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Digital Teacher Competence Levels in Elementary Schools on Learning and Knowledge Technologies (LKT)

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Abstract

This study examines the digital competency levels of elementary school teachers in Tecapán, El Salvador, with a focus on their ability to effectively utilize learning and knowledge technologies (LKT) in line with the Common Framework for Teacher Digital Competence (CFTDC). Employing a descriptive research design, data were gathered from a sample of 47 participants, including teachers, principals, and vice principals, using a 21-item online questionnaire. The instrument assessed five core dimensions of digital competence: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Results indicate that 72.2% of respondents demonstrate an intermediate level of digital competence. Notable strengths were observed in communication and collaboration (mean = 13.28), while significant weaknesses were identified in information and data literacy (mean = 6.49). Based on these findings, the study recommends targeted professional development initiatives to address identified gaps, particularly in data literacy and critical information handling. Enhancing teachers' digital proficiency is essential to promoting equitable access and effective integration of educational technology in elementary learning environments.

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Keywords: Digital Teacher Competencies; Learning and Knowledge Technologies; Blended Learning; Online Learning Environments; Technological Training Needs

INTRODUCTION

The rapid integration of learning and knowledge technologies (LKT), such as interactive whiteboards, learning management systems (LMS), and digital educational resources, has significantly transformed elementary education. As a result, there is a growing need for teachers to adapt their skill sets in order to foster engaging and inclusive learning environments. In particular, digital competence—encompassing the knowledge, skills, and attitudes required to effectively use LKTs—is essential for elementary school teachers to address the diverse needs of young learners. Nevertheless, many teachers encounter difficulties in pedagogically integrating these technologies, primarily due to inadequate training, limited infrastructure, or resistance to change. Consequently, this situation presents a major challenge in achieving equitable and effective education within digital classrooms.

The importance of digital competence is underscored by its role in enhancing student engagement, as well as supporting differentiated instruction and preparing students for a technology-driven world. In this context, frameworks like the European DigCompEdu and TPACK emphasize the necessity for teachers to combine technical proficiency with effective pedagogical strategies (Voithofer & Nelson, 2020; García-Vandewalle et al., 2023). Moreover, the COVID-19 pandemic accelerated the adoption of learning and knowledge technologies (LKT), thereby exposing both advancements and persistent gaps in teachers' capacities to use tools such as learning management systems for interactive learning (Toribio-López et al., 2024). However, elementary education presents distinct challenges, given that young learners need developmentally appropriate digital tools, and teachers require specialized training to meet these specific needs.

Recent studies indicate that, while secondary and higher education have received significant attention, research on digital competencies in elementary contexts remains limited. For instance, Tzafilkou et al. (2023) found that elementary teachers often lag in advanced LKT applications, such as digital assessment, mainly due to insufficient professional development (PD). Likewise, Kuş & Mert (2024) observed that infrastructure

disparities in elementary schools, especially in rural areas, hinder the development of digital competence. Therefore, this research gap underscores the need for studies that focus specifically on digital competencies in elementary education, given that the needs of teachers differ significantly from those of professors in higher education. Finally, the current study significantly contributes to the understanding of digital teacher competencies in elementary education, particularly in the context of Tecapán, El Salvador.

This study sets out to examine elementary school teachers' competency levels in the use of learning and knowledge technologies (LKT). It focuses on pinpointing areas where skills are lacking, identifying which professional development strategies are most effective, and suggesting a framework to help build stronger digital competence in this setting. By tackling these key issues, the research aims to support fairer and more effective use of technology in elementary classrooms.

Literature Review

The COVID-19 pandemic has drastically transformed the educational landscape, necessitating a swift transition to online teaching and highlighting the critical importance of digital competencies among teachers. This literature review explores the range of research findings regarding digital teacher competencies in elementary schools, particularly in the context of learning and knowledge technologies (LKT). The synthesis of these findings reveals significant challenges, the necessity for enhanced training programs, and gaps in existing research that can inform future directions.

Digital teacher competencies

The rapid shift to online education during the pandemic underscored the need for teachers to possess robust technological pedagogical knowledge and access to ICT tools. König et al. (2020) emphasized that these competencies were essential for maintaining social contact with students and navigating teaching challenges during unprecedented times. This finding aligns with the broader understanding that elementary teachers must develop digital skills to effectively utilize LKT, especially in emergencies (König et al., 2020). "Teacher digital competence (TDC) goes beyond technical skills. Teachers must be able to make decisions on which resources they use and how they use them, depending on the work situation and context" (Domínguez-González et al., 2025, p. 1).

