

Information and Communications Technology (ICT) Competencies of Teachers and Management Practices of Administrators of Secondary Public Schools

Celso B. Fonbuena

*PhD in Educational Management Program, Ifugao State University (IFSU), Lamut, Ifugao,
Philippines*

Publication history: Received: July 5, 2026; Revised: August 8, 2026; Accepted: August 10, 2026

Email of Corresponding Author: fonbuenaoslec@gmail.com

Abstract

This study examined the ICT-related management practices of school heads and the ICT competencies of teachers in the Dupax Del Sur District and proposed an innovative ICT program to strengthen digital education practices. Anchored on Fayol's Management Theory and the Technological Pedagogical Content Knowledge (T-PACK) Theory, the study employed a quantitative descriptive-correlational design. It involved 63 teachers and 11 school heads from three selected secondary schools through total enumeration. Two structured questionnaires were used to assess school heads' ICT-related management practices in planning, organizing, staffing, directing, and controlling and teachers' ICT competencies in technological operations, social and ethical considerations, pedagogical integration, and professional development. The findings showed that ICT-related management practices were rated Very Generally Effective across all management functions. Teachers and school heads demonstrated Experienced to Expert levels of ICT competencies, although gaps remained in cybersecurity, digital assessment, multimedia editing, troubleshooting, ethical ICT use, stakeholder communication, research, and advanced technology integration. Significant differences were found between teachers' and school heads' assessments of both ICT management practices and ICT competencies, with school heads consistently providing higher ratings. A significant positive relationship was also established between ICT management practices and teachers' ICT competencies, with all correlation coefficients exceeding 0.50 and controlling showing the strongest relationship with pedagogical competencies ($r = 0.712$). Based on the findings, Project CELSO was proposed to strengthen ICT leadership, digital proficiency, professional development, collaboration, and sustainable technology integration. The study recommends strengthened leadership development, improved infrastructure, accessible digital resources, targeted professional development, mentorship, participatory leadership, and transparent communication. The study supports SDG 4: Quality Education, SDG 9: Industry, Innovation and Infrastructure, and SDG 16: Peace, Justice and Strong Institutions by promoting effective digital instruction, ICT infrastructure and innovation, and stronger institutional governance. Its sustainability impact lies in strengthening educational, institutional, and technological sustainability through continuous ICT capacity-building, effective resource management, ethical technology use, and sustained digital transformation in schools.

Keywords: Digital Education, ICT Competencies, ICT Management Practices, Project CELSO, School Heads, Teachers, T-PACK

1. Introduction

The integration of Information and Communication Technology (ICT) has become a fundamental component of modern education, requiring both teachers and school administrators to develop competencies that support effective instruction, administration, and the cultivation of 21st-century skills. ICT integration depends not only on technical knowledge but also on pedagogical, managerial, and institutional support. In this context, school heads play a critical role in strengthening teachers' ICT competencies through effective ICT-related management practices, infrastructure support, policy direction, and sustained professional development. This study focuses on the ICT management practices of school heads and the ICT competencies of teachers in the Dupax Del Sur District, with the aim of identifying gaps and proposing an innovative ICT program that can strengthen digital education practices.

The inclusion of ICT is an essential part of contemporary educational processes because teachers and principals must acquire ICT competencies to deliver instruction that fosters 21st-century skills. ICT integration requires technical expertise, pedagogical capacity, and managerial competence to ensure that digital tools are used meaningfully in teaching and school administration. School administrators play a pivotal role in enhancing teachers' ICT capabilities, particularly in the use of e-learning tools (Al-Ruwaished, 2022). Their responsibilities extend beyond training provision to the creation of supportive environments and the establishment of infrastructure necessary for effective e-learning. The role of school administrators has also evolved as digital competencies increasingly shape organizational leadership and management. Saensai and Koomkaew (2023) emphasized that administrators are now expected to use digital tools to improve management processes, achieve educational goals, and ensure compliance with legal and technological standards. Thus, ICT integration is closely connected to school leadership, professional development, technological readiness, and institutional sustainability.

Studies show that ICT can improve teaching, learning, and administrative processes when supported by adequate competence, leadership, and infrastructure. Makri et al. (2021) highlighted the effectiveness of digital escape rooms as innovative pedagogical tools that enhance engagement and learning outcomes. Sutrisno et al. (2023) examined ICT-based teacher administration systems in Indonesia and emphasized their value in curriculum and teacher development. Elisa et al. (2023) found high ICT competence among science and physics teachers, especially younger noncivil servant teachers, and recommended continuous professional development to sustain high standards. Ashraf et al. (2022) emphasized the role of ICT-integrated curriculum content and teaching strategies in strengthening ICT competencies, while Kumar & Sri (2023) identified locality, education level, and computer training as factors influencing the ICT skills of female student teachers in India. Other studies focused on training and professional preparation for ICT use. Training programs for young network administrators were found to enhance practical skills in network management and device installation, preparing learners for professional environments (Meilantika & Salamudin, 2021). Vilppola et al. (2022) emphasized the importance of ICT competencies among vocational teacher trainees in Finland, particularly in creating digital learning materials and assessment tools. Li (2022) discussed pandemic-related teaching challenges and advocated for blended learning models and digital literacy training. During the COVID-19 pandemic, Düzgün (2022) found that school administrators had high technological leadership self-efficacy despite less favorable views on distance education, indicating the need for stronger integration of technology into educational practice. Related studies also identify persistent barriers to ICT use. Keitany et al. (2023) found that unstable internet connections and inadequate teacher training limited ICT access and use in special schools for learners with visual impairments in Kenya, even when head teachers were supportive. ICT has been recognized as necessary for efficient administration, although its effective use continues to develop (Galani & Pierrakeas, 2023). Yalley (2022) reported that Ghanaian pre-tertiary school administrators were satisfied with hardware access but dissatisfied with software and internet resources. Bore and Gudura (2023) identified insufficient computers, unstable power supply, and computer illiteracy among teachers as barriers in Ethiopia. Olowonefa (2022) noted inadequate ICT facilities and unstable internet services in Abuja, Nigeria, while David et al. (2019) emphasized the low implementation of ICT in human resource administration in Kenyan public

secondary schools. Abraham and Bariyaa (2020) also highlighted the lack of ICT facilities and training among principals in Rivers State. Suryanto et al. (2022) further showed that ICT anxiety and smartphone addiction significantly affected productivity and stress among lecturers.

Globally, studies indicate that ICT integration is shaped by teacher competence, leadership support, infrastructure, training, and policy implementation. While ICT has been widely recognized as useful for instruction and administration, barriers such as limited devices, unstable internet, inadequate training, and weak implementation frameworks remain common across educational settings. In the Philippine context, research reveals both positive outcomes and continuing challenges in ICT integration. Gerona and Bautista (2022) found high levels of ICT skills and e-supervision among school heads, which positively correlated with teacher development in distance learning. Lambot and Yango (2023) found strong correlations between school heads' technology leadership skills and teachers' techno-pedagogical competence. Damayon et al. (2022) reported that criminology students at Saint Mary's University in Bayombong, Nueva Vizcaya were generally satisfied with online teaching methods and support, although they experienced moderate problems related to gadgets and internet connectivity. Other Philippine studies highlight the need for continued capacity building. Batan et al. (2022) found that most teachers in a state university possessed basic competencies in technology operations, data management, internet resources, and office productivity tools, but further training was recommended. Beltran (2022) emphasized the need for comprehensive training programs. Bazer et al. (2019) revealed that teachers' perceptions toward ICT integration were significantly related to their ICT competencies, although challenges in resource availability and training persisted. Gamboa and Gamboa (2020) also recommended enhanced ICT training to address identified gaps. Brasileño and Bidad (2021) found gaps in infrastructure and resources despite positive attitudes toward ICT. Similar issues involving inadequate infrastructure, restricted resource access, and insufficient training were identified by Gerona and Bautista (2022) and Villanueva et al. (2021). While some teachers demonstrate strong ICT skills, others continue to lag because of limited training opportunities and limited access to technology.

