encompass the purposeful integration of technology for concept visualization, interactive problem-solving, differentiated learning, and ethical practices including data privacy, cybersecurity, and digital citizenship.

Across global educational systems, physical technology access does not automatically guarantee meaningful classroom integration. Teachers' confidence, digital skills, pedagogical knowledge, and access to appropriate resources strongly influence the depth and quality of ICT use (Sawyerr & Agyei, 2023). Empirical research by Zeng et al. (2022) established a significant positive relationship between ICT self-efficacy and Technological Pedagogical Content

Knowledge (TPACK), emphasizing that true ICT competence requires a dynamic interplay between technical mastery and pedagogical judgment (Dilling et al., 2024). Without this integration, technology risks remaining a passive tool for slideshow delivery rather than an active medium for mathematical reasoning and concept mastery in young learners.

In the Philippine basic education context, national frameworks such as the Basic Education Development Plan (BEDP) 2030 (Department of Education [DepEd], 2022) and the DepEd Computerization Program (DCP) prioritize digital transformation and teacher technological capacity. However, systemic challenges regarding specialized software provision, continuous professional development, and practical ICT integration persist across public schools. Agonas et al. (2024) identified significant infrastructure and training gaps in public elementary schools, while Andonga (2023) observed that many Filipino teachers remain at the basic knowledge-deepening stage rather than reaching the knowledge-creation level required for modern, interactive teaching. Furthermore, emerging national digital initiatives highlight growing concerns regarding student data protection, digital citizenship, and the ethical handling of learner records during online tasks (Torres-Hernández & Gallego-Arrufat, 2023).

At the local level, administrative reporting and instructional supervision records from the Department of Education – Division of Butuan City and the

West Butuan District Office document a pronounced operational disparity between physical resource acquisition and actual pedagogical integration across a three-year monitoring period (S.Y. 2023–2024 to S.Y. 2025–2026). Longitudinal findings from the *Division Information and Communications Technology (DICT) Profile Assessments* (Department of Education - Division of Butuan City, 2024, 2025, 2026) show that hardware delivery under the DCP progressively expanded baseline device and connectivity access across West Butuan schools from 62% in S.Y. 2023–2024, to 78% in S.Y. 2024–2025, and reaching 88% in S.Y. 2025–2026. However, comparative data from *District Monitoring, Evaluation, and Adjustment (DMEA) Supervisory Reports* demonstrate that classroom-level utilization remained persistently skewed toward passive instruction: elementary mathematics classes utilizing ICT strictly as a static visual presentation tool (e.g., non-interactive slide decks) moved only slightly from 78% in S.Y. 2023–2024, to 75% in S.Y. 2024–2025, and remained high at 72% in S.Y. 2025–2026 (West Butuan District Office [DMEA], 2024, 2025, 2026).

This operational gap is further compounded by persistent deficiencies in specialized software access, contingency handling, and data privacy implementation. Comparative learning resource inventories indicate that access to specialized interactive math tools registered minimal growth, rising from 22% in S.Y. 2023–2024, to 28% in S.Y. 2024–2025, and leveling off at 35% in S.Y. 2025–2026 (Department of Education - Division of Butuan City, 2024, 2025, 2026). Furthermore, district instructional supervisory feedback from DMEA findings reveals that teachers struggling to adapt or switch to alternative offline applications during unscheduled power or internet disruptions showed only marginal improvement over three years—dropping from 74% in S.Y. 2023–2024, to 68% in S.Y. 2024–2025, and 60% in S.Y. 2025–2026 (West Butuan District

Office [DMEA], 2024, 2025, 2026). Additionally, comparative audits by the Quality Assurance Division recorded that classroom maintaining structured, compliant student data privacy routines during digital assessment administration grew slowly from 20% in S.Y. 2023–2024, to 31% in S.Y. 2024–2025, and reached only 40% in S.Y. 2025–2026 (Department of Education - Division of Butuan City - Quality Assurance Division, 2024, 2025, 2026).

This three-year district trend confirms that steady increases in physical hardware access across public elementary schools in West Butuan District have not automatically translated into dynamic pedagogical flexibility, ethical mastery, or comprehensive ICT competence among elementary mathematics teachers (West Butuan District Office [DMEA], 2024, 2025, 2026). While prior studies have examined teacher technology readiness in isolated urban centers or secondary education contexts, limited empirical evidence systematically assesses the baseline conditions of ICT resource availability, instructional integration practices, ethical awareness, and technological competence specifically among elementary mathematics teachers in West Butuan District. Existing literature has largely treated ethical awareness as incidental to technical skill, failing to evaluate how data privacy standards and pedagogical app-flexibility jointly characterize overall teacher competence when delivering elementary mathematics lessons.

To address this empirical and instructional gap, the present study evaluated the extent of ICT resource availability, the levels of instructional practices and ethical awareness, and the overall level of ICT competence among elementary mathematics teachers in West Butuan District. Furthermore, it determined the significant relationships between these classroom conditions and teachers' ICT competence. Synthesizing these empirical findings, the study developed and proposed a targeted DepEd Lesson Exemplar with ICT integration for Grade 6 Mathematics. By embedding open-access software alternatives, structured visual fraction models, explicit data privacy routines, and offline contingency prompts into daily lesson plans, this output provides a practical instructional resource to strengthen effective, flexible, and ethically responsible technology integration in elementary mathematics classrooms

Related Studies

This section reviews related literature and studies that provided theoretical and empirical foundations for technology integration and ICT competence among mathematics teachers. It synthesizes local and international research on instructional practices, technology competence, and factors influencing effective ICT integration. The review also identified key concepts and trends that gave sound recommendations for the assessment of ICT competence among elementary mathematics teachers in West Butuan District.

ICT competence encompasses the knowledge, technical skills, and professional confidence that teachers possess in using digital tools, applications, and platforms to support instruction, assessment, and administrative tasks. Across global and national education systems, this construct has become a central focus as the growing presence of classroom technology requires educators to move beyond basic computer literacy toward purposeful, pedagogically sound ICT integration.

Examining this construct in an international context, Runge et al. (2023) evaluated technology competence among elementary educators in Germany and established that higher digital competence directly enables more effective ICT integration during instruction. Their findings revealed that teachers possessing strong technological knowledge express greater confidence in selecting digital tools aligned with specific learning objectives, demonstrating that competence fundamentally shapes both pre-instructional planning and real-time classroom implementation. In a broader regional evaluation, Ali and Sewani (2022) examined elementary teachers handling mathematics and revealed that while educators typically demonstrate solid

basic digital skills, many still lack advanced competencies required for specialized instructional applications, noting that higher ICT competence corresponds directly to more engaging, learner-centered teaching strategies.

Within the Philippine public school context, empirical assessments further confirm these findings while providing deeper insight into local classroom realities. Paciente (2022) evaluated DepEd teachers and established a positive, statistically significant relationship between educators' technical skills and their instructional attitudes toward digital integration, highlighting that baseline technical proficiency directly fosters positive instructional dispositions. Extending this to elementary basic education, Mariscal et al. (2023) assessed public school teachers in DepEd Cebu Province and confirmed that strong technological competence significantly enhances overall instructional effectiveness, as ICT-proficient educators exhibit greater readiness to integrate advanced digital tools and deliver technology-supported lessons.

Similarly, Pasayloon (2023) documented high overall levels of both technological capability and ICT-based instructional proficiency among 40 mathematics teachers in General Santos City. However, Pasayloon (2023) also observed that when educators attempted to integrate ICT into cooperative or peer-learning activities, they experienced difficulties structuring student interactions whenever technical proficiency or institutional support was constrained. Reinforcing these localized observations, Manaban et al. (2025) assessed mathematics teachers' ICT competence alongside operational integration barriers, concluding that while teachers display foundational competence, lingering technical challenges and pedagogical constraints frequently hinder seamless execution. Taken together, these studies suggest that while Philippine elementary mathematics teachers possess strong foundational capabilities, targeted support remains necessary to enhance specific instructional applications of ICT in the classroom.

Instructional practices comprise the specific pedagogical approaches, delivery methods, and evaluative techniques educators draw upon to guide learning and foster conceptual understanding. Embedding digital media into these daily routines empowers teachers to clarify complex mathematical processes, tailor content to individual learning paces, and sustain active classroom engagement. Examination of current empirical literature illustrates how varying degrees of technology adoption reshape instructional methodologies across diverse classroom settings.

Cross-cultural evidence highlights the transformative capacity of embedded technology. In an investigation of basic education classrooms in Saudi Arabia, Almazroa and Alotaibi (2023) established that meaningful digital adoption relies on treating technological tools as core pedagogical instruments rather than superficial supplements. Their analysis revealed that educators who intentionally incorporate digital strategies are better equipped to differentiate instruction, address diverse cognitive styles, and foster critical thinking along with learner autonomy.