Joshi et al. (2020) further supported this notion by identifying barriers faced by teachers in India, such as inadequate training and lack of technical support, which hindered

their ability to engage effectively in online education. The implication is clear: without adequate training and professional development, teachers may struggle to implement effective learning technologies, revealing a pressing need for structured programs that equip educators with necessary digital competencies. DTC is a fundamental aspect of education in a world increasingly permeated by technology, encompassing diverse digital skills indispensable for educational performance" (Gallego Joya et al., 2025, p. 1).

Training needs and professional development

The literature indicates a consensus on the necessity for enhanced teacher training programs focused on digital skills. Sánchez-Cruzado et al. (2021) highlighted a general low self-perception of digital competencies among Spanish teachers, advocating for systematic training plans to foster digital literacy. This is critical in an era where effective teaching increasingly relies on the integration of technology into pedagogical practices. "It is important to highlight that continuous training and professional development are essential for improving DTC, given that technologies are constantly evolving. The digital transformation of educational organizations requires ongoing training and innovation programs" (Palacios-Rodríguez et al., 2025, p. 180).

Moreover, Mannila et al. (2018) discussed the significant impact of professional development on teachers' self-efficacy regarding teaching computing and engineering, further illustrating the need for ongoing training in digital competencies. The findings suggest that teachers' beliefs and confidence in using technology can be significantly enhanced through targeted professional development programs. Furthermore, Domingo-Coscolla et al. (2020) emphasize the necessity of linking teacher training with societal needs, particularly as developing teachers' digital competencies... crucial for the professional development of future educators.

Blended learning and digital-based learning

The adoption of blended learning (BL) strategies is a pertinent consideration in the context of digital competencies. While primarily focused on higher education, Bokolo et al. (2020) provided insights into factors influencing the implementation of BL, which can inform elementary education. Understanding these factors is crucial for preparing teachers to adapt to new methodologies that incorporate technology, emphasizing the need for teacher competencies in utilizing blended learning approaches effectively. The integration of digital tools in blended learning environments requires teachers to adapt pedagogical

strategies, ensuring effective student engagement and support through platforms like video conferencing and learning management systems. Eventually, "this aligns with the notion that interactive and enjoyable elements are crucial for maintaining student interest in virtual learning environments" (Romero-Argueta et al., 2025, p. 1251).

Furthermore, Sulaiman and Ismail (2020) explored the perceptions of elementary teachers regarding digital-based learning, asserting that teacher competencies significantly influence student outcomes. The findings reinforce the idea that digital integration is not merely about technology availability but rather about the teachers' abilities to harness technology creatively and effectively. The evolution of information technology-based learning also needs continuous state involvement in the creation of equipment such as electricity and Internet networks, which allows instructors to apply digital pedagogical expertise to improve the learning process" (Bentri et al., 2022, p. 7).

Challenges in online learning environments

The challenges faced by teachers during the transition to online learning have been extensively documented. For instance, Lie et al. (2020) examined language teachers' engagement in online learning amidst the pandemic, identifying factors that affect their teaching practices. Their findings underscore the necessity for teachers to be adaptable and well-versed in technological tools to enhance their online engagement. Similarly, the experiences of primary school students during the pandemic, as explored by Pegalajar-Palomino et al. (2021), highlighted the need for teachers to support students effectively in remote learning environments. Likewise, this "support of virtual environments as facilitators of learning depends on the student's previous experience in virtual learning environments" (Coreas-Flores & Romero-Argueta, 2024, p.18). This indicates that teacher training programs must address competencies that prepare educators to provide adequate support to diverse learners, including those with disabilities (Jimenez et al., 2020). Additionally, while many studies emphasize the necessity for digital competencies, there is less focus on how these competencies can be systematically measured and evaluated in teacher training programs. Future research should explore the development of frameworks that assess digital competencies among teachers, ensuring that training programs can be tailored to address specific needs effectively.

METHODS

The research employs a cross-sectional and descriptive scope, focusing on quantitative data collection to analyze digital competencies in the use of Learning and Knowledge Technologies (LKT) in basic education. Specifically, it utilizes a deductive method, which begins with general theories about digital competencies and LKT to derive specific conclusions applicable to the educational context. For instance, the study builds on a theoretical framework that reviews existing literature on digital skills, LKTs implementation, and their impact on 21st-century teaching and learning skills. Consequently, this approach ensures a structured progression from broad principles to context-specific findings in basic educational institutions.