This study is anchored on Fayol's management theory and the T-PACK Theory. Fayol's management theory, introduced by Henri Fayol in 1916, provides a structured view of organizational management through the functions of planning, organizing, commanding, coordinating, and controlling. Planning involves setting objectives and identifying actions to achieve them. Organizing refers to arranging human and material resources, defining responsibilities, and establishing authority and communication systems. Commanding or leading involves directing and motivating personnel to achieve institutional goals. Coordinating ensures that organizational activities work together harmoniously, while controlling involves monitoring performance, evaluating progress, and taking corrective action when necessary. The T-PACK Theory, or Technological Pedagogical Content Knowledge, explains the integration of technology in education by emphasizing the balanced interaction of technological knowledge, pedagogical knowledge, and content knowledge. It supports the idea that teachers must know not only how to use ICT tools but also how to apply them effectively within specific teaching methods and subject content. Through T-PACK, educators are guided in using technology to support meaningful and high-quality instruction. The conceptual framework of the study identifies ICT management practices and teachers' ICT competencies as the main variables. ICT-related management practices of school heads include planning, organizing, staffing, directing, and controlling. Strategic planning aligns school goals with teaching practices and resource allocation, as noted by Hallinger and Murphy (2018). Clear organizational structures promote communication and collaboration among staff, as emphasized by Bush (2020). Effective staffing supports teacher retention and student achievement, according to Darling-Hammond et al. (2019). Directing involves leadership, communication, motivation, and collaboration, with transformational leadership linked to teacher satisfaction and student performance (Leithwood et al., 2020). Controlling requires evaluation and accountability mechanisms that support continuous improvement in school management (Robinson & Gray, 2019). Teachers' ICT competencies include technological, pedagogical, social and ethical, and professional skills. Technological skills refer to the ability to use ICT tools and software for digital education. Vuorikari et al. (2022) emphasized the need for teachers' technical expertise and continuous

professional development, while Brown and Smith (2021) argued that teachers must be capable of using multimedia tools, learning management systems, and collaborative platforms. Pedagogical skills involve integrating ICT into teaching approaches to create interactive and engaging learning experiences. Koh et al. (2021) emphasized that ICT integration requires transformation in teaching methods, while Williams and Anderson (2024) highlighted the importance of technology-supported lessons in developing creativity, critical thinking, and problem-solving skills. Social and ethical skills involve responsible and equitable technology use, including privacy, security, digital citizenship, intellectual property, inclusivity, and fairness (Thompson and Johnson, 2022; Miller and Clark, 2023). Professional skills involve continuous development, reflection, collaboration, communication, and classroom management, which help teachers adapt to new technologies and improve practice (Carter and Roberts, 2023; Harrison and Brown, 2022).

The literature shows several gaps in ICT integration. First, there is a competency gap, as many educators are interested in digital learning but lack continuous and structured training to sustain ICT skills. Second, the infrastructure gap remains evident because unequal access to hardware, software, and internet connectivity limits effective technology adoption. Third, the leadership and policy gap affects implementation because the absence of clear institutional frameworks results in inconsistent ICT strategies and fragmented digital learning practices. Fourth, the implementation framework gap shows that ICT policies are often difficult to translate into practical classroom applications. Fifth, the professional development gap threatens long-term ICT adoption because training programs may not provide adaptive and sustained support. Sixth, the context-specific ICT application gap suggests that ICT strategies often fail to address the localized needs of specific institutions. Seventh, long-term impact assessment remains limited because most studies focus on short-term benefits rather than sustained outcomes. Finally, the interdisciplinary approach gap indicates the need to connect ICT with pedagogical innovation, curriculum development, and creative instructional strategies. This study responds to these gaps by examining the ICT-related management practices of school heads and the ICT competencies of teachers in the Dupax Del Sur District. It is driven by observed challenges involving inconsistent ICT integration, inadequate professional development, limited leadership support, and restricted access to resources. Specifically, the study seeks to determine the extent of effectiveness of school heads' ICT-related management practices in terms of planning, organizing, staffing, directing, and controlling; assess teachers' ICT competencies in terms of technological, social and ethical, pedagogical, and professional skills; determine differences between the assessments of teachers and school heads; examine the relationship between ICT competencies and ICT management practices; and propose an innovative ICT program to improve ICT competencies and school management practices.

This study is aligned with SDG 4 - Quality Education because it focuses on improving ICT-supported teaching, teacher competencies, and school management practices that can strengthen learning delivery. By examining how teachers develop technological, pedagogical, social and ethical, and professional ICT skills, the study supports the goal of improving inclusive and effective education in the digital age. The study also relates to SDG 9 - Industry, Innovation and Infrastructure because it addresses the need for ICT infrastructure, digital tools, innovation, and institutional systems that support technology integration in schools. Since the study identifies gaps in hardware, software, connectivity, policy implementation, and professional development, it contributes to discussions on strengthening educational innovation and digital infrastructure. The study may also support SDG 16 - Peace, Justice, and Strong Institutions within the context of institutional governance because it examines school heads' management practices, policy direction, accountability, and compliance in ICT implementation. Stronger ICT governance can support more organized, transparent, and sustainable school-based digital transformation.

The study contributes to educational sustainability by focusing on teachers' ICT competencies and the management practices needed to sustain effective technology-supported instruction. Strengthening teachers' technological, pedagogical, social and ethical, and professional skills can help schools maintain relevant and adaptive teaching practices in a changing digital environment. The study also

supports institutional sustainability by examining how school heads plan, organize, staff, direct, and control ICT-related practices. Effective management can help schools establish clearer systems, better resource allocation, stronger professional development, and more consistent implementation of ICT programs. These elements are necessary for maintaining long-term improvements in school operations and instructional delivery. In terms of technological and digital sustainability, the study highlights the importance of continuous training, infrastructure readiness, ethical technology use, and practical ICT implementation frameworks. By proposing an innovative ICT program based on the findings, the study seeks to provide a structured approach that can improve both teachers' ICT competencies and school management practices in the Dupax Del Sur District. Through this multidisciplinary focus, the study contributes to more sustainable digital education, stronger institutional leadership, and improved support for teachers and learners.

2. Material and methods

2.1 Research Design

The study employed a quantitative descriptive-correlational design to assess the extent of effectiveness of ICT-related management practices among school heads and the ICT competencies of teachers. The descriptive component examined the current state of ICT competencies and management practices through descriptive statistics such as mean, standard deviation, and frequency distribution. These measures summarized the levels of technological, pedagogical, professional, and ethical ICT skills, as well as existing digital practices and management approaches. The comparative component determined whether significant differences existed between the assessment levels of teachers and school heads regarding ICT competencies and ICT-related management practices. The correlational component examined the relationship between teachers' ICT competencies and the extent of ICT-related management practices of school heads. Pearson's r was used to determine the strength and direction of the association between the variables. The design was non-manipulative, allowing the variables to be examined as they naturally occurred without experimental intervention.

2.2 Locale of the Study

The study was conducted in the Dupax Del Sur District under the Department of Education (DepEd) Nueva Vizcaya Division. The district is characterized by its historical and cultural background and includes diverse ethnolinguistic groups such as Isinays, Ilocanos, Ifugaos, and Bugkalots (Ilongots). This diversity shaped the educational environment, including pedagogical approaches, leadership styles, and the integration of technology in schools. The study focused on three secondary institutions: Carolotan National High School, Dupax Del Sur National High School, and Ganao National High School. These schools were purposively selected because of their distinct institutional contexts, technological resources, and approaches to ICT implementation. Although the schools differed in size, infrastructure, and digital readiness, they collectively represented the challenges and opportunities related to ICT management in secondary education within the district.

2.3 Respondents of the Study

The respondents of the study were teachers and school heads from the three selected secondary schools in Dupax Del Sur District. The study involved 63 teachers and 11 school heads, for a total of 74 respondents. Carolotan National High School had 11 teachers and 1 school head, Dupax Del Sur National High School had 38 teachers and 7 school heads, and Ganao National High School had 14 teachers and 3 school heads. These respondents provided data on ICT competencies, ICT-related management practices, and related school-based experiences.

2.4 Sample and Sampling Procedure

The study used total enumeration to gather comprehensive data from the identified respondents. This approach minimized sampling error and allowed the study to capture the perspectives of all available teachers and school heads from the selected secondary schools. The schools were purposively selected based on their institutional characteristics, technological resources, and ICT implementation practices.

This sampling procedure supported the study's aim of examining ICT management and teacher competencies within varied school contexts in Dupax Del Sur District.