Local empirical inquiries reinforce these insights while capturing the distinct conditions of Philippine basic education. Evaluating technology-driven teaching practices among local educators, Caresosa (2024) uncovered a robust positive relationship between the frequency of digital tool usage and overall lesson execution efficiency. The study highlighted that routine ICT application improves classroom management, stimulates student participation, and streamlines the ongoing assessment of academic progress. Paralleling these insights, research by Llanos et al. (2022) across public elementary schools indicated that educators demonstrating advanced ICT integration lean toward student-centered, highly interactive teaching styles. Conversely, the authors pointed out that lacking reliable digital learning modules and steady administrative backing causes classroom practices to remain stuck at basic substitution levels.

Taken together, these empirical findings confirm that expanding the depth of ICT application plays a vital role in shifting conventional elementary mathematics instruction toward dynamic, learner-centered learning environments.

Technology integration in mathematics education involves the deliberate use of digital tools such as visualization software, dynamic simulations, and interactive online platforms to support the teaching and learning of mathematical concepts. Because mathematics frequently requires abstract reasoning, technology serves as a vital pedagogical bridge that renders complex ideas more concrete and accessible through visual, interactive representation. A review of current empirical scholarship demonstrates how digital integration shapes instructional practices across varying national and institutional environments.

Evaluating teacher readiness within basic education, Njiku et al. (2022) investigated mathematics teachers' technology integration self-efficacy among 125 educators in Tanzania. Their findings revealed moderate self-efficacy overall, with perceived capabilities significantly influenced by prior technology-related training and background factors. Crucially, the authors established that educators who completed professional development in technology integration reported substantially greater confidence in deploying digital tools during lesson delivery, reinforcing the pivotal role formal training plays in building instructional confidence.

Broadening this focus to systemic drivers, a systematic review conducted by Msambwa et al. (2024) synthesized the literature on secondary school ICT integration and confirmed that while technology use directly enhances learner motivation, engagement, and academic achievement, successful implementation consistently depends on three foundational pillars: adequate physical infrastructure, continuous professional development, and proactive administrative leadership. They concluded that digital tools alone cannot transform classroom outcomes; rather, success stems from the dynamic interplay between teacher competence, resource availability, and sustained institutional backing.

In primary education settings, empirical evidence highlights how subject-tailored applications directly impact student learning. In a study on primary school mathematics instruction, Bray and Tangney (2021) observed that incorporating interactive, technology-enhanced tasks significantly improves pupils' spatial visualization skills and conceptual understanding. Their results emphasized that learning gains are maximized when digital tools enable active mathematical manipulation rather than passive presentation.

Addressing the interaction between teacher capabilities and institutional support, Chao et al. (2021) examined elementary educators' digital tool utilization and perceived competence in mathematics instruction. Their findings revealed that while elementary teachers maintain positive attitudes toward technology, actual classroom integration remains heavily moderated by the availability of technical support and school infrastructure. The researchers concluded that bridging the gap between basic access and meaningful pedagogical integration requires structured, continuous training programs tailored to primary mathematics instruction.

Synthesizing these scholarly perspectives reveals that teacher competence, instructional methods, and organizational environments operate as an interconnected framework. Empirical findings consistently confirm that individual teacher capability dictates the initial adoption of digital tools, while institutional support and targeted training sustain high-level integration. Addressing persistent skill and resource gaps through structured professional development remains essential for advancing elementary mathematics instruction.

The physical foundation of technology-integrated instruction rests upon the availability and operational adequacy of digital resources, encompassing hardware, reliable internet connectivity, educational software, and technical support services. In the absence of functional infrastructure, even highly proficient and

motivated educators encounter insurmountable operational bottlenecks when attempting to implement digital pedagogy. A review of contemporary studies indicates that institutional infrastructure and access to hardware directly shape how effectively educators incorporate digital tools into their daily teaching practices.

Establishing the foundational role of physical access in Philippine public education, Agonas et al. (2024) observed that public elementary school teachers exhibit significantly higher technology usage and instructional readiness when core infrastructure specifically stable internet connectivity and functional hardware is readily accessible. Their investigation demonstrated that schools equipped with reliable network access and working multimedia devices report higher rates of daily technology integration during lesson execution, highlighting that infrastructure readiness serves as an indispensable prerequisite for sustaining long-term digital pedagogy.

Providing localized empirical evidence within the Philippine basic education sector, Gamit (2023) examined ICT implementation among 102 elementary mathematics teachers in Cabanatuan City. Although educators reported that basic ICT elements were generally available in their institutions, the actual functionality of these school facilities received notably lower evaluations. Restricted resource access directly hindered teachers' instructional delivery, with public school educators reporting significantly lower availability and implementation levels compared to their private school counterparts. Furthermore, delayed hardware maintenance, overdue software upgrades, and unrenewed software licenses continually disrupted classroom execution, emphasizing that physical resource provision and timely technical support are essential for maintaining consistent technology-enhanced mathematics instruction.

Examining these operational realities across broader international basic education settings, Akram et al. (2022) conducted a systematic review evaluating teachers' perceptions of technology integration. Their synthesis established that while educators maintain overwhelmingly positive attitudes toward digital instruction, actual classroom usage remains heavily compromised by structural obstacles, including sluggish internet speeds, frequent power interruptions, equipment shortages, and insufficient professional training. Favorable teacher mindsets alone cannot overcome systemic infrastructure deficits, demonstrating that positive attitudes fail to translate into effective classroom practice when underlying technology and connectivity remain unreliable.

These localized and international findings align directly with comprehensive systematic research on educational technology adoption barriers. In a review analyzing 116 empirical studies on in-service teachers' instructional obstacles, Chen et al. (2026) classified first-order barriers such as inadequate physical resources, lack of technical support, and time constraints as the most pervasive challenges facing educators. Crucially, a strong co-occurrence was revealed between first-order resource shortages and second-order barriers related to teacher beliefs and attitudes, illustrating that physical infrastructure deficits directly compound teacher-level reluctance. This evidence reinforces the principle that providing adequate ICT infrastructure is a necessary, though not solely sufficient, condition for teachers' successful technology integration.

Complementing these systemic perspectives, Murithi and Yoo (2021) evaluated ICT facility availability and teacher capacity across public primary schools. Their findings indicated that educators perceived available ICT infrastructure as vastly inadequate, creating persistent challenges during curriculum delivery. Furthermore, a majority of teachers had received only basic computer literacy training, restricting their ability to optimize even the limited digital tools on hand. This body of evidence confirms that infrastructure gaps and professional development deficits frequently compound one another in resource- constrained environments, preventing the transition to fully interactive classroom technology integration.

As classrooms become increasingly digitized, educators are expected not only to deploy educational technologies skillfully but also to model responsible, legal, and ethical digital conduct. This responsibility

encompasses safeguarding learner information, respecting intellectual property rights, and adhering strictly to institutional and governmental data privacy regulations. Existing literature highlights how educators interpret and apply principles of digital responsibility, privacy protection, and ethical usage across diverse school environments.

Establishing the foundational necessity of digital ethics in teacher preparation, Novella-García and Cloquell-Lozano (2021) examined the ethical dimension of digital competence within teacher training programs. They emphasized that professional educator preparation increasingly mandates that digital proficiency be grounded in ethical responsibility, given teachers' central role in modeling appropriate technology use for learners. The authors argued that awareness of student data protection is not a peripheral add-on to ICT competence, but rather a core expectation of professional digital practice that must be systematically cultivated across all career stages.

Connecting teacher awareness to organizational governance, Vázquez-Cano et al. (2023) demonstrated that primary school teachers actively recognize and implement data protection and digital security practices during technology- integrated instruction. Their findings revealed that teachers' heightened awareness of privacy risks is strongly contingent upon clear institutional policies and structured administrative guidance. However, Torres-Hernández and Gallego-Arrufat (2023) observed that while teachers generally recognize data privacy risks in principle, notable implementation gaps persist in the practical, day-to-day management of student records. This disconnect indicates that abstract ethical awareness does not automatically translate into uniform or secure classroom data management.

Reinforcing this gap between attitude and actual execution, Villén-Contreras et al. (2024) evaluated educators' personal data protection capabilities under the European DigComp 2.2 framework. Their investigation revealed that although teachers maintain positive mindsets toward safeguarding personal information, they exhibit lower proficiency in managing data securely and responsibly while navigating online environments. Furthermore, the researchers observed that operational competence improves alongside age, teaching experience, and specialized training hours, confirming that favorable mindsets alone cannot ensure safe practice without targeted instruction.

Extending these insights to broader socio-legal frameworks, Marín et al. (2023) analyzed pre-service teachers' social media usage, privacy awareness, and risk management across international contexts. They argued that educational literature frequently neglects cultural and regulatory determinants, demonstrating that educators' privacy practices fluctuate according to their institutional and legal surroundings. Their conclusions highlight that ethical awareness is deeply contextual, underlining the necessity of localized policy frameworks such as the Philippine Data Privacy Act in directing technology usage in schools.