Instruments

To guide the research, a descriptive statistical analysis was proposed to categorize the digital competency levels among teachers. In particular, this analysis posited significant variations in LKT competency among schools' teachers based on the Common Framework for Teacher Digital Competence (CFTDC). Moreover, data collection involved an online questionnaire with 21 structured items, designed to assess teachers' digital skills, LKTs application in classrooms, and related academic outcomes. The questionnaire demonstrated excellent internal consistency, indicating that its 21 items reliably measure the same underlying construct (see Table 1). Thus, the survey instrument, featuring polytomous frequency response options, ensured quantifiable data for statistical analysis to validate the proposed research objective.

Table 1. ***Reliability Statistics for the Questionnaire Evaluating Digital Competencies***

Reliability statistic	
Cronbach's Alpha	Number of items
0.97	21 items

Population and sampling

The study targeted 47 participants amongst teachers, principals, and vice principals from public basic education schools in Tecapán town, El Salvador, using a census sampling technique to include the entire population. Additionally, the questionnaire was structured

with sections for sociodemographic data and content aligned with research objectives, ensuring confidentiality and anonymity for participants. Subsequently, the collected data underwent statistical analysis to identify significant differences in digital competency levels, particularly between urban and rural settings. As a result, the findings provided evidence-based conclusions to support or challenge the role of digital competencies and LKT in enhancing the teaching-learning process, informing strategies for educational improvement.

Data procedures and analysis strategies

To obtain the data, a questionnaire through Microsoft Survey was used, and it was shared via social media and email. This link included informed consent and the two sections of the instrument, and it was disseminated between September and October 2024. Once this stage was completed, the information was exported through a Microsoft Excel spreadsheet to be transferred to the Jamovi statistical software.

Once the data was organized on Jamovi, each of the corresponding statistical analyses was developed to answer the research objective proposed. Firstly, each subject was characterized. In addition, the descriptive statistics were streamed. Subsequently, a distribution normality test was applied. Finally, differences in Means (M) were examined based on the teachers' answers through the survey, delving only into the descriptive analysis procedure, considering the level of teachers' LKT levels and teachers' digital competences.

RESULTS

Table 2 presents statistical measures for five digital competences, offering insights into their performance and reliability. Furthermore, the mean scores range from 6.49 for "Information and data literacy" to 13.28 for "Communication and collaboration," indicating varying levels of proficiency, with the latter being the strongest and the former the weakest. In addition, standard deviations and variances, both ranging from 1.02 to 2.22, reflect differing levels of score dispersion, with "Communication and collaboration" showing the greatest variability. Moreover, Cronbach's Alpha values, all between 0.77 and 0.88, confirm good internal consistency across all competences, with "Communication and collaboration" achieving the highest reliability (0.88) and "Information and data literacy" the lowest (0.77), though still acceptable. Consequently, this suggests that while all measures are reliable, there is room for targeted improvement in areas with lower means and higher variability.

Table 2. ***Digital competencies areas statistics***

Digital competences	Mean	Standard deviation	Variance	Cronbach's Alpha
Information and data literacy	6.49	1.02	1.02	0.77
Communication and collaboration	13.28	2.22	2.22	0.88
Digital content creation	8.98	1.55	1.55	0.84
Safety	9.02	1.66	1.66	0.85
Problem solving	8.79	1.56	1.56	0.82

Table 3 breaks down "Information and data literacy" into three sub-components, providing a de-tailed view of its structure. Besides, the sub-components—browsing, searching, and filtering (33.11%), evaluating (33.78%), and managing (33.11%)—are nearly evenly distributed, with evaluat-ing showing a slight edge. This balanced distribution indicates that all aspects are comparably em-phasized, though the marginal lead in evaluating (33.78%) might suggest it is a slightly more critical or developed skill within this competence. In addition, the consistency across these percentages highlights a well-rounded approach to information and data literacy, with no single sub-component dominating the others.