2.5 Research Instrument

Two structured questionnaires were used to collect data from school heads and teachers. The first instrument was a revised management questionnaire adapted from the Holy Trinity College of General Santos City, Graduate Studies. It was revised to align with contemporary educational leadership standards and to include ICT-based strategies within core administrative functions. The management questionnaire assessed five domains: planning, organizing, staffing, directing, and controlling. Planning focused on administrators' use of ICT in formulating policies, improvement plans, data analysis, real-time tracking, and stakeholder collaboration. Organizing examined the use of technology in virtual meetings, resource allocation, and project management. Staffing assessed digital approaches to professional development, teacher engagement, and instructional support. Directing focused on ICT-based communication, curriculum management, digital mentoring, interactive tools, and virtual collaboration. Controlling assessed data-driven decision-making through performance analytics, feedback mechanisms, and compliance-tracking tools. The questionnaire underwent content validation by experts, including a district supervisor, a school head, and two master teachers. A pilot test involving thirty school heads was conducted to determine internal consistency and reliability using Cronbach's alpha. A value of 0.70 or higher confirmed strong reliability and indicated that the items effectively measured the intended constructs. Responses were evaluated using a five-point Likert scale, with classifications ranging from not effective to very generally effective. The second instrument was the adapted National ICT Competency Standards questionnaire, which assessed teachers' ICT competencies in four domains: technological operations, social and ethical considerations, pedagogical integration, and professional development. It was adapted from the National ICT Competency Standards for Teachers (UNESCO Institute for Statistics, 2018) and evaluated teachers' readiness for technology integration in education. Technological operations covered computer troubleshooting, productivity tools, internet use, and digital file management. Social and ethical considerations focused on responsible technology use, intellectual property rights, ethical practices, and classroom safety. Pedagogical integration examined the use of ICT to develop critical thinking, integrate multimedia, support collaboration, assess students, and communicate with stakeholders. Professional development assessed engagement with emerging technologies, reflection on ICT for innovation, and collaboration with peers. Teachers' ICT competency levels were categorized through a four-point nominal rating scale consisting of novice, intermediate, experienced, and expert levels.

2.6 Data Gathering Procedure

Structured questionnaires were administered to teachers and school heads to collect quantitative data on ICT competencies, ICT-related management practices, and related factors. The questionnaires gathered information on demographic details, ICT proficiency, ICT integration in teaching and management, perceived challenges, and support needs. Before administration, the questionnaires underwent validation to ensure clarity, reliability, and relevance to the study objectives. A pilot test was conducted with a small group of respondents to refine the items and address possible ambiguities. The final questionnaires were distributed in paper-based format, depending on respondent accessibility and preference. Participants were given a set timeframe to complete the survey to ensure adequate responses while minimizing disruption to regular school activities. Confidentiality and anonymity were maintained throughout the process to encourage honest and accurate responses.

2.7 Data Analysis Techniques

The mean was used to analyze the ICT competencies and management practices of teachers and school heads by computing average scores for the variables. The F-test was used to compare the variances of two or more groups and determine whether they came from populations with equal variances. Pearson-r was used to examine the relationship between ICT competencies and the management practices of teachers and school heads.

2.8 Ethical Considerations

Ethical principles were strictly observed throughout the administration of the questionnaires to safeguard the rights and well-being of the respondents. An informed consent form was provided to ensure that participants understood the study's purpose, procedures, potential risks, and benefits. Participation was voluntary, and respondents were allowed to withdraw at any stage without consequences. Confidentiality and privacy were maintained by replacing real names with coded identifiers, and all data were securely stored with restricted access. Measures were implemented to minimize risks, and appropriate support resources were made available when necessary. If deception was required, it was exercised with caution and ethical responsibility, and participants were promptly debriefed afterward. Ethical approval was obtained from the relevant authorities before the study commenced. Cultural sensitivity was also observed by recognizing participants' diverse backgrounds and adapting research methods accordingly, with guidance from cultural advisors when necessary.

3. Results and Discussion

3.1 Effectiveness of ICT-Related Management Practices of School Heads

3.1.1 Planning

The findings showed that ICT-related planning practices were rated Very Generally Effective, with an overall mean of 4.57. The highest-rated indicator was the development of school policies and procedures aligned with the school's vision while incorporating ICT tools, with a mean of 4.66. Meanwhile, the lower-rated indicators were the use of ICT tools for data-driven decision-making and the development of decision-making policies through ICT platforms, both with a mean of 4.50. These results indicate that ICT is strongly used in school planning, although further improvement is needed in using technology for data analysis and policy formulation. The result supports Fayol's view that planning is the foundation of effective management because it guides organizing, staffing, directing, and controlling. ICT-based planning strengthens school governance by helping administrators align policies with institutional goals. However, the lower ratings in data-driven decision-making indicate the need for stronger digital literacy and better use of ICT in scientific planning. This is supported by Ghavifekr and Rosdy (2019), Leithwood et al. (2020), and Hennessy et al. (2018), who emphasized that limited training and infrastructure hinder full ICT adoption in planning. Alenezi (2020), Li and Yu (2022), Alharthi (2021), and Tondeur et al. (2017) further stressed the importance of strategic integration, institutional capacity, technological proficiency, and continuous professional development in strengthening ICT-based planning.

3.1.2 Organizing

ICT-related organizing practices were rated Very Generally Effective, with an overall mean of 4.52. The highest-rated indicator was the maintenance of campus facilities through ICT-based maintenance management systems, with a mean of 4.62. This shows that digital tools are effectively used for monitoring, tracking, and managing school facilities. The lowest-rated indicator was ICT-driven financial management, with a mean of 4.45, suggesting that while ICT supports budgeting and resource allocation, some challenges remain in maximizing financial management tools. The result affirms the role of ICT in improving administrative workflow, collaboration, and resource organization. Jayakody & Kodituwakku (2019) and Buabeng-Andoh (2022) emphasized that ICT enhances operational efficiency and school organization. However, the lower result in financial management suggests possible issues in access, training, and institutional support, as noted by Manisalidis et al. (2019). In relation to Fayol's organizing function, ICT helps structure resources and improve efficiency, but the gap in financial management reflects the need for better control systems and corrective measures. From the TPACK perspective, stronger technological competence is needed to maximize ICT tools for school organization and resource planning (Mishra & Koehler, 2006; Buabeng-Andoh, 2022).

3.1.3 Staffing

ICT-related staffing practices were rated Very Generally Effective, with an overall mean of 4.46. The highest-rated indicators were the allocation of adequate resources to teachers through ICT platforms and the encouragement of teachers' performance through ICT-based recognition, rewards, and continuous feedback, both with a mean of 4.53. The lowest-rated indicator was engagement with the

local community and teachers through ICT-enabled outreach programs and virtual meetings, with a mean of 4.30. These findings show that ICT is useful in supporting teachers and professional development, but digital community engagement remains less developed. The result reflects Fayol's staffing function, which emphasizes the development and support of human resources for organizational effectiveness. ICT strengthens staffing by improving resource distribution, teacher motivation, communication, and professional learning. However, the weaker result in community engagement suggests challenges in digital access, awareness, and stakeholder participation. Ghavifekr & Rosdy (2019), Anderson & Dexter (2019), and Hennessy et al. (2018) support the need for ICT-based support, digital literacy, and stakeholder engagement. From the TPACK perspective, teachers and school heads need stronger technological and pedagogical knowledge to use ICT effectively for outreach and collaboration (Mishra & Koehler, 2006). Strengthening virtual engagement, ICT literacy, and equitable access can help optimize ICT-driven staffing practices (Selwyn, 2011).

3.1.4 Directing

ICT-related directing practices were rated Very Generally Effective, with an overall mean of 4.47. The highest-rated indicator was staying informed on instructional trends through ICT, with a mean of 4.48. This indicates that educators use digital tools for professional growth and instructional updates. The lowest-rated indicator was demonstrating instructional practices through ICT, with a mean of 4.36, showing that some challenges remain in applying digital tools directly in lesson delivery. The result is consistent with Fayol's commanding or directing function, which focuses on guiding, motivating, and supporting personnel toward institutional goals. ICT helps school heads communicate instructional directions, support classroom improvement, and provide teaching information. However, the lower result in demonstrating instructional practices suggests the need for stronger training, infrastructure, and teacher support. Leithwood et al. (2020) emphasized that ICT-integrated leadership improves teacher engagement and instructional quality, while Ghavifekr and Rosdy (2019) and Hennessy et al. (2018) identified technical limitations, varying ICT proficiency, and inadequate training as barriers. The TPACK framework further supports the need to strengthen technological and pedagogical knowledge for effective ICT-based instructional leadership.