Grounding these themes in the Philippine basic education setting, Paunil (2026) surveyed public and private school teachers using the Code of Ethics for Professional Teachers as an analytical framework. The study established that educators consistently exhibit responsible digital behavior, which directly correlates with their overall professional ethical conduct. Although younger educators demonstrated slightly higher privacy implementation levels, generational affiliation did not alter the core relationship between digital proficiency and ethical practice. The author concluded that digital professionalism remains robust across career stages when technical competence is nurtured, recommending integrated digital ethics training across school divisions to maintain compliant data management practices.

Self-efficacy an educator’s belief in their capacity to utilize technology successfully during instruction operates as a decisive factor in predicting actual classroom integration, frequently demonstrating greater explanatory power than material access alone. While physical equipment creates the structural possibility for

adoption, teachers' internal confidence ultimately determines whether available digital resources are translated into active learning experiences. Various studies demonstrate how teachers' confidence in using digital tools develops and actively supports their overall classroom practice and professional skills.

Probing the interplay between psychological readiness and school environments, Kundu et al. (2020) evaluated secondary school educators to trace how self-efficacy correlates with environmental perceptions. Their work documented a substantial positive alignment between technological self-efficacy and overall appraisals of school ICT infrastructure, illustrating that internal confidence and structural readiness function as mutually reinforcing factors. Crucially, the authors pointed out that physical availability in isolation fails to guarantee instructional mastery, highlighting that personal efficacy serves as the vital bridge linking resource access to active classroom application.

Shifting the analytical lens to cognitive frameworks, Zeng et al. (2022) conducted a comprehensive meta-analysis investigating the link between technological self-efficacy and Technological Pedagogical Content Knowledge (TPACK). Their synthesis demonstrated that efficacy beliefs correlate significantly and positively with educators' broader pedagogical-technological knowledge base, with this connection manifesting most prominently among pre-service teachers. These empirical patterns verify that a teacher's sense of efficacy is deeply embedded within their overarching understanding of how technology, pedagogy, and subject matter intersect.

Unpacking the structural drivers of this psychological state, Wang and Zhao (2021) examined ICT self-efficacy and TPACK development among teacher candidates within university settings. Their analysis revealed that technological self-efficacy directly channels the positive effects of institutional support onto educators' knowledge growth. The researchers established that systematic exposure to effective digital modeling and structured institutional guidance significantly bolsters candidates' confidence to integrate technology into their future teaching routines.

Adding an interpersonal dimension to these individual and organizational drivers, Yonezawa and Nakai (2024) investigated the social dynamics of digital confidence among elementary school teachers using ICT for inquiry-based learning. Their findings indicated that teachers who possess greater confidence in collaborating with colleagues likewise exhibit higher ICT self-efficacy. Notably, the study observed that peer collaboration and collegial networks are rated as more critical than physical hardware alone in sustaining long-term technology integration, confirming the pivotal role of school-based social structures in cultivating enduring technological competence.

The Technological Pedagogical Content Knowledge (TPACK) framework conceptualizes the specialized knowledge architecture educators draw upon to align digital tools, pedagogical strategies, and subject matter effectively. In mathematics education, TPACK offers a vital analytical framework because effective technology adoption extends far beyond generic software operation; it

demands a deep structural understanding of how interactive digital applications can illuminate abstract mathematical principles. Scholarly literature confirms that integrating pedagogical, content, and technological knowledge directly influences mathematics teachers' technical proficiency and guides their instructional methods.

Probing the core relationship between cognitive knowledge structures and practical technology execution, Akram et al. (2022) conducted a systematic review evaluating educators' technology integration perceptions and capabilities. Their synthesis revealed a strong positive relationship between teachers' technological pedagogical content knowledge and their overall digital competencies, underscoring that higher TPACK directly enhances the instructional quality of the learning environment. Crucially, the researchers

observed that teachers with well-developed TPACK are significantly more disposed to design interactive, student-centered learning tasks that encourage active mathematical inquiry.

Taking a multi-dimensional approach to teacher readiness, Sawyerr and Agyei (2023) formulated the Will-Skill-Tool-Pedagogy (WSTP) model to account for varying stages of classroom technology integration. They positioned advanced ICT competence as the synergistic outcome of positive teacher mindsets (will), technical proficiency (skill), adequate resource availability (tools), and pedagogical confidence. Their findings confirm that sophisticated technology adoption is not merely a reflection of isolated technical skill, but rather the result of a dynamic alignment across multiple personal and environmental domains.

Focusing on how foundational preparation shapes professional perspectives, Sintema (2021) examined pre-service mathematics teachers' TPACK profiles alongside their mindsets regarding digital adoption. The study established that educators possessing higher levels of content and pedagogical knowledge maintain noticeably more positive attitudes toward incorporating technology into mathematics classrooms. These insights led Sintema to assert that teacher education programs must cultivate technological knowledge and constructive instructional attitudes in tandem, rather than treating them as independent training goals.

Connecting these empirical insights to systemic challenges across the field, Kholid et al. (2023) completed a systematic literature review analyzing mathematics-focused TPACK research published between 2018 and 2022. Their synthesis identified recurring hurdles that impede teachers' TPACK growth, specifically low self-efficacy, pedagogical inertia, insufficient administrative support, and physical resource constraints. To counteract these widespread barriers, the authors advocated for active, practice-oriented professional development initiatives specifically tailored to the nuances of mathematics instruction.

Professional development and structured training opportunities serve as essential mechanisms for building and sustaining teachers' ICT competence over time. Rather than representing a static milestone, digital proficiency requires continuous cultivation through hands-on practice, collaborative mentoring, and targeted skill development. Contemporary studies demonstrate that targeted professional development frameworks significantly enhance teachers' technical skills and transform their digital instructional strategies.

Evaluating the direct connection between training volume and skill acquisition, Ibarrientos (2024) assessed secondary school educators across multiple digital domains to inform a TPACK readiness program. The investigation established that teachers' proficiency fluctuated across technical operations, ethical practice, pedagogy, and professional growth, with the number of ICT-related training sessions attended demonstrating a strong positive relationship with overall competence levels. Consequently, the author recommended structured, domain-based training programs to systematically bridge identified capability gaps.

Highlighting the need for tailored instruction, Salmerón Aroca et al. (2023) conducted a systematic review analyzing teacher professional development literature. Their synthesis verified that continuous, lifelong learning acts as a vital catalyst for sustained professional growth while revealing distinct generational patterns in training engagement. The researchers noted that younger educators frequently exhibit higher technical proficiency, whereas experienced teachers display greater mastery over relational and process-oriented teaching strategies. These patterns suggest that professional development initiatives should be differentiated according to educators' career stages and existing experiential strengths.

Demonstrating the transformative impact of practice-based learning, Reisoğlu (2022) examined a collaborative digital competence initiative centered on interactive e-book creation. Utilizing a qualitative case study design, the author observed marked enhancements in teachers' capabilities regarding digital resource deployment, lesson organization, educational assessment, and learner empowerment. Crucially, Reisoğlu (2022) reported that participants actively planned to integrate their newly acquired competencies into daily

evaluation, feedback, and student engagement practices, proving that hands-on, practice-oriented training successfully translates abstract technical concepts into concrete instructional strategies.

Extending these insights to broader structural frameworks within developing education systems, Hennessy et al. (2022) completed a comprehensive review of technology-mediated professional development across 40 low- and middle-income countries. Their analysis identified virtual coaching, peer messaging networks, blended instruction, video reflection, and subject-specific software applications as particularly promising professional development models. However, Hennessy et al. (2022) emphasized that long-term sustainability and meaningful classroom transformation depend heavily on expert facilitators and peer mentoring, confirming that technology-focused professional development achieves maximum efficacy when delivered as an ongoing, human-supported process rather than an isolated, one-time workshop.

Despite widespread recognition of the benefits of technology-enhanced instruction, educators across various educational landscapes continue to navigate significant obstacles that constrain consistent and effective classroom application . These challenges encompass physical resource deficits, individual teacher-level constraints, and broader structural limitations. Academic studies highlight the diverse structural and instructional obstacles educators face across both domestic and global school systems.

Cataloging structural operational deficits, Nettey et al. (2024) investigated basic school teachers in Ghana to identify primary obstacles in ICT integration. Their investigation revealed that equipment shortages, unlicensed software, missing electrical outlets, unreliable connectivity, and frequent power disruptions severely restricted daily technology implementation. Crucially, the authors observed that educators maintained strong instructional motivation despite these persistent physical hurdles, demonstrating that personal willingness alone cannot substitute for functional institutional infrastructure.

Framing obstacles through a multi-tiered lens, Kibirige (2023) examined primary STEM educators during post-pandemic instruction in Uganda. The analysis categorized implementation barriers into three interconnected domains: infrastructural and network constraints, individual capabilities alongside administrative support deficits, and curriculum or instructional material gaps. The study concluded that overcoming these operational bottlenecks requires a holistic intervention model uniting physical resource expansion, targeted pedagogical training, and modernized curriculum development.

