



Levels of Digital Literacy and Teaching Performance among Early Childhood Education Teachers: An Input for Enhancement Program

April Lyn F. Enterina

Tubod College- Tubod, Lanao del Norte, Philippines

E-mail: enterinaaprillyn55@gmail.com ORCID ID: <https://orcid.org/0009-0008-3688-4182>

Janilou A. Juntilla

Tubod College- Tubod, Lanao del Norte, Philippines

E-mail: janiloujuntilla70@gmail.com ORCID ID: <https://orcid.org/0009-0002-3514-0698>

Carl Jay I. Oliveros

Tubod College- Tubod, Lanao del Norte, Philippines

E-mail: carljay.oliveros@sccpag.edu.ph ORCID ID: <https://orcid.org/0009-0006-7198-415X>

Favejane S. Oporto

Tubod College- Tubod, Lanao del Norte, Philippines

E-mail: ofavejane@gmail.com ORCID ID: <https://orcid.org/0009-0006-7118-8006>

Elliana Grace C. Tapao

Tubod College- Tubod, Lanao del Norte, Philippines

Ellianagracetapao62@gmail.com ORCID ID : <https://orcid.org/0009-0000-3831-3473>

Received 30/11/2025

Revised 19/01/2026

Accepted 21/02/2026

Abstract

Background and Aim: Digital literacy (DL) is a core 21st-century competency for Early Childhood Education (ECE) teachers, essential for fostering foundational skills in young learners and ensuring effective instructional quality in a digital world. A significant gap currently exists in the consistent pedagogical integration of digital tools, often due to insufficient specialized training, limited institutional support, and a lack of knowledge regarding developmentally appropriate technology use. This study investigated ECE teachers' levels of digital literacy and determined their predictive relationship with their measured teaching performance, encompassing functional skills, critical thinking, and ethical digital practice.

Materials and Methods: A quantitative descriptive-correlational design was employed, using validated instruments (specifically a Digital Literacy Scale and a Classroom Observation Tool) administered to a sample of 30 early-grade educators.

Results: Participants demonstrated high levels of digital literacy, which was confirmed as a significant positive predictor of high teaching performance (Spearman's $\rho = 0.589, p < 0.001$). Professional engagement also emerged as a critical driver and strong predictor.

Conclusion: The study implies that educational institutions must develop supportive policies and continuous professional development programs that strategically combine digital skills training with initiatives to foster sustained professional engagement, thereby elevating the overall quality of ECE technology integration and teacher effectiveness.

Keywords: Digital literacy, Teaching Performance, Early Childhood Education, Professional Engagement, Instructional Quality

Introduction

Educators, including Early Childhood Education (ECE) teachers, are now required to develop essential digital literacy skills as educational institutions globally integrate technology into traditional teaching practices. Over the past decade, educational policies worldwide have adopted curricula prioritizing digital skills, driving the mass implementation of digital resources in ECE classrooms. The varied levels of digital literacy among ECE teachers inevitably lead to differing levels of teaching performance, affecting their ability to teach effectively while maintaining student interest. This study is conceptually grounded in essential theoretical concepts that explore the effects of digital literacy on teaching performance outcomes for early childhood educators. According to Cognitive





Load Theory (Sweller, 1988), digital literacy functions as a factor that shapes how educators manage information, thereby determining their capability to execute technology-based teaching methods effectively. Educators with advanced digital competencies can diminish unnecessary mental workload, dedicating greater attention to improving teaching methodology and interacting with students. Furthermore, Social Cognitive Theory (Bandura, 1997) posits that self-efficacy influences educators' teaching performance. Through Bandura's concept of observational learning, digitally skilled teachers acquire new teaching strategies by encountering innovative educational resources and tools.

The primary objective of this study was to measure ECE teachers' digital skills in educational tools and investigate their relationship with teaching competencies, thereby exploring Early Childhood teaching performance. Assessing the digital literacy of ECE teachers is necessary to determine their training and resource needs for competency improvement and overall educational effectiveness. The research specifically investigated digital literacy and training programs for effectiveness assessment at a specified Day Care Center in the Preschool of Tubod, Lanao Del Norte.

Objectives

The objectives of this study were to:

1. Determine the profile of Early Childhood Education (ECE) teachers in terms of educational attainment, teaching experience, and training received.
2. Assess the level of digital literacy among ECE teachers, including the effectiveness of digital literacy training and the integration of digital skills.
3. Identify the challenges ECE teachers face in strengthening their teaching performance, specifically regarding communication, pedagogical knowledge, and professionalism.
4. Determine the relationship between ECE teachers' digital literacy and their teaching performance.
5. Propose an enhancement program based on the findings to improve teaching performance.

Literature review

Recent studies consistently highlight the growing importance of digital literacy and professional development in enhancing teachers' instructional effectiveness, particularly in technology-integrated learning environments. Ji et al. (2024) demonstrated the strong potential of digital resources and tools in improving STEM instruction, emphasizing that teachers' ability to effectively distribute and utilize digital resources is closely tied to the quality of digital professional development they receive. Their findings suggest that access to digital tools alone is insufficient; rather, sustained and well-structured professional development programs are essential to ensure meaningful classroom integration. Similarly, evidence from a study conducted in Central Java, Indonesia, underscores the role of systematic training in strengthening teachers' digital competencies. Using a quality-based management model that incorporated observations, interviews, and questionnaires, the study reported a substantial improvement in teachers' basic digital literacy following a continuously designed training program, with proficiency levels increasing from 62.74% to 84.74%. This indicates that ongoing, context-sensitive digital literacy initiatives can produce measurable gains in teachers' skills. Taken together, these studies suggest that digital professional development functions as a critical mechanism through which digital literacy translates into improved teaching practices, particularly when training is sustained, institutionally supported, and aligned with instructional goals.