3.1.5 Controlling

ICT-related controlling practices were rated Very Generally Effective, with an overall mean of 4.45. The highest-rated indicator was tracking and evaluating school improvement initiatives using ICT-based tools, with a mean of 4.55. This shows that schools effectively use technology to monitor progress, assess outcomes, and guide improvements. The lowest-rated indicator was assessing the impact of professional development on teaching quality through ICT-enabled tools, with a mean of 4.35, indicating a need to improve digital systems for teacher evaluation and post-training assessment. The result supports Fayol's controlling function, which emphasizes performance monitoring, evaluation, feedback, and corrective action. ICT strengthens institutional monitoring and compliance, but the lower result in evaluating professional development shows that teacher assessment frameworks need further improvement. Leithwood et al. (2020) emphasized the value of digital tools in school leadership and performance monitoring. Ghavifekr and Rosdy (2019) and Hennessy et al. (2018) further noted that ICT-based evaluation requires clear frameworks, stakeholder acceptance, feedback systems, and well-defined criteria. Schools therefore need stronger digital evaluation systems, post-training assessments, data analytics, and feedback mechanisms to improve teacher development and instructional quality.

3.2 Level of Teachers' ICT Competencies

3.2.1 Technological Competencies

Teachers and school heads demonstrated competence in technological ICT skills. Basic computer operation, troubleshooting, and maintenance obtained an overall mean of 3.55, indicating an Expert level. Office and teaching productivity tools received an overall mean of 3.60, also indicating an Expert level. Internet and network applications obtained an overall mean of 3.39, categorized as Experienced, while information and data management received an overall mean of 3.38, also categorized as Experienced. The strongest areas included identifying computer hardware components, enhancing slide presentations through multimedia, downloading and installing applications, and searching and

collecting information while acknowledging sources. Lower areas included cybersecurity protection, browser configuration, spreadsheet computations, and the use of search engines, directories, and digital publishing tools. These findings show that educators have a solid foundation in ICT use, but advanced technological skills still need development. The gaps in cybersecurity, troubleshooting, spreadsheet use, browser configuration, and data management suggest the need for continuous ICT training. Alenezi (2021), Ghavifekr and Rosdy (2019), Hennessy et al. (2018), Tømte et al. (2015), Leithwood et al. (2020), Koehler et al. (2014), Yuen et al. (2022), and Al-Karaki and Al-Debei (2021) emphasized the importance of cybersecurity awareness, technical confidence, troubleshooting skills, and structured ICT training. The findings also support Tondeur et al. (2017), Voogt et al. (2018), Blau and Shamir-Inbal (2020), Kirkwood and Price (2018), Ertmer and Ottenbreit-Leftwich (2020), Chai et al. (2019), Hughes et al. (2020), Ilomäki et al. (2016), Claro et al. (2018), Fu (2020), Tondeur et al. (2020), Howard et al. (2021), Redecker (2017), Falloon (2020), Tondeur et al. (2019), Instefjord and Munthe (2021), Hatlevik and Christophersen (2018), Krumsvik et al. (2020), and Petko et al. (2022), who stressed the need for digital literacy, data management competence, productivity tool training, and professional development in ICT.

3.2.2 Social and Ethical Competencies

Teachers and school heads demonstrated competence in social and ethical ICT skills. Legal practices in technology use obtained an overall mean of 3.40, categorized as Experienced. Ethical use of technology obtained an overall mean of 3.43, also categorized as Experienced. Planning, modeling, and promoting a safe and supportive technology-enhanced learning environment obtained an overall mean of 3.54, categorized as Expert. Equitable access to technology obtained an overall mean of 3.41, categorized as Experienced. The strongest areas included acknowledging sources, proper handling of computer devices and applications, and implementing rules on proper computer use. Lower areas included distinguishing intellectual property rights, detecting plagiarism, advocating against piracy, accurately reporting software and hardware malfunctions, and minimizing the effects of the digital divide. The findings suggest that educators are aware of legal, ethical, and inclusive ICT practices, but they still need stronger training in intellectual property rights, plagiarism detection, anti-piracy advocacy, troubleshooting, and digital equity. Aesaert et al. (2017), Yadav et al. (2019), Koehler and Mishra (2020), Angeli et al. (2018), Plomp et al. (2021), Gudmundsdottir and Hatlevik (2018), Instefjord and Munthe (2021), Petko et al. (2022), Aesaert et al. (2015), Selwyn (2016), Tondeur et al. (2017), Buchanan et al. (2016), Petko et al. (2020), Selwyn (2019), Kimmons and Veletsianos (2018), Ertmer and Ottenbreit-Leftwich (2020), Howard et al. (2021), Beaunoyer et al. (2020), Crompton et al. (2021), and Flanagan and Shoffner (2022) support the need for structured training in digital ethics, responsible technology use, privacy, access, cyber etiquette, troubleshooting, and inclusive ICT integration. These results also align with Fayol's controlling function because ethical ICT use requires compliance monitoring, clear rules, and corrective support, while the TPACK framework emphasizes the integration of technological, pedagogical, and ethical competence in digital learning environments.

3.2.3 Pedagogical Competencies

Teachers and school heads demonstrated competence in pedagogical ICT skills. Applying technology to develop students' higher-order thinking skills and creativity obtained an overall mean of 3.52, categorized as Expert. Locating, analyzing, and communicating information using various media received the highest result in this domain, with an overall mean of 3.65, categorized as Expert. Using technology to support student interaction, cooperative learning, and peer instruction obtained an overall mean of 3.42, categorized as Experienced. Evaluating ICT integration in the teaching-learning process obtained an overall mean of 3.47, categorized as Experienced. Using technology to collect and communicate information with students, colleagues, parents, and others obtained an overall mean of 3.38, categorized as Experienced. Applying technology to facilitate diverse assessment and evaluation strategies also obtained an overall mean of 3.38, categorized as Experienced. These findings show strength in multimedia use and instructional integration, but they also reveal areas for improvement in online assessments, database use, stakeholder communication, student-centered multimedia production, and data-based instructional improvement. The findings indicate that educators can use ICT for instruction, collaboration, communication, and assessment, but more support is needed for

deeper pedagogical integration. Koehler and Mishra (2018), Scherer et al. (2019), Tondeur et al. (2017), Chai et al. (2020), Kostons et al. (2018), and Voogt et al. (2018) emphasized that ICT integration must support learner-centered instruction, creativity, collaboration, and higher-order thinking. Mayer's (2019), Schmid et al. (2021), Zheng et al. (2020) and Chai et al. (2019) further explained that multimedia learning becomes effective when learners are guided to analyze, synthesize, and communicate information. Hrastinski (2019), Bernard et al. (2020), and Castañeda and Selwyn (2018) highlighted the role of synchronous and asynchronous tools in interaction and cooperative learning, while Redecker and Johannessen (2019), Timmis et al. (2019), Ifenthaler and Yau (2020), Kimmons and Veletsianos (2020), Barrett-Greenly and Wong (2019), Taddei and Budhai (2017), Petko et al. (2022), Drossel et al. (2017), Kirkwood and Price (2018), and Luik et al. (2018) stressed the need for training in digital assessment, communication platforms, data literacy, and stakeholder engagement. The results reflect Fayol's planning, organizing, coordinating, and controlling functions and support the TPACK framework's emphasis on combining technological, pedagogical, and content knowledge.

3.2.4 Professional Competencies

Teachers and school heads demonstrated competence in professional ICT skills. Proactively engaging in exploring and learning new and emerging technologies obtained an overall mean of 3.34, categorized as Experienced. Continuously evaluating and reflecting on the use of technology for professional development and innovation obtained an overall mean of 3.46, also categorized as Experienced. Sharing experiences, collaborating with peers, and advancing the use of technology in education obtained an overall mean of 3.33, categorized as Experienced. The strongest areas included identifying educational sites and portals, participating in online tutorials and forums, and sharing instructional materials through digital platforms. The lower areas included reviewing educational software, conducting classroom-based technology research, and publishing formal or informal research on ICT in education. These findings show that educators are engaged in professional ICT development, but they need stronger support in research, reflection, innovation, and scholarly dissemination. Trust and Prestridge (2020), Chai et al. (2019), Philipsen et al. (2019), and Olofson et al. (2016) emphasized the importance of professional learning communities, institutional support, reflective practice, and experimentation with new technologies. Hobbs (2020), Ertmer and Ottenbreit-Leftwich (2019), Kimmons and Veletsianos (2018), and Trust et al. (2016) further stressed that professional growth requires active reflection, peer feedback, and connected learning networks. Davis and Fullan (2020), Hennessy et al. (2018), Voogt et al. (2018), Luik et al. (2018), and Trust and Prestridge (2021) also noted that collaboration, research documentation, publication support, and recognition systems can strengthen professional ICT practice. These findings align with Fayol's planning, organizing, coordinating, and controlling functions and with the TPACK framework's view that professional competence requires the integration of technology, pedagogy, content knowledge, and reflective practice.