Table 3. ***Information and data literacy***

Competences	Percentage
Browsing, searching and filtering data, information, and digital content	33.11 %
Evaluating data, information, and digital content	33.78 %
Managing data, information, and digital content	33.11 %
Total	100 %

Table 4 illustrates the breakdown of "Information and collaboration" into five sub-components, providing a comprehensive view of its structure. Initially, "Interacting through digital technologies" leads with the highest percentage at 17.79%, indicating it is the most emphasized skill within this competence. Furthermore, "Sharing information and content through digital technologies" follows closely with 16.83%, suggesting a strong focus on information exchange. In addition, "Engaging in citizenship through digital technologies" and "Collaborating through digital technologies" both register at 16.51% and 15.87% respectively, reflecting a balanced but slightly lower emphasis on civic engagement and

teamwork. Moreover, "Netiquette" and "Managing digital identity" trail with 16.67% and 16.6% respectively, showing a moderate but consistent contribution to the overall competence. This distribution highlights a well-rounded approach, with a slight dominance in in-teraction skills, which may indicate their perceived importance or higher development in the sample.

Table 4. ***Information and collaboration***

Competences	Percentage
Interacting through digital technologies	17.79 %
Sharing information and content through digital technologies	16.83 %
Engaing in citizenship through digital technologies	16.35 %
Collaborating through digital technologies	15.87 %
Netiquette	16.51 %
Managing digital identity	16.67 %
Total	100 %

Table 5 delineates the "Digital content creation" competence into four sub-components, offering a detailed perspective on its composition. Initially, "Developing digital content," "Integrating and elaborating digital content," and "Copyright and licenses" each contribute 25.12%, highlighting a remarkably balanced distribution and a robust focus on these core areas. Furthermore, "Program-ming" trails slightly at 24.64%, indicating its relevance while suggesting a marginally reduced empha-sis. In addition, this consistent spread across the sub-components underscores a well-integrated strategy for enhancing digital content creation skills. Consequently, the minor dip in "Programming" might indicate a lower priority or a less developed competency in this domain.

Table 5. ***Digital content creation***

Competences	Percentage
Developing digital content	25.12 %
Integrating and re-elaborating digital content	25.12 %
Copyright and licences	25.12 %
Programming	24.64 %
Total	100 %

Table 6 dissects the "Safety" competence into four unique sub-categories, delivering an in-depth understanding of its apportionment. To commence, "Protecting devices"

establishes an initial benchmark at 24.76%, acting as a foundation for the set, while "Protecting personal data and pri-vacy" follows narrowly at 25.00%, hinting at a slight uptick in attention to data safeguarding. More-over, "Protecting health and well-being" corresponds with "Protecting devices" at 24.76%, signify-ing an equivalent focus on personal welfare alongside device protection. Additionally, "Protecting the environment" advances slightly with 25.47%, indicating a minor preference for ecological preservation. As a result, this highly even distribution, with figures ranging from 24.76% to 25.47%, emphasizes a well-balanced safety approach where each component is given similar prominence.

Table 6. ***Safety***

Competences	Percentage
Protecting devices	24.76 %
Protecting personal data and privacy	25.00 %
Protecting health and well-being	24.76 %
Protecting the environment	25.47 %
Total	100 %

Table 7 segments the "Problem-solving" competence into four sub-elements, delivering an exhaus-tive perspective on its makeup. Initially, "Solving technical problems" commences at 23.49%, laying a somewhat reduced foundation relative to the others, while "Identifying needs and technological responses" rises to 25.18%, indicating a slightly elevated interest in this field. Moreover, "Creatively using digital technologies" escalates to 25.67%, underscoring a notable focus on technological orig-inality, and "Identifying digital competence gaps" peaks at 25.87%, hinting at a marginal inclination toward recognizing deficiencies. Therefore, this fairly consistent distribution, with values ranging from 23.49% to 25.87%, accentuates a well-rounded approach to problem-solving, where all as-pects are equally appreciated.

Table 7. ***Problem solving***

Competences	Percentage
Solving technical problems	23.49 %
Identifying needs and technological responses	25.18 %
Creatively using digital technologies	25.67 %
Identifying digital competence gaps	25.67 %
Total	100 %

Figure 1 outlines teachers' digital competences across various sub-components, offering a concise view of their distribution. Initially, "Identifying digital competence gaps" and "Creatively using digi-tal technologies" top at 4.84% each, emphasizing gap detection and innovation. Additionally, "Identifying needs and technological responses" (4.75%), "Solving technical problems" (4.43%), and "Protecting the environment" (4.94%) show balanced focus. Likewise, "Protecting health and well-being" (4.80%), "Protecting personal data and privacy" (4.84%), and "Protecting devices" (4.80%) highlight safety concerns. Furthermore, "Copyright and licenses" (4.75%), "Integrating and re-elaborating digital content" (4.84%), and "Developing digital content" (4.84%) reflect content creation balance. Finally, "Collaborating through digital technologies" (4.52%), "Engaging in citizenship" (4.66%), and "Interacting through digital technologies" (5.07%) indicate varied emphasis, with "Managing data, information, and digital content" (4.62%) and others like "Evaluating" (4.71%) and "Browsing" (4.62%) following. Thus, this range from 4.43% to 5.07% points to a comprehensive approach, influenced by educational needs.