Contextualizing these structural obstacles within Philippine basic education, Cabunoc and Ubayubay (2024) evaluated public school teachers in Tagoloan District. Their study established that educators' digital proficiency is significantly shaped by demographic factors specifically age, teaching experience, and personal mindsets and that a strong relationship exists between technical skill levels and systemic barriers involving administrative policy, workforce readiness, and school facilities. The researchers highlighted that ongoing challenges, such as resource scarcity, instructional inertia, hardware unreliability, and insufficient professional development, underscore the urgent necessity for advanced training initiatives and structured policy execution.

Reinforcing the interplay between personal characteristics and organizational support within the Philippine context, Ayunar et al. (2024) assessed public school teachers in Bukidnon using the European DigCompEdu framework. Their findings demonstrated that while most teachers function at an intermediate competence level, higher educational attainment correlates positively with digital mastery, whereas years of teaching experience exhibit a slight negative relationship. Notably, although a majority of educators evaluated their school environments as conducive to technology usage, the authors concluded that favorable working conditions alone are insufficient, emphasizing that teacher-level capabilities and school-level support must

operate in tandem alongside continuous infrastructure upgrades to sustain effective ICT integration in resource-constrained settings.

Demonstrating how the severity of specific barriers depends on macro-level developmental contexts, Schmitz et al. (2022) analyzed secondary school educators across European nations, controlling for national technological advancement. Their cross-national analysis revealed that physical equipment shortages and access constraints exert a substantially stronger negative impact on technology use in less technologically developed environments. Conversely, in highly developed contexts, teacher-belief barriers proved more prominent. These findings confirm that infrastructure deficits remain far more consequential in resource-scarce environments, directly aligning with the operational realities facing developing basic education systems.

Validating these persistent barrier dynamics among veteran educators, Pen and Morrell (2024) interviewed late-career public high school teachers in Cambodia regarding technology adoption. Their qualitative inquiry revealed that even when educators hold highly favorable attitudes toward digital tools, actual classroom integration remains constrained by first-order resource shortages, second-order belief and attitude conflicts, and third-order systemic obstacles. The researchers asserted that positive mindsets cannot overcome underlying structural and personal barriers, reinforcing the universal pattern that structural investment and ongoing skill development must precede sustained technology integration.

Within the Philippine setting, the Department of Education (DepEd) has institutionalized comprehensive policy frameworks and capital investment initiatives, most notably the DepEd Computerization Program (DCP), to accelerate digital transformation across public elementary and secondary schools. Despite these national mandates, contemporary empirical scholarship demonstrates that translating central policy frameworks into consistent classroom-level instructional practices remains highly variable across school divisions, district topologies, and teacher demographic profiles. An analysis of recent local literature illuminates the operational realities and systemic factors governing technology integration in Philippine basic education.

Investigating the institutional rollout and field-level reception of national initiatives, Bucar (2023) analyzed the implementation of the DepEd Computerization Program across public elementary schools in the Bohol Division. The study documented that school personnel generally appraised the program as highly effective while self-reporting very satisfactory levels of computer literacy. Importantly, Bucar observed that teachers' digital literacy was significantly tied to demographic and professional indicators—specifically age, teaching longevity, and specialized training hours—while operational difficulties encountered with DCP equipment varied according to package configurations and teacher background. These empirical patterns demonstrate that national equipment provisioning yields optimal classroom results only when paired with targeted, teacher-specific support.

Highlighting the practical execution bottlenecks associated with program delivery, Rondubio and Gantalao (2025) explored DCP implementation and instructional technology use among elementary educators. Their assessment indicated that a substantial proportion of teachers lacked adequate ICT training, directly correlating with low technology adoption during daily instruction. Furthermore, educators faced persistent structural and systemic hurdles, including inadequate hardware ratios, unreliable internet connectivity, heavy ancillary workload assignments that restricted lesson preparation time, and personal financial constraints regarding professional growth. Notably, the researchers documented that several teachers struggled with foundational software applications, prompting a strong recommendation for structured, skill-delineated division training programs.

Shifting the perspective to how demographic characteristics intersect with institutional support mechanisms, Wong et al. (2025) evaluated the digital competence of 296 public elementary school teachers in the Romblon District. By comparing digital natives (born after 1980) with digital immigrants (born prior to 1980), the inquiry confirmed that younger generational affiliation correlated with higher baseline digital proficiency. However, Wong et al. stressed that institutional factors significantly bridged these generational divides: educators who accessed frequent training workshops, robust school technology resources, and active peer collaboration networks exhibited substantially stronger digital capabilities regardless of age. The authors concluded that adaptive training initiatives, equitable resource allocation, and collaborative learning communities are vital for elevating competence across all career stages.

Grounding these systemic patterns within rural district environments similar to the present study site, Lambunao (2024) surveyed public elementary school teachers in the Manolo Fortich II District, Bukidnon. The investigation established that teachers functioned at an intermediate proficiency level across technological, pedagogical, social, and professional competency domains, yet encountered persistent difficulties in leveraging ICT for higher-order instructional delivery. Lambunao underscored that bridging these persistent performance gaps requires a unified approach combining modernized school infrastructure, sustained institutional funding, and domain-specific professional development.

Taken together, the empirical literature reviewed demonstrates that teacher technological competence and classroom ICT integration are governed by an interdependent ecosystem of personal, pedagogical, and structural factors. While national initiatives like the DepEd Computerization Program have established essential infrastructural baselines across Philippine public schools, local and international evidence confirms that hardware delivery alone does not ensure pedagogical transformation. Rather, teachers' actual technology adoption during mathematics instruction remains deeply contingent upon their technological pedagogical content knowledge (TPACK), self-efficacy beliefs, ethical data handling practices, and sustained access to practice-based professional development.

This body of literature directly shaped the present investigation by providing the theoretical architecture anchored in established competency and knowledge models to evaluate technological competence as a multidimensional construct rather than basic software operational skill. Furthermore, empirical patterns in prior studies guided the construct design and indicator selection of the quantitative research instrument, ensuring a targeted assessment of teachers' self-efficacy, pedagogical practices, and levels of instructional technology integration.

Finally, by analyzing global, national, and regional evidence, this review exposed a distinct empirical gap regarding public elementary mathematics teachers in localized district settings, establishing the precise contextual foundation and analytical benchmark against which the findings in West Butuan District are interpreted and evaluated.

Theoretical / Conceptual Framework

This study was anchored on the Technology Acceptance Model (TAM) developed by Davis (1989), which explains how individuals accept and use technology. The model posits that perceived usefulness and perceived ease of use influence users' attitudes, behavioral intentions, and actual technology use. Perceived usefulness refers to the belief that technology can enhance performance, while perceived ease of use refers to the extent to which technology is perceived as easy to use. TAM provided a basis for understanding teachers' acceptance and use of ICT in mathematics instruction.

The study reflected TAM's relevance by considering teachers' perceptions of ICT and their capacity to integrate digital technologies into instruction. In the context of West Butuan District, ICT competence was considered not only in relation to resource availability but also to teachers' ability to recognize and use technology appropriately for instructional purposes. Thus, TAM provided a theoretical perspective for understanding mathematics teachers' acceptance and use of ICT.

The study also adopted Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework. TPACK emphasizes integrating technological, pedagogical, and content knowledge for effective teaching. The framework recognizes that technology becomes meaningful when it is appropriately connected to subject matter and instructional strategies. In mathematics education, this integration supports the purposeful use of ICT to explain concepts, facilitate learning activities, and assess learner understanding. TPACK complemented TAM by providing a pedagogical perspective on ICT integration. While TAM explained teachers' acceptance and willingness to use technology, TPACK provided a basis for understanding how teachers could integrate technological knowledge with content and pedagogy in classroom practice.

To complement TAM and TPACK with a cognitive-design perspective specific to instructional media, the study was further grounded in Mayer's (2009/2021) Cognitive Theory of Multimedia Learning (CTML). CTML posits that people learn more deeply from words and pictures than from words alone, grounded in three cognitive science principles: dual channels (visual and auditory processing), limited capacity, and active processing. In teaching elementary mathematics, CTML explains how teachers select and design visual representations such as animated fraction models, interactive slide decks, and digital manipulatives to avoid cognitive overload and facilitate mental model construction. While TAM addresses technology acceptance and TPACK addresses general pedagogical integration, CTML provided the theoretical basis for evaluating how teachers effectively translate digital tools into clear, visual, and mentally digestible instructional materials in the classroom.

While TAM, TPACK, and CTML accounted for teachers' acceptance of technology, pedagogical integration, and multimedia instructional design, none of these frameworks directly addressed the responsible and ethical use of ICT. This dimension is increasingly critical given growing concerns about data privacy, cybersecurity, and digital citizenship in instructional settings. To address this gap, the study was anchored in Ribble's (2015) Digital Citizenship framework, which identifies digital security, digital rights and responsibilities, digital law, and digital etiquette as elements that responsible technology users must observe. Ribble's framework provided the theoretical grounding for treating ethical awareness specifically teachers' handling of learner data, adherence to data privacy principles, and observance of responsible technology practices as a legitimate and theoretically justified dimension of ICT competence, rather than as a construct incidental to the other frameworks.