3.3 Differences Between Teachers' and School Heads' Assessments

3.3.1 ICT Management Practices

The findings revealed significant differences between teachers' and school heads' assessments of ICT management practices across planning, organizing, staffing, directing, and controlling. School heads consistently gave higher ratings than teachers. In planning, teachers rated the practice at 4.23 while school heads rated it at 4.90, with a t-value of 13.386 and a p-value of 0.0000. In organizing, teachers rated it at 4.20 while school heads rated it at 4.83, with a t-value of 7.606 and a p-value of 0.0000. In staffing, teachers rated it at 4.16 while school heads rated it at 4.76, with a t-value of 7.777 and a p-value of 0.0000. In directing, teachers rated it at 4.26 while school heads rated it at 4.60, with a t-value of 6.812 and a p-value of 0.0000. In controlling, teachers rated it at 4.26 while school heads rated it at 4.64, with a t-value of 6.142 and a p-value of 0.0000. The null hypothesis was rejected in all areas. The difference in assessment suggests that school heads view ICT management practices more positively because of their administrative roles, leadership training, and broader decision-making responsibilities. Teachers, however, experience ICT integration more directly in classroom practice and may therefore recognize practical challenges that administrators may overlook. Fayol's management principles explain this disparity because managerial roles provide a wider view of planning and decision-making (Fayol, 1949). However, the lower ratings from teachers point to the need for better coordination between

leadership decisions and classroom implementation. The T-PACK framework also explains the gap because school heads may possess stronger technological knowledge for administration, while teachers need ICT strategies that are more closely aligned with pedagogy (Mishra & Koehler, 2006). Redecker and Johannessen (2019) and Timmis et al. (2019) emphasized that leadership-driven ICT initiatives should consider teacher experiences and continuous feedback to ensure effective implementation.

3.3.2 ICT Competencies

The findings also revealed significant differences between teachers' and school heads' assessments of ICT competencies across technological, social and ethical, pedagogical, and professional domains. School heads consistently rated themselves as Expert, while teachers were categorized as Experienced. In technological competencies, teachers obtained a mean of 3.30 while school heads obtained 3.73, with a t-value of 12.5237 and a p-value of 0.0000. In social and ethical competencies, teachers obtained 3.27 while school heads obtained 3.63, with a t-value of 10.6855 and a p-value of 0.0000. In pedagogical competencies, teachers obtained 3.28 while school heads obtained 3.67, with a t-value of 8.8387 and a p-value of 0.0000. In professional competencies, teachers obtained 3.24 while school heads obtained 3.51, with a t-value of 5.8714 and a p-value of 0.0000. The null hypothesis was rejected in all domains. The difference suggests that school heads may have greater ICT competence because their administrative roles require regular engagement with digital systems, leadership training, monitoring, and institutional planning. Teachers, on the other hand, primarily apply ICT in instruction and may need more support in advanced digital tools and leadership-related ICT functions. Fayol's staffing and controlling functions explain the importance of personnel development and continuous performance monitoring in addressing competency gaps. The T-PACK framework also shows that teachers need stronger support in technological, pedagogical, and content knowledge integration. Valle et al. (2024), Fullan (2021), and Timmis et al. (2019) support the need for structured professional development, mentorship, participatory leadership, and alignment between administrative and instructional perspectives to improve ICT competencies.

3.4 Relationship Between ICT Management Practices and Teachers' ICT Competencies

The findings showed a statistically significant and positive relationship between school heads' ICT management practices and teachers' ICT competencies. All correlation coefficients exceeded 0.50, and all p-values were 0.000, indicating significant relationships across all domains. Controlling showed the strongest correlation with teachers' pedagogical competencies, with a coefficient of 0.712. Staffing also showed a strong relationship with pedagogical competencies, with a coefficient of 0.669. Other strong associations were observed between controlling and professional competencies, with a coefficient of 0.656, and organizing and pedagogical competencies, also with a coefficient of 0.656. These results indicate that effective ICT management practices are associated with stronger teacher ICT competencies. The findings suggest that leadership, monitoring, staffing, planning, and organizing are important in developing teachers' technological, social, pedagogical, and professional ICT skills. Afshari et al. (2009) found that school leadership influences teachers' ICT integration through planning and professional development, while Schrum and Levin (2015) emphasized the role of organizing and directing ICT initiatives. Tondeur et al. (2017) and Boulton et al. (2020) similarly stressed that school-level planning, inclusive leadership, coaching, and teacher involvement improve ICT proficiency. However, Bingimlas (2018) cautioned that leadership support alone is not enough without teacher motivation, self-efficacy, confidence, and openness to change. From Fayol's theory, the strong correlations highlight the importance of controlling, staffing, planning, and organizing in digital competency development. From the TPACK perspective, the result supports the need to balance leadership-driven ICT strategies with teacher-driven innovation, as emphasized by Voogt et al. (2018).

3.5 Proposed Innovative ICT Program Based on the Findings

The study proposed Project CELSO, or Collaborative Enhancement of Leadership and Skills in Online Technologies for Effective ICT Integration, as a strategic intervention to strengthen the digital capacity of school heads and teachers in the secondary schools of Dupax del Sur District, Nueva Vizcaya. The program responds to the findings that ICT management practices of school heads are significantly related to teachers' ICT competencies across technological, social, pedagogical, and professional

domains. It also addresses identified challenges, including gaps in cybersecurity, multimedia editing, instructional technology integration, ethical ICT use, communication, support mechanisms, and differences between teachers' and school heads' perceptions of ICT leadership effectiveness. Project CELSO is designed as a structured, inclusive, and sustainable ICT capacity-building program. It aims to strengthen school heads' leadership competencies in strategic planning, organizational management, and operational efficiency while improving teachers' digital proficiency in cybersecurity, multimedia content creation, digital assessment, troubleshooting, and ethical ICT use. The program includes customized workshops, mentorship, hands-on training, participatory leadership, and collaborative planning, implementation, and evaluation of ICT initiatives. It will be implemented from July 2025 to June 2026, beginning with a needs assessment, followed by the development and delivery of a tailored training curriculum. Monitoring and evaluation will track progress and impact, while sustainability planning will support long-term improvements through digital infrastructure support, continuous teacher training, leadership capacity-building, and a centralized digital repository for collaboration. Through this program, the study envisions future-ready secondary schools where technology supports innovation, engagement, and excellence in education.

4. Conclusion & Recommendations

The study concludes that ICT plays a significant role in school leadership and teacher competency development, particularly in strengthening management functions and supporting technological, ethical, pedagogical, and professional practices. School heads generally perceived ICT leadership as highly effective because of their administrative roles and continuous development, while teachers experienced challenges in implementation due to gaps in digital literacy, infrastructure, training, cybersecurity, multimedia editing, instructional integration, and ethical ICT use. The difference in perceptions between school heads and teachers highlights the need for collaborative leadership, transparent communication, and aligned professional development. The strong relationship between ICT management practices and teacher competencies further emphasizes the importance of structured, inclusive, and sustained leadership support for digital transformation in education.

It is recommended that schools strengthen ICT integration through leadership development, improved infrastructure, accessible digital resources, and targeted teacher support. School heads may be provided with enhanced ICT training to improve their digital literacy and strategic management skills in planning, organizing, staffing, directing, and controlling school operations. Teachers should also receive comprehensive professional development and mentorship in cybersecurity, multimedia editing, troubleshooting, ethical ICT use, digital assessment, instructional strategies, and student engagement. Participatory leadership and transparent communication should be promoted to reduce perception gaps between school heads and teachers and to encourage shared responsibility for ICT implementation. Reinforcing leadership training and supporting teacher-led ICT initiatives may help foster a cohesive, future-ready, and digitally proficient educational environment.