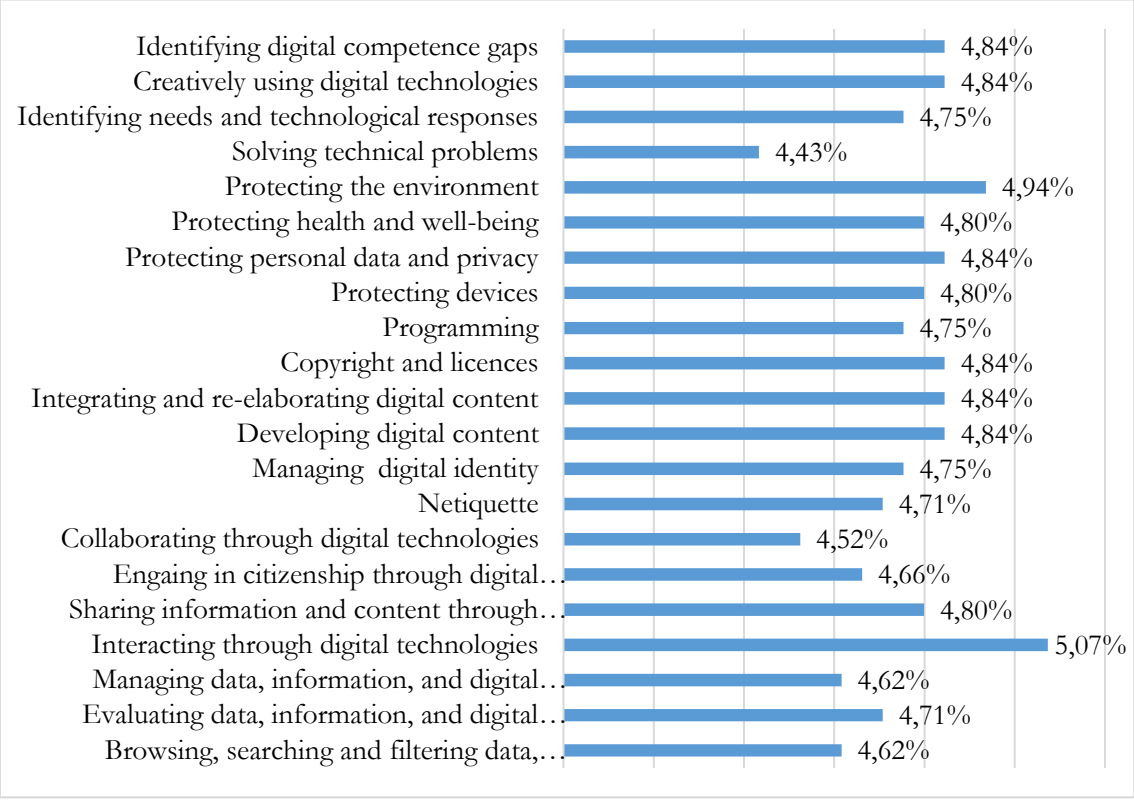


Figure 1. Teachers' digital competences

Figure 2 classifies the competence levels of teachers in learning and knowledge technologies into three categories, offering a concise insight into their spread. Initially, the

"Basic level" constitutes a mere 2.38%, pointing to a scarce representation at this stage. Furthermore, the "Intermediate level" prevails with a commanding 72.2%, indicating that most teachers hold a moderate skill set in this area. Additionally, the "Advanced level" contributes 25.62%, showing a significant yet smaller group of highly proficient educators. Consequently, this distribution, spanning from 2.38% to 72.2%, underscores a pronounced focus at the intermediate level, suggesting a potential need for enhanced training to boost advanced competencies.