In the study, TAM, TPACK, CTML, and Ribble's (2015) Digital Citizenship framework served as complementary theoretical lenses in examining ICT competence among elementary mathematics teachers. TAM provided a perspective on technology acceptance, particularly perceived usefulness and ease of use; TPACK provided a perspective on the appropriate integration of technology with mathematics content and pedagogy; CTML provided a perspective on effective multimedia design and visual presentation to optimize cognitive processing; and Ribble's framework provided a perspective on responsible and ethical technology use, particularly regarding data privacy and digital security. Together, the four frameworks provided a theoretical basis for examining ICT use from acceptance, pedagogical, cognitive-design, and ethical perspectives, supporting the interpretation of ICT competence and technology-integrated mathematics instruction in West Butuan District

This study was anchored on the premise that teachers' ICT competence was shaped by the availability of ICT resources and how these resources were integrated into instructional and ethical practices. ICT competence among elementary mathematics teachers was influenced not only by individual technical skill but also by the resource conditions and integration practices present within the school context. Persistent gaps in ICT integration highlighted the critical need to examine these enabling conditions and translate empirical findings into a contextually relevant instructional resource. Therefore, this study assessed ICTresource availability, ICT integration, and ICT competence among elementary mathematics teachers in West Butuan District to provide the empirical basis for a targeted lesson exemplar. By analyzing how ICT resources and integration practices, as directly experienced and described by the teachers, related to overall ICT competence, this study aimed to translate the current state of technology use into a practical resource that strengthens mathematics instruction.

Figure 1 presents the study's research paradigm, illustrating the interplay of the variables in evaluating ICT resources, ICT integration, and their relationship to the ICT competence of elementary mathematics teachers.

The framework followed an Independent–Dependent–Output model, which showed how perceived resource and integration conditions were systematically evaluated, statistically analyzed, and translated into a definitive instructional resource. This model provided a structured flow for identifying how ICT resources and integration practices contributed to teachers' ICT competence.

The research paradigm illustrates the conceptual structure of the study, capturing the empirical assessment of classroom ICT conditions, teacher competence, and the resulting instructional output.

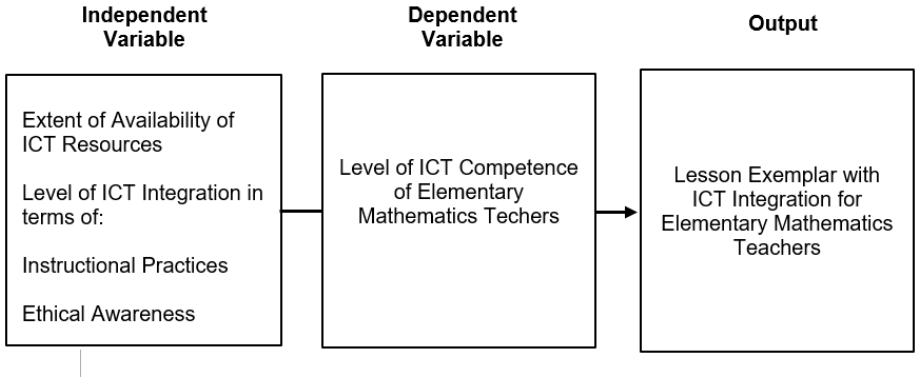
The first phase of the assessment focuses on the enabling classroom and instructional conditions present within the research site. This encompasses determining the extent of availability of ICT resources utilized by elementary mathematics teachers, as well as evaluating the level of ICT integration across two distinct dimensions: Instructional Practices and Ethical Awareness.

Together, these elements reflect the foundational environment and practical routines that shape technology use during mathematics instruction.

The second phase evaluates the overall level of ICT competence demonstrated by elementary mathematics teachers. Framed within a descriptive-correlational assessment design, this component examines teachers' technological knowledge and skills while determining whether significant relationships exist between the extent of ICT resource availability, the level of ICT integration (in terms of instructional practices and ethical awareness), and teachers' overall level of ICT competence. The connecting arrow between these phases represents this hypothesized statistical association, illustrating how resource availability and integration practices are evaluated in relation to teacher competence.

The final phase of the framework represents the study's practical output: the Proposed Lesson Exemplar with ICT Integration for Elementary Mathematics Teachers. Synthesized directly from the empirical findings generated in the assessment of resource availability, integration practices, ethical awareness, and teacher competence, this instructional resource provides targeted, localized lesson plans. By embedding dynamic visual models, open-access software alternatives, offline contingency procedures, and explicit student data privacy routines, the exemplar serves as an active tool to address identified instructional gaps and strengthen overall technological competence among elementary mathematics teachers in the district.

Figure 1. Research Paradigm Showing the Relationship Between Variables of the Study



Objectives of the Study

This study sought to: (1) determine the extent of availability of ICT resources used by elementary mathematics teachers in the West Butuan District; (2) determine the level of ICT integration among these teachers in terms of instructional practices and ethical awareness; (3) determine their level of ICT competence; (4) examine whether significant relationships exist among the extent of ICT resource availability, the level of ICT integration, and the level of ICT competence; and (5) propose a lesson exemplar for elementary mathematics based on the findings of the study.

Methodology

The study employed a descriptive-correlational research design to assess ICT resource availability, ICT integration in terms of instructional practices and ethical awareness, and ICT competence among public elementary mathematics teachers in the West Butuan District, and to examine the relationships among these variables. The study involved 95 mathematics teachers from eight public elementary schools. The sample was proportionally allocated across schools, and respondents were selected through systematic sampling within each school. Data were gathered using a researcher-developed questionnaire with a five-point Likert scale. The instrument was content-validated by a Master Teacher, a District Supervisor with expertise in curriculum and instruction, and a School ICT Coordinator. It was pilot-tested with 30 mathematics teachers from a ninth school, yielding Cronbach's alpha coefficients ranging from .860 to .944. After securing approval from the Public Schools District Supervisor and coordinating with school principals, the researcher administered the questionnaire with informed consent and kept responses confidential. Frequency and percentage were used to describe the distribution of respondents, weighted means were used to summarize ratings for each variable, and Spearman's rho was used to test for significant relationships at the .05 level. The findings served as the basis for proposing a lesson exemplar for elementary mathematics.

Results and Discussion

Problem 1. To what extent are the ICT resources used by elementary mathematics teachers in the West Butuan District available in their schools?

Table 1 presents the weighted mean distribution on the extent of availability of ICT resources utilized by elementary mathematics teachers in West Butuan District.

Table 1. *Weighted Mean Distribution of the Extent of Availability of ICT Resources Utilized by the Mathematics Teachers*

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
The school provides internet connection for instructional use.	4.68	0.531	Strongly Agree	Very Highly Available
The school provides technical support for ICT concerns.	4.33	0.846	Agree	Highly Available
The school maintains ICT facilities.	4.29	0.861	Agree	Highly Available
The ICT resources align with the mathematics curriculum.	4.24	0.821	Agree	Highly Available
The school provides digital devices for mathematics instruction.	4.20	1.026	Agree	Highly Available
The school provides updated digital tools for classroom use.	4.01	1.005	Agree	Highly Available
The school regularly upgrades ICT facilities and equipment.	3.98	0.928	Agree	Highly Available
The school provides digital platforms for assessment teaching.	3.96	0.962	Agree	Highly Available
The school provides digital platforms for assessment.	3.93	0.885	Agree	Highly Available
The school provides educational software, like Canva, for mathematics teaching.	3.82	0.929	Agree	Highly Available
Average Weighted Mean	4.14	—	Agree	Highly Available

Legend : (1) 1.0-1.49 strongly disagree (2) 1.50-2.49 disagree (3) 2.50-3.49 neither agree nor disagree (4) 3.50-4.49 agree (5) 4.50- 5.00 strongly agree

As shown in the Table, the indicator obtaining the highest rating is "The school provides internet connection for instructional use," which yielded a weighted mean of 4.68 (SD = 0.531), verbally described as Strongly Agree and interpreted as Very Highly Available. This finding reveals that baseline connectivity infrastructure is firmly established across public elementary schools in the district, serving as the foundational operational backbone for digital pedagogy. The near-universal presence of connectivity demonstrates that school heads have successfully prioritized fundamental network access, aligning with findings on public school infrastructure readiness where stable network connectivity and functional hardware serve as essential prerequisites for sustaining technology use in basic education (Agonas et al., 2024). Crucially, this high internet availability shifts the district's operational landscape from a phase of basic access to one of pedagogical activation; internet access is no longer the primary bottleneck, meaning any ongoing instructional gaps stem from resource selection, skill application, or execution rather than physical disconnectivity.