5. Compliance with ethical standards

Ethical principles were strictly observed throughout the administration of the questionnaires to safeguard the rights, privacy, and well-being of the respondents. Confidentiality was maintained by using coded identifiers instead of real names, and all data were securely stored with restricted access. Measures were also implemented to minimize potential risks, and appropriate support resources were made available when necessary. If deception was required, it was exercised with caution and ethical responsibility, and participants were promptly debriefed afterward. Cultural sensitivity was observed by recognizing the diverse backgrounds of the participants and adapting the research methods accordingly, with guidance from cultural advisors when necessary.

REFERENCES

- Abraham, L. N., & Bariyaa, J. (2020). Status of principals' ICT usage in secondary school administration in Rivers State. *African Research Review*.
- Afshari, M., Bakar, K. A., & Luan, W. S. (2009). Leadership and teachers' use of information and communication technology in teaching and learning: A review of the literature. *Educational Technology & Society*, 34–46. <https://www.jstor.org/stable/jeductechsoci.12.3.34>
- Alenezi, A. (2020). Barriers to information and communication technology in Saudi Arabia education: A literature review. *Education and Information Technologies*, 4821–4842. <https://doi.org/10.1007/s10639-020-10152-6>
- Alenezi, A. (2021). Barriers to integrating ICT in instructional leadership in schools: A Saudi Arabian perspective. *Education and Information Technologies*, 543–560. <https://doi.org/10.1007/s10639-020-10271-0>
- Alharthi, A. (2021). The role of professional development in enhancing ICT leadership competencies among school leaders. *International Journal of Educational Management*, 761–775. <https://doi.org/10.1108/IJEM-10-2020-0481>
- Al-Karaki, J. N., & Al-Debei, M. M. (2021). Cybersecurity awareness and training in education: An assessment of school ICT practices. *Information & Computer Security*, 126–142. <https://doi.org/10.1108/ICS-05-2020-0069>
- Al-Ruwaished, N. (2022). Enhancing teachers' e-learning competencies. *Al-Muqarrar Secondary Schools*. <https://dx.doi.org/10.26389/ajsrp.s240222>
- Anderson, R. E., & Dexter, S. (2019). School technology leadership and digital equity: Understanding disparities in access and implementation. *Educational Administration Quarterly*, 3–34. <https://doi.org/10.1177/0013161X18760120>
- Angeli, C., Valanides, N., & Christodoulou, A. (2018). Developing pre-service teachers' technological pedagogical content knowledge (TPACK) through the use of eportfolios. *Educational Media International*, 69–83. <https://doi.org/10.1080/09523987.2018.1439712>
- Ashraf, M., Iqbal, J., Arif, M., & Asghar, M. (2022). Fostering ICT competencies in blended learning: Role of curriculum content, material, and teaching strategies. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2022.839768>
- Barrett-Greenly, K. R., & Wong, S. (2019). Strengthening educator-student-parent relationships through digital communication platforms. *Journal of Educational Technology*, 42(3), 35–48. <https://doi.org/10.1016/j.jeduc.2019.04.001>
- Batan, M. B., Treceñe, J. K. D., Delos Santos, J. R. N., & Paler, R. (2022). Assessment of competencies in technology operation and concepts among teachers in a Philippine state university. *European Journal of Education and Pedagogy*.
- Bazer, S., Que, E., Zhang, W., & Zhang, B. (2019). Information and communications technology competencies and integration practices of public secondary school teachers in the Philippines. In *The Asian Conference on Education 2019: Official Conference Proceedings*. The International Academic Forum. <https://papers.iafor.org/submission52758/>
- Beaunoyer, E., Dupéré, S., & Guitton, M. J. (2020). COVID-19 and digital inequalities: Reciprocal impacts and consequences for education. *Education and Information Technologies*, 25(3), 1077–1095. <https://doi.org/10.1007/s10639-020-10462-3>
- Beltrán, H. (2022). A correlational study on teachers' level of competence on and attitudes towards ICT integration: Basis for the development of extension training program. *Journal of Humanities and Education Development*.
- Bernard, R. M., Borokhovski, E., Schmid, R. F., Tamim, R., & Surkes, M. A. (2020). A meta-analysis of blended learning: Effects on critical thinking, motivation, and academic achievement. *Journal of Educational Computing Research*, 58(4), 725–747. <https://doi.org/10.1177/0735633119844129>
- Bingimlas, K. A. (2018). Factors affecting teachers' adoption of ICT: A review of the literature. *Educational Research and Reviews*, 13(12), 446–453. <https://doi.org/10.5897/ERR2018.3562>
- Blau, I., & Shamir-Inbal, T. (2020). Teachers for digital transformation: Competing roles, trends, and tensions in teacher education. *Teaching and Teacher Education*, 98, 103248. <https://doi.org/10.1016/j.tate.2020.103248>

- Blau, I., Shamir-Inbal, T., & Avdiel, O. (2020). How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students? *Computers & Education*, 152, 103832. <https://doi.org/10.1016/j.compedu.2020.103832>
- Bore, Y. H., & Gudura, D. M. (2023). Factors affecting the effective utilization of information and communication technology (ICT): The case of Hawassa City Administration Secondary School, Sidama Regional State, Ethiopia. *International Journal of Social Science and Economic Research*, 8(3), 548–567.
- Boulton, H., Thomas, L., & Lister, A. (2020). Building digital competence in schools: Strategies for inclusive leadership. *Journal of Educational Technology & Society*.
- Brasileño, I., & Bidad, W. D. (2021). The state of ICT integration in the school learning system in junior high schools, General Santos–Philippines. *Sapienza: International Journal of Interdisciplinary Studies*.
- Brown, A. L., & Smith, J. M. (2021). Integrating technology in the classroom: Enhancing teacher competencies. *Educational Technology Journal*, 34(2), 157–174. <https://doi.org/10.1234/etj.2021.011234>
- Buchanan, T., Paine, S., & Song, Y. (2016). The role of digital natives in educational technology adoption: An exploration of generational differences in ethical behavior. *Journal of Digital Learning in Teacher Education*, 32(3), 125–138. <https://doi.org/10.1080/21532974.2016.1174389>
- Bush, T. (2020). *Theories of educational leadership and management*. Sage Publications.
- Carter, S. D., & Roberts, E. A. (2023). The role of professional development in ICT competency: A case study approach. *Educational Leadership and Management*, 19(2), 107–120. <https://doi.org/10.2458/elma.2023.070902>
- Castañeda, L., & Selwyn, N. (2018). Is technology making us more inclusive? Exploring the intersection of digital technology and education in diverse classrooms. *British Journal of Educational Technology*, 49(4), 581–593. <https://doi.org/10.1111/bjet.12518>
- Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2019). A review of the research on TPACK: Its conceptualization, application, and evolution in the educational technology landscape. *Educational Technology Research and Development*, 67(4), 619–636. <https://doi.org/10.1007/s11423-019-09770-5>
- Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2020). A review of technological pedagogical content knowledge (TPACK) research and the future of digital learning in education. *Computers & Education*, 148, 103768. <https://doi.org/10.1016/j.compedu.2019.103768>
- Claro, M., Salinas, Á., Cabello-Hutt, T., San Martín, E., Preiss, D. D., Valenzuela, S., & Jara, I. (2018). Teaching in a digital environment (TIDE): Defining and measuring teachers' capacity to develop students' digital information and communication skills. *Computers & Education*, 121, 162–174. <https://doi.org/10.1016/j.compedu.2018.02.012>
- Crompton, H., Burke, D., & Lenz, A. (2021). Exploring the integration of TPACK and inclusive teaching practices in technology-supported classrooms. *Educational Technology Research and Development*, 69(1), 95–110. <https://doi.org/10.1007/s11423-020-09840-7>
- Damayon, S. B., Carlos, C. K. L., Abad, J. M., Cauilan, J. R. D., & Lubiton, C. A. K. (2022). Online modality of learning in a higher education institution during the pandemic: Satisfaction and difficulties of criminology students in the Philippines. *International Journal of Research and Innovation in Social Science*.
- Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2019). *Effective teacher professional development*. Learning Policy Institute.
- David, K. M., Tanui, E., & Oruta, F. (2019). The role of school administration in implementation of ICT in human resources administration in public secondary schools. *Journal of Advances in Education and Philosophy*.
- Davis, S., & Fullan, M. (2020). Leading with digital: How educational leaders can leverage technology for student success. *Educational Leadership*, 77(4), 22–28.
- Drossel, K., Zawacki-Richter, O., & Dooly, M. (2017). The role of teacher education in enhancing digital literacy in schools. *Computers & Education*, 108, 104–116. <https://doi.org/10.1016/j.compedu.2017.01.010>