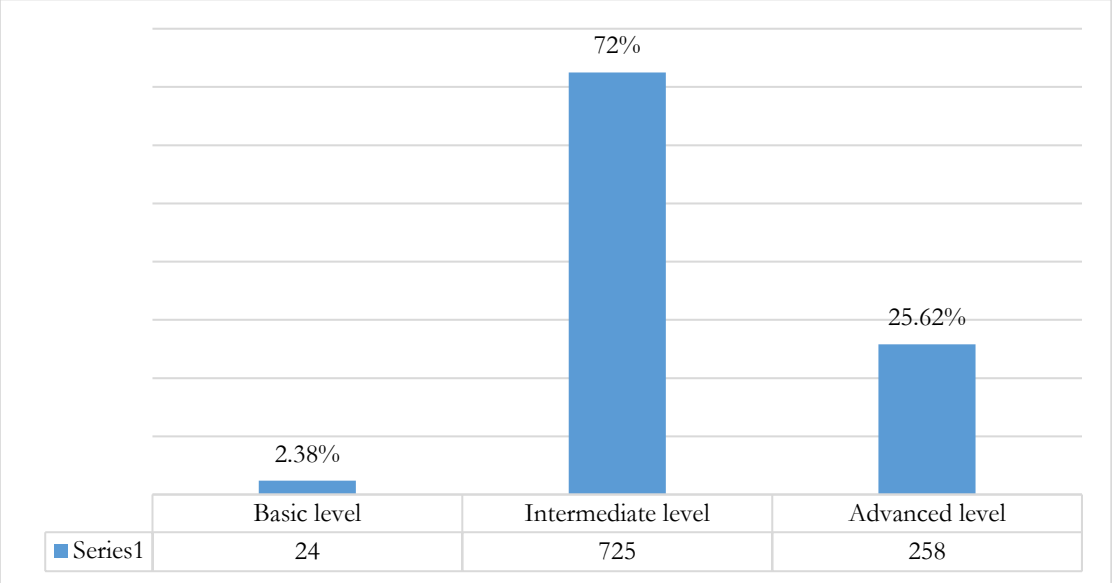


Figure 2. Learning and knowledge technologies teachers' competence levels

Table 8 outlines the statistical measures—mean, standard deviation, and variance—for three com-petence levels of teachers in learning and knowledge technologies, providing a thorough analysis. Initially, the "Basic" level presents a mean of 0.0243, a standard deviation of 0.0672, and a variance of 0.00452, pointing to a low average with little variation. Furthermore, the "Intermediate" level displays a much higher mean of 0.7345, a standard deviation of 0.3155, and a variance of 0.09955, indicating a strong average competence with moderate spread. Additionally, the "Advanced" level features a mean of 0.2614, a standard deviation of 0.3434, and a variance of 0.11790, suggesting a moderate average with the widest variability. Consequently, this distribution highlights the Intermediate level's prominence in mean performance, while the Advanced level's greater dispersion may reflect diverse expertise.

Table 8. ***Statistical measures of teachers' digital competencies level***

Levels	Mean	Standard deviation	Variance
Basic	0.0243	0.0672	0.00452
Intermediate	0.7345	0.3155	0.09955
Advanced	0.2614	0.3434	0.11790

DISCUSSION

This study aimed to assess the digital competence levels of elementary school teachers in Tecapán, El Salvador, in utilizing Learning and Knowledge Technologies (LKT) and to identify areas for professional development. The results indicate that 72.2% of teachers operate at an intermediate competency level, with only 2.38% at a basic level and 25.62% at an advanced level, according to the Common Framework for Teacher Digital Competence (CFTDC). Among the five competen-cy areas, Communication and Collaboration scored the highest (mean = 13.28, SD = 2.22, Cronbach's Alpha = 0.88), while Information and Data Literacy was the weakest (mean = 6.49, SD = 1.02, Cronbach's Alpha = 0.77). These findings confirm the research objective of identifying varying competence levels and highlight the need for targeted interventions to address skill gaps.

The predominance of intermediate-level digital competences suggests that most teachers in Tecapán possess a foundational ability to integrate LKT into their teaching but lack advanced skills for sophisticated applications, such as digital assessment or content creation. The high mean score in "Communication and collaboration" reflects teachers' proficiency in using digital tools for inter-action, likely driven by the necessity of online engagement during the COVID-19 pandemic. Con-versely, the low score in "Information and data literacy" indicates challenges in navigating and eval-uating digital resources, which may hinder effective lesson planning and resource utilization. The urban-rural disparity underscores the role of infrastructure in enabling digital competence, with rural teachers facing barriers like limited internet access. These results suggest that while teachers are adapting to digital demands, targeted training is essential to elevate their skills to advanced levels, particularly in underrepresented areas.