Conversely, the indicator receiving the lowest rating is "The school provides educational software, like Canva, for mathematics teaching," which registered a weighted mean of 3.82 (SD = 0.929), verbally described as Agree and interpreted as Highly Available. Although this item remains within the Highly Available range, its position at the bottom of the spectrum points to a distinct structural disparity between general connectivity and specialized, discipline-specific digital tools. This empirical pattern aligns with the findings of Gamit (2023), who observed among elementary mathematics teachers that while basic ICT infrastructure elements are present in schools, delayed software maintenance, overdue upgrades, and unrenewed software licenses create operational bottlenecks during classroom delivery. From an instructional standpoint, this relative deficit demonstrates that elementary mathematics teachers are often forced to rely on free, generic web tools or personal initiative to supplement their daily lesson delivery, revealing that institutional resource procurement remains skewed toward broad utility infrastructure rather than subject-tailored pedagogical tools.

Taking all indicators into account, the average weighted mean reaches 4.14, corresponding to a verbal description of Agree and interpreted as Highly Available, signifying that ICT resources are generally available to public elementary mathematics teachers across West Butuan District. This strong baseline provision confirms that the district has successfully established an environment capable of supporting technology-mediated instruction, consistent with the empirical synthesis of Msambwa et al. (2024), which established that successful classroom technology implementation consistently depends on adequate physical infrastructure functioning alongside teacher competence and administrative backing. Ultimately, the combined state of ICT resource availability reflects a mature physical foundation paired with an emerging need for software specialization, guaranteeing that teachers operate within a supportive technological environment that serves as the necessary foundation for deeper instructional integration.

Problem 2. What is the level of ICT integration among elementary mathematics teachers in the West Butuan District in terms of instructional practices and ethical awareness?

Table 2 highlights the weighted mean distribution of the level of ICT integration among elementary mathematics teachers in West Butuan District in terms of instructional practices.

Table 2. Weighted Mean Distribution of the Level of ICT Integration among Elementary Mathematics Teachers in terms of Instructional Practices

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
The use of ICT tools enhances the presentation of mathematics lessons and concepts in my classroom.	4.68	0.606	Strongly Agree	Always Practiced
The ICT tools increase instructional productivity.	4.68	0.531	Strongly Agree	Always Practiced
The digital resources improve lesson delivery.	4.67	0.535	Strongly Agree	Always Practiced
The use of ICT tools supports the teaching of mathematics concepts effectively.	4.67	0.573	Strongly Agree	Always Practiced

The integration of multimedia resources (e.g., videos, animations) supports students' understanding of mathematics concepts.	4.61	0.657	Strongly Agree	Always Practiced
The integration of ICT into lessons is manageable.	4.61	0.589	Strongly Agree	Always Practiced
ICT tools are integrated into the delivery of the mathematics lessons.	4.61	0.624	Strongly Agree	Always Practiced
The integration of technology-based assessments is evident in my mathematics teaching practices.	4.60	0.608	Strongly Agree	Always Practiced
The utilization of online educational platforms and digital resources supports my mathematics teaching.	4.59	0.627	Strongly Agree	Always Practiced
The use of presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction.	4.53	0.727	Strongly Agree	Always Practiced
Average Weighted Mean	**4.63**		**Strongly Agree**	**Always Practiced**

Legend : (1) 1.0-1.49 strongly disagree (2) 1.50-2.49 disagree (3) 2.50-3.49 neither agree nor disagree (4) 3.50-4.49 agree (5) 4.50- 5.00 strongly agree

Based on the findings, two indicators tied for the highest rating: "The use of ICT tools enhances the presentation of mathematics lessons and concepts in my classroom" (SD = 0.606) and "The ICT tools increase instructional productivity" (SD = 0.531), both yielding a weighted mean of 4.68, verbally described as Strongly Agree and interpreted as Always Practiced. This result reveals that teachers strongly experience digital technology as an effective catalyst for both visual concept delivery and workflow efficiency during elementary mathematics instruction. Utilizing digital tools enables educators to clarify abstract mathematical concepts while streamlining classroom tasks, aligning with the empirical insights of Bray and Tangney (2021), who demonstrated that incorporating interactive, technology-enhanced tasks significantly improves primary pupils' spatial visualization and conceptual understanding, rendering abstract ideas more concrete. Analytically speaking, these top-tier ratings highlight that teachers do not view technology merely as an extra burden, but rather as a vital asset that actively simplifies lesson execution and heightens teaching effectiveness.

On the other hand, the indicator receiving the lowest rating is "The use of presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction," which registered a weighted mean of 4.53 (SD = 0.727), verbally described as Strongly Agree and interpreted as Always Practiced. Although this item remains firmly within the highest descriptive and qualitative category, its position at the bottom of the distribution points to slight operational variance in how frequently or consistently teachers build formal slide decks compared to their broader use of general digital tools. This pattern mirrors the observations of Pasayloon (2023) among local mathematics teachers, who noted that while educators possess high overall technological capabilities, structuring specific software applications during daily classroom routines can still experience slight variations when preparation time or institutional resources are constrained. From a pedagogical standpoint, this relative position demonstrates that while teachers routinely draw upon digital media for real-time lesson enhancement, creating elaborate slide presentations involves greater preparation effort, leading to slight variations in daily implementation across classrooms.

Evaluating the dataset as a whole, the average weighted mean reached 4.63, corresponding to a verbal description of Strongly Agree and interpreted as Always Practiced. This rating signifies that ICT resources and tools are consistently utilized in instruction across public elementary mathematics classrooms in West Butuan District. This high level of instructional execution confirms that teachers systematically leverage digital media to support learning, consistent with the empirical research of Mariscal et al. (2023), who established that strong technological competence among public elementary school teachers directly enhances instructional effectiveness and fosters readiness to integrate advanced digital tools. Fundamentally, the combined state of instructional practices reflects an established culture of technology-enhanced teaching, where digital tools serve as primary instruments for deepening conceptual understanding and maximizing instructional efficiency in elementary mathematics classrooms.

Table 3. Weighted Mean Distribution of the Level of ICT Integration among Elementary Mathematics Teachers in terms of Ethical Awareness

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
The use of digital platforms follows data privacy standards.	4.62	0.605	Highly aware	Very High Level of Awareness
The use of digital resources follows copyright policies.	4.60	0.534	Highly aware	Very High Level of Awareness
The guidance on responsible technology use is provided to learners.	4.59	0.592	Highly aware	Very High Level of Awareness
The selection of digital materials respects intellectual property.	4.58	0.576	Highly aware	Very High Level of Awareness
The modeling of ethical ICT practices occurs in instruction.	4.58	0.576	Highly aware	Very High Level of Awareness
The use of digital tools follows school policies.	4.56	0.680	Highly aware	Very High Level of Awareness
The conduct of digital assessment follows fairness principles.	4.56	0.560	Highly aware	Very High Level of Awareness
The promotion of responsible digital behavior occurs in class.	4.55	0.579	Highly aware	Very High Level of Awareness
The use of digital platforms avoids misuse.	4.54	0.580	Highly aware	Very High Level of Awareness
Student data protection is observed during ICT use.	4.53	0.682	Highly aware	Very High Level of Awareness
Average Weighted Mean	**4.57**		**Highly aware**	**Very High Level of Awareness**

Legend : (1) 1.0-1.49 strongly not aware (2) 1.50-2.49 not aware (3) 2.50-3.49 slightly aware (4) 3.50-4.49 aware (5) 4.50- 5.00 highly aware

Regarding the specific statistical indicators, the item securing the highest rating is "The use of digital platforms follows data privacy standards," which yielded a weighted mean of 4.62 (SD = 0.605), verbally described as Highly Aware and interpreted as a Very High Level of Awareness. This result highlights that educators actively prioritize regulatory compliance and digital security protocols when integrating online learning environments. Adhering to institutional privacy guidelines ensures that digital platforms serve as safe spaces for mathematical instruction, aligning with the research of Vázquez-Cano et al. (2023), who established that primary school teachers demonstrate strong compliance with data protection and digital security standards when guided by clear organizational policies. Significantly, this top-tier awareness reflects a proactive professional culture where teachers recognize that legal compliance is a fundamental component of effective digital teaching rather than a secondary administrative task.

At the other end of the scale, the indicator registering the lowest rating is "Student data protection is observed during ICT use," which obtained a weighted mean of 4.53 (SD = 0.682), verbally described as Highly Aware and interpreted as a Very High Level of Awareness. Although this item remains firmly within the highest descriptive and qualitative category, its position at the bottom of the distribution indicates subtle operational variations in real-time classroom execution compared to broader policy adherence. This pattern mirrors the empirical observations of Torres-Hernández and Gallego-Arrufat (2023), who noted that while educators express strong conceptual recognition of privacy risks, managing daily student records and real-time digital tasks can present minor practical implementation gaps. Important to note, this relative score reveals that translating policy knowledge into consistent, day-to-day data handling routines requires continuous reinforcement during routine classroom activities.