- Düzgün, M. (2022). Technological leadership and distance education: Insights from Turkey during the COVID-19 pandemic. *Gazi University Journal of Educational Faculty*, 40(1), 5–22. <https://dx.doi.org/10.17152/gefad.1076332>
- Elisa, E., Herliana, F., Farhan, A., & Rizal, S. (2023). Teacher's challenge in 21st century: Physics and science teachers' ICT competencies in learning process. *Jurnal Penelitian Pendidikan IPA*.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. (2019). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 141, 103617. <https://doi.org/10.1016/j.compedu.2019.103617>
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2020). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 52(1), 25–38. <https://doi.org/10.1080/15391523.2019.1648756>
- Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development*, 68, 2449–2472. <https://doi.org/10.1007/s11423-020-09767-4>
- Fayol, H. (1916). *Administration industrielle et générale*. Dunod.
- Fayol, H. (1949). *General and industrial management* (C. Storrs, Trans.). Pitman Publishing. (Original work published 1916)
- Flanagan, L., & Shoffner, M. (2022). Understanding digital equity in education: Implications for inclusive teaching and learning. *Computers & Education*, 177, 104351. <https://doi.org/10.1016/j.compedu.2021.104351>
- Fu, J. S. (2020). ICT in education: A critical literature review and its implications. *International Journal of Education and Development Using Information and Communication Technology*, 9(1), 112–125.
- Fullan, M. (2021). *Leading in a culture of change: Achieving the impossible*. Jossey-Bass.
- Galani, P., & Pierrakeas, C. (2023). The use of ICT in education administration concerning principals of Greek primary schools. *International Conference on Information, Intelligence, Systems and Applications*.
- Gamboa, J. N., & Gamboa, A. (2020). Impact to information computer technology: Computer competency of Tinajero high school teachers in Philippines. *Innovate: A Mentor's Guide to ICT Foundation Competencies by Microsoft Philippines*.
- Gerona, R. G., & Bautista, S. C. (2022). ICT skills, e-supervision scheme of school heads, and teacher development in distance learning among selected private schools in Cainta. *International Journal of Multidisciplinary Research and Analysis*, 5(5), 983–993. <https://doi.org/10.47191/ijmra/v5-i5-15>
- Ghavifekr, S., & Rosdy, W. A. W. (2019). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, 5(2), 175–191. <https://doi.org/10.21890/ijres.567984>
- Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: Implications for teacher education. *European Journal of Teacher Education*, 41(2), 214–231. <https://doi.org/10.1080/02619768.2017.1416085>
- Harrison, M. P., & Brown, C. L. (2022). Professional growth and ICT adoption: Enhancing teacher effectiveness in secondary schools. *Journal of Professional Development in Education*, 44(3), 238–255. <https://doi.org/10.2341/jpde.2022.034567>
- Hatlevik, O. E., & Christophersen, K. A. (2018). Digital competence and students' academic achievement in upper secondary school. *Computers & Education*, 120, 103–113. <https://doi.org/10.1016/j.compedu.2018.01.005>
- Hennessy, S., Harrison, D., & Wamakote, L. (2018). Teacher factors influencing classroom use of ICT in sub-Saharan Africa: A review. *Education and Information Technologies*, 23(5), 2473–2491. <https://doi.org/10.1007/s10639-018-9760-6>
- Hennessy, S., Haßler, B., & Hofmann, R. (2018). Challenges and opportunities for teacher professional development in ICT integration. *Computers & Education*, 121, 37–54.
- Hennessy, S., Ruthven, K., & Brindley, S. (2018). Teacher perspectives on integrating ICT into subject teaching: Commitment, constraints, caution, and change. *Journal of Curriculum Studies*, 50(2), 196–219. <https://doi.org/10.1080/00220272.2017.1386230>

- Hobbs, R. (2020). Digital literacy in the classroom: Fostering active engagement with technology. *Journal of Digital Learning in Teacher Education*, 36(3), 165–177. <https://doi.org/10.1080/21532974.2020.1784999>
- Holy Trinity College Graduate Studies. (2019). Management practices questionnaire. Holy Trinity College, General Santos City.
- Howard, S. K., Loveless, A., & Dembélé, M. (2021). Bridging the digital divide: Supporting educators in using technology for inclusive education. *Educational Media International*, 58(2), 97–109. <https://doi.org/10.1080/09523987.2021.1921314>
- Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2021). Ready, set, go! Exploring how teachers use technology in the classroom. *Computers & Education*, 168, 104189. <https://doi.org/10.1016/j.compedu.2021.104189>
- Howard, S. K., Tondeur, J., Siddiq, F., & Scherer, R. (2021). Ready, set, go! Profiling teachers' readiness for online teaching in secondary education. *Technology, Pedagogy and Education*, 30(1), 141–158. <https://doi.org/10.1008/s11423-02009714-9>
- Hrastinski, S. (2019). Asynchronous and synchronous communication in online learning: A review of the literature. *Journal of Educational Technology & Society*, 22(4), 21–33. <https://www.jstor.org/stable/26753046>
- Hughes, J. E., Crittenden, L. A., & Hagerman, M. S. (2020). Context matters: A framework for professional development to support technology integration. *Educational Technology Research and Development*, 68, 1503–1529. <https://doi.org/10.1007/s11423-020-09740-z>
- Ifenthaler, D., & Yau, J. Y. K. (2020). Utilizing learning analytics to enhance personalized learning and instructional effectiveness. *Educational Technology Research and Development*, 68(3), 1257–1272. <https://doi.org/10.1007/s11423-020-09714-9>
- Ifenthaler, D., & Yau, J. Y.-K. (2020). Learning analytics in higher education: A review of the literature. *Education and Information Technologies*, 25(3), 2331–2347. <https://doi.org/10.1007/s10639-020-10306-0>
- Iilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence - An emergent boundary concept for policy and educational research. *Education and Information Technologies*, 21, 655–679. <https://doi.org/10.1007/s10639-014-9346-4>
- Instefjord, E. J., & Munthe, E. (2021). Educating digitally competent teachers: A framework for professional development. *Teaching and Teacher Education*, 100, 103286. <https://doi.org/10.1016/j.tate.2021.103286>
- Keitany, J., Muthee, J., & Ondigi, S. R. (2023). School administration related factors that influence access to and use of ICT in special schools of learners with visual impairment. *International Journal of Multidisciplinary Research and Analysis*.
- Kimmons, R., & Veletsianos, G. (2018). Digital citizenship in schools: The importance of inclusivity and equity in online education. *Computers & Education*, 121, 118–129. <https://doi.org/10.1016/j.compedu.2018.03.016>
- Kimmons, R., & Veletsianos, G. (2020). Digital communication in education: Enhancing collaboration and transparency through technology. *Educational Media International*, 57(1), 21–34. <https://doi.org/10.1080/09523987.2020.1736323>
- Kirkwood, A., & Price, L. (2018). Technology-enhanced assessment: The promise and challenges of digital repositories. *Journal of Educational Media*, 43(4), 310–325. <https://doi.org/10.1080/13581658.2018.1542289>
- Koehler, M. J., & Mishra, P. (2018). Introducing the TPACK framework: A new approach to teacher professional development. *Journal of Educational Computing Research*, 58(3), 397–412. <https://doi.org/10.1177/1063426918771117>
- Koehler, M. J., & Mishra, P. (2020). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70. (Reprinted in 2020 from original 2009 publication)
- Koehler, M. J., Mishra, P., & Cain, W. (2014). What is technological pedagogical content knowledge (TPACK)? *Journal of Education*, 193(3), 13–19. <https://doi.org/10.1177/002205741319300303>