The findings align with prior research highlighting the uneven development of digital competences among elementary teachers. Tzafilkou et al. (2023) noted similar deficiencies in advanced LKT ap-plications, particularly in digital assessment, attributing them to

insufficient professional develop-ment, which corroborates the low scores in Information and "Data literacy" observed in this study. Similarly, Kuş and Mert (2024) identified infrastructure disparities in Turkey, particularly in rural areas, mirroring the urban-rural divide in Tecapán. However, this study's emphasis on "Communi-cation and collaboration" as a strength contrasts with Sánchez-Cruzado et al. (2021), who reported generally low self-perceived digital competencies among Spanish teachers, suggesting contextual differences in training or technology adoption. Unlike Bokolo et al. (2020), who focused on blend-ed learning in higher education, this study's focus on elementary contexts highlights unique chal-lenges for younger learners, reinforcing the need for developmentally appropriate digital strategies.

The results have significant implications for enhancing digital education in elementary schools. By identifying "Communication and collaboration" as a strength, schools can leverage these skills to foster peer-learning networks, enabling teachers to share best practices in LKT use. The identified weaknesses in Information and "Data literacy" call for targeted professional development pro-grams focusing on data management and evaluation skills, which are critical for evidence-based teaching. Addressing the urban-rural disparity requires investment in infrastructure, such as reliable internet and devices in rural schools, to ensure equitable access to LKT. Furthermore, the proposed framework for professional development can guide policymakers in designing systematic training programs, aligning with frameworks like DigCompEdu to promote sustainable digital integration in elementary education, ultimately enhancing student engagement and learning outcomes.

This study has some limitations that warrant consideration. The sample size of 47 participants from Tecapán, El Salvador, limits the generalizability of findings to other regions or educational contexts. The reliance on self-reported data through the questionnaire may introduce bias, as teachers' per-ceptions of their competences may not fully reflect their actual skills. Additionally, the study focused on a specific set of LKT tools, potentially overlooking emerging technologies like AI-based educational applications. Finally, the cross-sectional design provides a snapshot of competence but does not capture longitudinal changes or the impact of interventions over time.

Future research should address the identified limitations by expanding the sample size and scope to include diverse regions and educational settings, enhancing generalizability. Developing objective assessment tools, such as performance-based evaluations, could

complement self-reported data to provide a more accurate measure of digital competencies. Exploring the impact of specific professional development interventions, particularly those targeting "Information and data literacy", would offer practical insights for training programs. Additionally, longitudinal studies could track changes in competency levels over time, assessing the effectiveness of infrastructure improvements and training initiatives. Finally, investigating the integration of emerging technologies, such as AI and virtual reality, in elementary education could further refine the CFTDC framework, ensuring its relevance in a rapidly evolving digital landscape.

CONCLUSION

This study successfully examined teachers' competence levels in Learning and Knowledge Technol-ogies (LKT) among 47 elementary school educators in Tecapán, El Salvador, revealing that 72.2% possess intermediate proficiency, 25.62% advanced, and 2.38% basic, as measured by the Common Framework for Teacher Digital Competence (CFTDC). Specifically, teachers demonstrated strong proficiency in "Communication and collaboration" (mean = 13.28), indicating effective use of digital tools for interaction. In contrast, they showed weaknesses in "Information and data literacy" (mean = 6.49), reflecting challenges in managing digital resources. Overall, these findings fulfill the objective by providing a detailed profile of LKT competences, thereby guiding targeted profes-sional development to strengthen technology integration in elementary education.

In alignment with the objective of examining LKT competence levels, the study found that 72.2% of teachers in Tecapán operate at an intermediate level, with only 25.62% achieving advanced pro-ficiency and 2.38% at a basic level, according to the CFTDC framework. While high performance was observed in "Communication and collaboration" (mean = 13.28), it stands in contrast to the lower proficiency in "Information and data literacy" (mean = 6.49), thus highlighting a skewed skill distribution. As a result, these findings provide a clear understanding of teachers' LKT capabilities, which in turn enables the design of focused training programs to address specific competence gaps and enhance digital teaching effectiveness.

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