Summarizing the findings across the entire domain, the average weighted mean reached 4.57, corresponding to a verbal description of and interpreted as a Very High Level of Awareness. This rating signifies that elementary mathematics teachers maintain a strong, district-wide commitment to legal mandates, intellectual property rights, and ethical digital conduct. Demonstrating high ethical integrity across digital tasks confirms that technical capability is grounded in professional responsibility, consistent with the foundational work of Novella-García and Cloquell-Lozano (2021), who emphasized that true technological competence in education must be grounded in ethical responsibility and digital citizenship. In essence**,** the combined state of ethical awareness confirms that mathematics teachers in West Butuan District serve as responsible digital role models, ensuring that technology integration remains safe, fair, and legally compliant.

Problem 3. What is the level of ICT competence among elementary mathematics teachers in the West Butuan District?

Table 4 outlines the weighted mean distribution regarding the level of ICT competence among elementary mathematics teachers in West Butuan District. Highlighting the highest statistical measure, the indicator securing the topmost position is "The application of ICT supports mathematics instruction," which registered a weighted mean of 4.63 (SD = 0.566), verbally described as Highly

Table 4. Weighted Mean Distribution of the Level of ICT Competence of the Mathematics Teachers

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
The application of ICT supports mathematics instruction.	4.63	0.566	Highly Competent	Excellent
The use of digital tools supports the classroom.	4.59	0.574	Highly Competent	Excellent
The adaptation of digital resources supports learner needs.	4.57	0.595	Highly Competent	Excellent
The creation of digital instructional materials is part of teaching mathematics integrated with ICT.	4.55	0.597	Highly Competent	Excellent
The integration of interactive tools is practiced.	4.45	0.632	Competent	Very Good
The analysis of digital assessment results informs instruction.	4.44	0.664	Competent	Very Good
Minor ICT problems are handled during instruction. For example, unscheduled loss of internet connectivity is replaced by downloaded videos.	4.44	0.680	Competent	Very Good
The management of online learning platforms is part of instruction.	4.43	0.679	Competent	Very Good
There is an updated PowerPoint presentation in every lesson.	4.42	0.693	Competent	Very Good
There is flexibility in the use of apps when other app resources are not available.	4.41	0.692	Competent	Very Good
Average Weighted Mean	**4.49**		**Competent**	**Very Good**

Legend : (1) 1.0-1.49 not competent (2) 1.50-2.49 slightly competent (3) 2.50-3.49 moderately competent (4) 3.50-4.49 competent (5) 4.50- 5.00 highly competent

Competent and interpreted as Excellent. This outcome indicates that teachers possess a high degree of technical capability in directly embedding digital utilities into core mathematics pedagogy. Being able to harness technological resources to facilitate mathematical concepts demonstrates strong foundational digital literacy, corroborating the empirical work of Sailer et al. (2021), who emphasized that educators' core technological competence is most pronounced when digital applications directly enhance domain-specific instructional objectives. What stands out is that this peak rating demonstrates that teachers' technological skills are not merely theoretical or isolated, but are actively operationalized to strengthen the delivery of mathematical content.

Conversely, the indicator registering the lowest rating is "There is flexibility in the use of apps when other app resources are not available," which obtained a weighted mean of 4.41 (SD = 0.692), verbally described as Competent and interpreted as Very Good. Although this item remains firmly within a highly proficient qualitative threshold, its position at the lower end of the distribution highlights minor operational constraints when educators face sudden technological shifts or missing digital tools. This pattern aligns with

the findings of Instefjord and Munthe (2020), who observed that while teachers demonstrate proficient digital skills in standard, planned instructional environments, real-time adaptive switching between alternative software platforms requires higher-order digital agility and troubleshooting confidence. An essential perspective here is that this relative score reveals that while routine digital execution is solid, enhancing adaptive digital resourcefulness under constrained conditions remains a target for technical mastery.

Synthesizing the domain in its entirety, the average weighted mean reached 4.49, corresponding to a verbal description of Competent and interpreted as Very Good. This rating confirms that elementary mathematics teachers across West Butuan District exhibit a high level of technological competence, equipping them to manage, adapt, and implement digital resources in their classrooms. Maintaining a high baseline of digital capability validates that educators are well-prepared to navigate modern learning environments, consistent with the framework of Tondeur et al. (2023), which posits that robust teacher technological competence is a key prerequisite for sustained, meaningful educational technology adoption. From an overarching standpoint, the collective state of teacher ICT competence demonstrates a strong technical foundation across the district, ensuring that digital integration is backed by proficient, capable educators.

Problem 4. Are there significant relationships among ICT resource availability, the level of ICT integration, and the level of ICT competence among elementary mathematics teachers in the West Butuan District?

Table 5. Correlation Analysis among the Availability of ICT Resources , Instructional Practices , and Ethical Awareness, with ICT Competence of Math Teachers

Independent variable	Level of ICT competence			Interpretation
	r	P	Decision	
ICT resources	.603	.000	Reject null hypothesis	Significant
Instructional practices	.745	.000	Reject null hypothesis	Significant
Ethical awareness	.857	.000	Reject null hypothesis	Significant

Note: n= 95. Correlation is significant at the 0.01 level (2-tailed).

Table 5 illustrates the bivariate correlation analysis using Spearman's rank-order correlation to test the relationships between the evaluated classroom conditions Availability of ICT Resources, Instructional Practices, and Ethical Awareness and the Level of ICT Competence of elementary mathematics teachers in West Butuan District.

Focusing first on the relationship between ICT resources and competence, the statistical computation reveals a Spearman rank-order correlation coefficient of $\rho = .603$ with a p-value of .000. Because the p-value is less than the .01 alpha level, the null hypothesis is rejected, establishing a statistically significant moderate positive relationship. This outcome implies that increased availability and accessibility of hardware, software, and internet infrastructure directly correspond to higher ranks of technical competence among teachers. When teachers are provided with adequate digital tools, their opportunities to practice and build self-efficacy expand naturally, mirroring the findings of Al-Awidi and Aldhafeeri (2022), who observed that physical access

to technology serves as an indispensable foundational catalyst for developing teachers' operational ICT skills. A key observation here is that infrastructural investment acts as a vital practical gateway, ensuring that skill development is supported by available tools rather than hindered by resource scarcity.

Turning to the association between instructional practices and competence, the data yields a Spearman correlation coefficient of ρ = .745 with a p-value of .000. This result warrants the rejection of the null hypothesis, confirming a statistically significant strong positive correlation between how frequently teachers integrate ICT into their pedagogy and their overall digital competence. Regularly embedding technology into lesson delivery, interactive exercises, and student assessments continually refines educators' operational confidence and technical mastery. This outcome aligns with the empirical conclusions of Scherer et al. (2021), who demonstrated that active, routine classroom integration serves as the primary practical arena where teachers transition from basic functional literacy to advanced instructional technology competence. What stands out in this context is that technical competence is not merely an antecedent to technology integration, but is actively cultivated and sharpened through daily pedagogical execution.

Examining the relationship regarding ethical awareness, the analysis demonstrates the strongest association in the matrix, producing a Spearman correlation coefficient of ρ= .857 with a p-value of .000. Consequently, the null hypothesis is rejected, indicating a statistically significant very strong positive correlation between ethical awareness and ICT competence. Educators who possess high awareness regarding data privacy standards, copyright policies, and digital citizenship exhibit the highest levels of technical expertise. This pattern suggests that a strong ethical framework instills the professional responsibility and confidence needed to explore, master, and deploy complex digital tools safely. This strongly supports the empirical insights of Falloon (2020), who highlighted that digital citizenship and ethical understanding are integral components of comprehensive digital literacy, driving teachers toward higher standards of technical execution. What these underlines is that professional ethics and technical proficiency operate synergistically, proving that responsible digital practices reinforce and elevate overall technological capability.

Problem 5. What elementary mathematics lesson exemplar may be proposed based on the findings of the study?

Table 6. Lowest Rated Indicators Across Domains

ICT Domain / Category	Lowest Rated Indicator	Weighted Mean (M)	Standard Deviation (SD)	Verbal Description	Qualitative Interpretation
Level of ICT Integration (Ethical Awareness)	Indicator 2: Student data protection is observed during ICT use.	4.53	0.682	Strongly Agree	Very High Level of Awareness
Instructional Practices / ICT Use	Indicator 3: The use of presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction.	4.53	0.727	Strongly Agree	Very Highly Practiced
Level of ICT Competence	Indicator 9: There is flexibility in using apps when other app resources are not available.	4.41	0.692	Agree	Very Good

Extent of Availability of ICT Resources	Indicator 3: The school provides educational software, such as Canva, for mathematics teaching.	3.82	0.929	Agree	Highly Available

The analysis of the study's findings revealed specific areas across the different ICT domains that received the lowest evaluation ratings from the respondents. While these indicators represent the lowest points within their respective categories, their overall mean scores remain within the high-to-moderate descriptive ratings. This indicates a generally positive baseline of ICT integration, resource availability, instructional practices, and teacher competence. However, because these items scored lowest compared with other indicators, they highlight critical gaps that require targeted enhancement to ensure effective, secure, and resilient technology integration in Grade 6 Mathematics instruction.

Table 7 summarizes the lowest-rated indicators identified across each evaluated ICT domain, providing an empirical basis for pinpointing the specific operational targets that require enhancement in elementary mathematics instruction.