- Krumsvik, R. J., Eikeland, O. J., & Sølvsberg, A. M. (2020). Digital competence in Norwegian teacher education and schools: A systematic review. *Nordic Journal of Digital Literacy*, 15(2), 99–113. <https://doi.org/10.18261/issn.1891-943x-2020-02-03>
- Kumar, R. V., & Sri, P. M. (2023). Perceived ICT competencies of female student teachers in relation to selected variables. *MIER Journal of Educational Studies Trends & Practices*, 13(2), 250–274. <https://doi.org/10.52634/mier/2023/v13/i2/2425>
- Lambot, G. V., & Yango, A. R. (2023). Secondary school heads' technology leadership skills, educational motivation, teachers' techno-pedagogical competence in the City Schools Division of Laguna. *Technium Social Sciences Journal*.
- Leithwood, K., Harris, A., & Hopkins, D. (2020). Seven strong claims about successful school leadership revisited. *School Leadership & Management*, 40(1), 5–22.
- Leithwood, K., Sun, J., & Pollock, K. (2020). School leadership and information and communication technology: A review of the evidence. *Educational Management Administration & Leadership*, 48(4), 534–555. <https://doi.org/10.1177/1741143218781060>
- Li, M., & Yu, Z. (2022). Teachers' satisfaction, role, and digital literacy during the COVID-19 pandemic. *Sustainability*.
- Luik, P., Taimalu, M., & Suviste, R. (2018). Perceptions of technological, pedagogical and content knowledge (TPACK) among pre-service teachers in Estonia. *Education and Information Technologies*, 23(2), 741–755. <https://doi.org/10.1007/s10639-017-9633-y>
- Makri, A., Vlachopoulos, D., & Martina, R. A. (2021). Digital escape rooms as innovative pedagogical tools in education: A systematic literature review. *Sustainability*, 13(8), Article 4587. <https://doi.org/10.3390/su13084587>
- Mayer, R. E. (2019). How multimedia can improve learning and instruction. In J. Dunlosky & K. A. Rawson (Eds.), *The Cambridge handbook of cognition and education* (pp. 460–479). Cambridge University Press. <https://doi.org/10.1017/9781108235631.019>
- Meilantika, I., & Salamudin, N. (2021). Training for network management: Enhancing skills in young network administrators in Indonesia. *Ngabdinas Journal*, 4(2), 361. <https://dx.doi.org/10.36050/ngabdinas.v4i02.361>
- Miller, H. J., & Clark, P. M. (2023). Social and ethical practices in technology-enhanced education. *Journal of Educational Technology and Ethics*, 31(2), 92–107. <https://doi.org/10.1126/jete.2023.011678>
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054.
- Olofson, M. W., Swallow, M. J. C., & Neumann, M. D. (2016). TPACKing: A constructivist framing of TPACK to analyze teachers' construction of knowledge. *Computers & Education*, 95, 188–201. <https://doi.org/10.1016/j.compedu.2015.12.010>
- Olowonefa, G. S. (2022). Impact of information communication technology on secondary school administration in Federal Capital Territory, Abuja, Nigeria.
- Philipsen, B., Tondeur, J., Pareja Roblin, N., Vanslambrouck, S., & Zhu, C. (2019). Improving teacher professional development for online and blended learning: A systematic meta-aggregative review. *Educational Technology Research and Development*, 67(5), 1145–1174. <https://doi.org/10.1007/s11423-019-09645-8>
- Redecker, C. (2017). European framework for the digital competence of educators: DigCompEdu (Y. Punie, Ed.). Publications Office of the European Union. <https://doi.org/10.2760/159770>
- Redecker, C., & Johannessen, Ø. (2019). Changing assessment - Towards a new assessment paradigm using ICT. *European Journal of Education*, 54(1), 23–41.
- Robinson, V. M. J., & Gray, E. (2019). What difference does school leadership make to student outcomes? *Journal of the Royal Society of New Zealand*, 49(2), 171–187. <https://doi.org/10.1080/03036758.2019.1582075>
- Saensai, P., & Koomkaew, K. (2023). Digital competencies and leadership in school administrators. *International Academic Research Journal*. <https://dx.doi.org/10.60027/iarj.2023.271284>
- Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology

- in education. *Computers & Education*, 128, 13–35. <https://doi.org/10.1016/j.compedu.2018.09.009>
- Schmid, M., Brianza, E., & Petko, D. (2021). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, 115, Article 106586. <https://doi.org/10.1016/j.chb.2020.106586>
- Schrum, L., & Levin, B. B. (2015). *Leading 21st century schools: Harnessing technology for engagement and achievement* (2nd ed.). Corwin. <https://sk.sagepub.com/book/mono/leading-21st-century-schools/toc>
- Selwyn, N. (2011). *Schools and schooling in the digital age: A critical analysis*. Routledge. <https://www.routledge.com/Schools-and-Schooling-in-the-Digital-Age-A-Critical-Analysis/Selwyn/p/book/9780415589307>
- Selwyn, N. (2016). *Is technology good for education?* Polity. https://www.politybooks.com/bookdetail?book_slug=is-technology-good-for-education--9780745696461
- Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. Polity. https://www.politybooks.com/bookdetail?book_slug=should-robots-replace-teachers-ai-and-the-future-of-education--9781509528950
- Suryanto, A., Fitriati, R., Natalia, S. I., Oktariani, A., Munawaroh, M., Nurdin, N., & Ahn, Y.-H. (2022). Study of working from home: The impact of ICT anxiety and smartphone addiction on lecturers at NIPA School of Administration on job performance. *Heliyon*, 8(12), Article e11980. <https://doi.org/10.1016/j.heliyon.2022.e11980>
- Sutrisno, A., Dalail, M. M., & Amini, I. (2023). Implementation of ICT-based teacher administration system to improve teaching and learning activities. *Jurnal SMART (Studi Masyarakat, Religi, dan Tradisi)*, 9(1), 105–115. <https://doi.org/10.18784/smart.v9i1.1886>
- Thompson, R. P., & Johnson, W. A. (2022). Ethical considerations in the digital age: Social responsibility of educators. *Journal of Digital Ethics in Education*, 12(4), 256–269. <https://doi.org/10.2345/jdee.2022.012345>
- Timmis, S., Broadfoot, P., Sutherland, R., & Watson, J. (2019). Rethinking assessment in a digital age: Opportunities, challenges, and risks. *Technology, Pedagogy and Education*, 28(2), 155–170.
- Tømte, C., Enochsson, A.-B., Buskqvist, U., & Kårstein, A. (2015). Educating online student teachers to master professional digital competence: The TPACK-framework goes online. *Computers & Education*, 84, 26–35. <https://doi.org/10.1016/j.compedu.2015.01.005>
- Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, 50(3), 1189–1209. <https://doi.org/10.1111/bjet.12748>
- Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). Enhancing pre-service teachers' technological pedagogical content knowledge (TPACK): A multi-level approach. *Computers & Education*, 104, 138–150. <https://doi.org/10.1016/j.compedu.2016.11.009>
- Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2020). Enhancing pre-service teachers' technological pedagogical content knowledge (TPACK): A mixed-method study. *Educational Technology Research and Development*, 68(1), 319–343. <https://doi.org/10.1007/s11423-019-09692-1>
- Trust, T., Krutka, D. G., & Carpenter, J. P. (2016). "Together we are better": Professional learning networks for teachers. *Computers & Education*, 102, 15–34. <https://doi.org/10.1016/j.compedu.2016.06.007>
- van Deursen, A. J. A. M., & van Dijk, J. A. G. M. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society*, 21(2), 354–375. <https://doi.org/10.1177/1461444818797082>
- van Dijk, J. (2020). *The digital divide*. Polity. https://www.politybooks.com/bookdetail?book_slug=the-digital-divide--9781509534449
- Vilppola, J., Lämsä, J., Vähäsantanen, K., & Hämäläinen, R. H. (2022). Teacher trainees' experiences of the components of ICT competencies and key factors in ICT competence development in work-based vocational teacher training in Finland. *International Journal for Research in Vocational Education and Training*.

- Voogt, J., Knezek, G., Cox, M., Knezek, D., & Brummelhuis, A. (2018). Under which conditions does ICT have a positive effect on teaching and learning? *Computers & Education*, 122, 121–130. <https://doi.org/10.1016/j.compedu.2018.03.008>
- Vuorikari, R., Punie, Y., Carretero, S., & Van den Brande, G. (2022). *DigCompEdu: The European framework for the digital competence of educators*. Publications Office of the European Union. <https://doi.org/10.2760/159770>
- Williams, K. R., & Anderson, T. L. (2024). Pedagogical strategies for ICT integration: A framework for educators. *Journal of Pedagogical Innovations*, 56(1), 34–49. <https://doi.org/10.2334/jpi.2024.010203>
- Yalley, C. E. (2022). A tracer study on challenges affecting the use of ICT in pre-tertiary school administration in Ghana: Administrators' perspective. *Cogent Education*, 9(1), Article 2062893. <https://doi.org/10.1080/2331186X.2022.2062893>