Tying for the highest position among the lowest-rated metrics are indicators under Ethical Awareness and Instructional Practices, both registering a weighted mean of 4.53. Under Ethical Awareness, "Student data protection is observed during ICT use" (SD = 0.682) is verbally described as Strongly Agree and interpreted as a Very High Level of Awareness. The relative positioning of this item highlights subtle practical implementation gaps when teachers manage daily student records and online assessment routines compared to broader policy adherence. Under Instructional Practices, "The use of presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction" (SD = 0.727) is verbally described as Strongly Agree and interpreted as Very Highly Practiced. While digital presentation tools are widely utilized across classrooms, this score reflects minor variations in how consistently teachers build structured slide decks for every topic due to preparation time or resource limitations.

Following in sequence, under Level of ICT Competence, the indicator "There is flexibility in using apps when other app resources are not available" obtained a weighted mean of 4.41(SD = 0.692), verbally described as Agree and interpreted as Very Good. While remaining firmly within a high performance threshold, its position reflects slight operational constraints when teachers face sudden technical disruptions, platform downtime, or missing digital tools during live instruction, indicating that real-time platform switching requires further strengthening.

Registering the lowest numerical score in the entire evaluation is under Extent of Availability of ICT Resources, specifically "The school provides educational software, such as Canva, for mathematics teaching," which yielded a weighted mean of 3.82 (SD = 0.929), verbally described as Agree and interpreted as Highly Available. This item also recorded the highest standard deviation (SD = 0.929) across all domains, demonstrating noticeable statistical variance across elementary schools within the district regarding specialized software provision. While general hardware and connectivity infrastructure are established, subject-tailored, interactive mathematical tools remain comparatively limited or inconsistently provided.

Collectively, these lowest-rated indicators across domains establish the empirical rationale for the study's proposed DepEd Lesson Exemplar. By embedding open-access software alternatives, structured visual presentation templates, explicit student data privacy routines, and adaptive app-flexibility prompts into daily Grade 6 Mathematics lesson planning, the proposed output directly addresses these specific operational targets.

Alignment Matrix for Proposed DepEd Mathematics Lesson Exemplar

Learning Competency: The learners can divide different combinations of fractions, whole numbers, and mixed numbers.

Exemplar Section	Existing Content / Activity in Exemplar	Targeted Lowest-Rated Indicator (Category / Domain & Exact Indicator Phrasing)	Explanation of Alignment
A. Content Standards	The pupils should have knowledge and understanding of the four operations with different combinations of fractions, whole numbers, and mixed numbers.	*(No direct target present)*	Contains no ICT-specific strategies.
B. Performance Standards	By the end of the 1ST term, pupils can perform the four operations with different combinations of fractions, whole numbers, and mixed numbers. The learners can divide different combinations of fractions, whole numbers, and mixed numbers.		
C. Learning Competencies and Objectives	Division of Fractions	*(No direct target present)*	
D. Content	ICT		Contains no ICT-specific strategies.
E. Integration			
Section II: Learning Resources	"PowerPoint or Canva, Google Forms, online fraction manipulatives"	Extent of ICT Resource Availability *Indicator 3:* The school provides educational software, like Canva for mathematics teaching.	Addresses software availability by explicitly listing Canva, Google Forms, and free online manipulatives as available instructional media.

Section III-A: Activating Prior Knowledge (Day 1)	"The teacher presents a short interactive review using a PowerPoint/Canva presentation."	Daily Instructional Practices *Indicator 3:* Using presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction ICT use.	Establishes standard presentation tool usage during daily lesson warm-ups and review drills.
Section III-B & C: Lesson Purpose & Lesson Proper	"Activity 4 intends to visualize the division of fractions... through PowerPoint animation or using Canva." "The teacher uses: PowerPoint/Canva – presentation of concepts and animated fraction models."	Daily Instructional Practices *Indicator 3:* The use of presentation software, such as PowerPoint, Canva, or Google Slides, is part of my mathematics instruction ICT use.	Embeds presentation software directly into core instruction to dynamically show step-by-step animated fraction models.
Section III-C: Lesson Proper	Incorporates guided discussions on "(a) responsible and ethical use of technology, (b) digital collaboration and teamwork, (c) digital citizenship and respect for others."	Ethical Awareness & Data Protection *Indicator 2:* Student data protection is observed during ICT use.	Directly weaves digital citizenship, ethical tech usage, and responsible online behavior into mathematical problem-solving discussions.
Section III-D: Making Generalization	"Pupils may use words, numbers, or illustrations to explain their answers" ***"The teacher emphasizes that ICT tools should be used appropriately, and purposefully... rather than simply replace traditional classroom activities."***	ICT Competence & Pedagogical Flexibility *Indicator 9:* There is flexibility in the use of apps when other app resources are not available.	Shows pedagogical flexibility by allowing alternative response formats (manual drawings vs. digital tools) and balancing ICT with non-digital methods.

Section IV-A: Evaluating Learning	*(None)*	*(No direct target present)*	Assessment items do not explicitly outline technology procedures.
Section IV-B: Teacher's Remarks	*(None)*	*(No direct target present)*	Focuses on general observations rather than specific ICT indicator targets.
Section IV-C: Teacher's Reflection	*(None)*	*(No direct target present)*	Focuses on general reflective practice.

Conclusions

Based on the overall results and analysis of the study, the following conclusions are drawn:

1. Integrating ICT in mathematics education requires an enabling environment where teachers can access appropriate digital resources. These resources provide the foundation for meaningful, technology-supported instruction.
2. Effective ICT integration in mathematics is grounded in the purposeful use of technology within teaching and learning processes. Technology becomes more meaningful when it is aligned with instructional objectives, learner needs, classroom activities, and assessment practices.
3. Ethical responsibility is an essential component of ICT integration. Responsible technology use requires attention to data privacy, digital citizenship, copyright, security, and adherence to relevant policies and guidelines.
4. ICT competence encompasses more than technical ability. It involves the capacity to select, apply, adapt, and manage digital technologies in ways that are appropriate to mathematics instruction and responsive to classroom situations. Teachers' ICT competence is developed through interconnected technological, pedagogical, and ethical dimensions. Strengthening ICT resources, instructional practices, and ethical awareness can contribute to a more effective and responsible approach to technology integration in mathematics education.
5. A structured lesson exemplar can serve as a practical way to translate ICT competence into classroom practice. Such a resource can guide mathematics teachers in planning and implementing technology-supported lessons that are purposeful, adaptable, and ethically responsible.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed:

School administrators could prioritize providing and maintaining adequate ICT resources by improving internet connectivity, ensuring the availability of functional digital devices and instructional software, and providing timely technical assistance. Since ICT resource availability was significantly associated with teachers' ICT competence, sustained institutional support is essential for effective technology integration.

Schools Division Office and district supervisors may strengthen continuous professional development for mathematics teachers, emphasizing areas that require greater flexibility and application, such as alternative digital applications, online learning platforms, digital assessment tools, interactive technologies, and emerging educational technologies. Training should include hands-on activities that allow teachers to apply newly acquired skills to actual mathematics lessons.

Mathematics teachers should continue to integrate ICT purposefully into mathematics instruction by selecting digital tools based on lesson objectives, learner needs, and the nature of mathematical concepts being taught. Teachers should also build their ability to switch between applications and resources when technical problems or limited access to preferred platforms occur.

Schools should strengthen the ethical dimension of ICT integration through sustained awareness and capacity-building activities. Orientations and learning sessions may focus on data privacy, cybersecurity, copyright, responsible digital citizenship, and the ethical use of emerging technologies, including artificial intelligence. This is particularly important because ethical awareness demonstrated the strongest relationship with teachers' ICT competence.

Proposed lesson exemplar may be utilized and further refined as a practical instructional resource for mathematics teachers. Implementing it may give teachers structured opportunities to apply ICT in mathematics instruction while building flexibility in selecting and using digital tools. School-based monitoring and teacher feedback may help improve the exemplar before wider adoption.

Educators should adopt a practical, blended approach to refine instruction, elevate engagement, and deepen retention. First, teachers must advance their pedagogical skills beyond static slideshows to simple interactive modeling, backed by data privacy routines and offline contingency plans like printed task cards to handle power or internet cuts. Second, to boost student engagement, lessons should turn passive viewers into active participants using offline-friendly tools, group templates, and hands-on tasks. Finally, to maximize retention, educators should blend brief gamified review drills, printed visual charts, and quick reflective discussions where pupils explain math steps in their own words to cement concepts into long-term memory.

Researchers may consider expanding the study's scope by involving larger and more diverse populations, different grade levels, subject areas, and school divisions. Future studies may also examine other factors related to ICT competence, such as teachers' attitudes toward technology, digital leadership, technology acceptance, perceived usefulness, and perceived ease of use. Experimental or action research may likewise be conducted to evaluate the effectiveness of the proposed lesson exemplar in actual classroom settings.

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