Research across different educational contexts highlights the importance of systematic and continuous professional development in strengthening teachers' digital literacy. Using a quality-based management framework, Sari et al (2023) examined how elementary schools in Central Java, Indonesia, enhanced teachers' digital literacy through a structured training program. Employing a qualitative research design involving principals and elementary school teachers, the study utilized observations, interviews, and questionnaires, with data analyzed using Miles and Huberman's interactive model. The findings revealed that a continuously implemented digital literacy training program—guided by the Plan–Do–Check–Action (PDCA) cycle—led to substantial improvements in teachers' basic digital





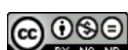
literacy levels, increasing from 62.74% to 84.74%. These results underscore the role of institutional leadership, systematic planning, and ongoing evaluation in ensuring the effectiveness of digital professional development initiatives. Collectively, such evidence suggests that digital literacy development is most effective when embedded within structured management models rather than delivered as one-time training interventions.

The Technological Pedagogical Content Knowledge (TPACK) framework has emerged as a central model in understanding effective technology integration in early childhood education (ECE). Rather than emphasizing isolated technical skills, TPACK highlights the dynamic interaction among content knowledge, pedagogical strategies, and technological tools. In a study conducted in China, Luo et al (2023) validated the relevance and suitability of the TPACK domains within ECE contexts, demonstrating that early childhood educators benefit more from training programs that emphasize pedagogically grounded digital integration than from those focused solely on basic technical competencies. The study argued for a paradigm shift in ECE professional development—from teaching how to use digital tools to cultivating educators' capacity to apply technology meaningfully in developmentally appropriate ways. This perspective aligns with broader literature suggesting that effective digital integration in early childhood settings requires a holistic framework that connects technology use with instructional goals and learner needs.

Scholarly interest in the Technological Pedagogical Content Knowledge (TPACK) framework has grown substantially alongside the rapid development of information and communication technologies in education. Through a large-scale review of 106 peer-reviewed articles indexed in Springer, Irwanto (2021) provided a comprehensive synthesis of TPACK-related research to identify emerging trends and future research directions. The analysis revealed sustained and increasing scholarly attention to TPACK over the past decade, with the framework consistently featured in both the titles and abstracts of the reviewed publications. Methodologically, qualitative research approaches dominated TPACK studies, while quantitative, mixed-methods, and non-empirical designs showed a relative decline. In terms of publication outlets, *The Asia-Pacific Education Researcher* and *TechTrends* emerged as leading journals in disseminating TPACK-related research. These findings suggest that while the conceptual relevance of TPACK is well established, there remains a methodological imbalance in the literature, pointing to the need for more context-specific empirical studies that quantitatively examine how TPACK-related competencies influence teaching outcomes.

Educational policies across various contexts increasingly position formal professional development as a key mechanism for enhancing teachers' pedagogical strategies in digital technology-supported learning environments. In a qualitative study conducted in Ghana, Abedi (2024) examined formal technology-related professional development opportunities and teachers' perceived training needs through interviews with teachers, education officials, and school leaders. While policy frameworks emphasized professional development as a central strategy for promoting higher-order, technology-enhanced learning, the findings revealed a persistent gap between policy intentions and actual practice. Most professional development initiatives focused primarily on general capacity building, with limited attention to pedagogical innovation or emerging technological advancements in classroom integration. This disconnect suggests that formal professional development alone may be insufficient unless it explicitly targets pedagogically grounded and context-responsive technology integration skills.

Teachers' conceptions of learning and teaching play a critical role in shaping pedagogical practices, particularly in the development of students' generic skills. In a large-scale survey study involving higher education teachers, Hyytinen and colleagues (2025) examined the relationships among teachers' conceptions of teaching generic skills, their pedagogical practices, pedagogical training, and teaching experience. Based on responses from 286 teachers, the findings revealed a significant association between teachers' conceptions and their pedagogical practices, indicating that how teachers understand generic skills strongly influences how these skills are taught in practice. In contrast, teaching experience alone was not significantly related to teachers' conceptions of generic skills, although it was linked to certain pedagogical practices. These results highlight the importance of pedagogical training in shaping teachers' conceptual understanding and instructional approaches, suggesting that



professional development should move beyond experience-based learning to explicitly address teachers' beliefs and conceptions related to generic skills development.

Conceptual Framework

The conceptual framework for this research posits that **Digital Literacy** (the Independent Variable) directly influences **Teaching Performance** (the Dependent Variable) among Early Childhood Education teachers. Digital literacy capability is examined through various sub-dimensions, including the effectiveness of digital literacy training, technological pedagogical content knowledge (TPACK), and the integration of digital skills. These factors are expected to affect teaching standards, student relationships, and learning achievements. Teaching performance is operationalized as a multi-dimensional construct encompassing effective communication and collaboration, pedagogical content knowledge, professionalism, and continuous improvement. The framework also considers external elements such as institutional backing, access to digital materials, and professional training opportunities, which may influence the relationship between digital literacy and performance.

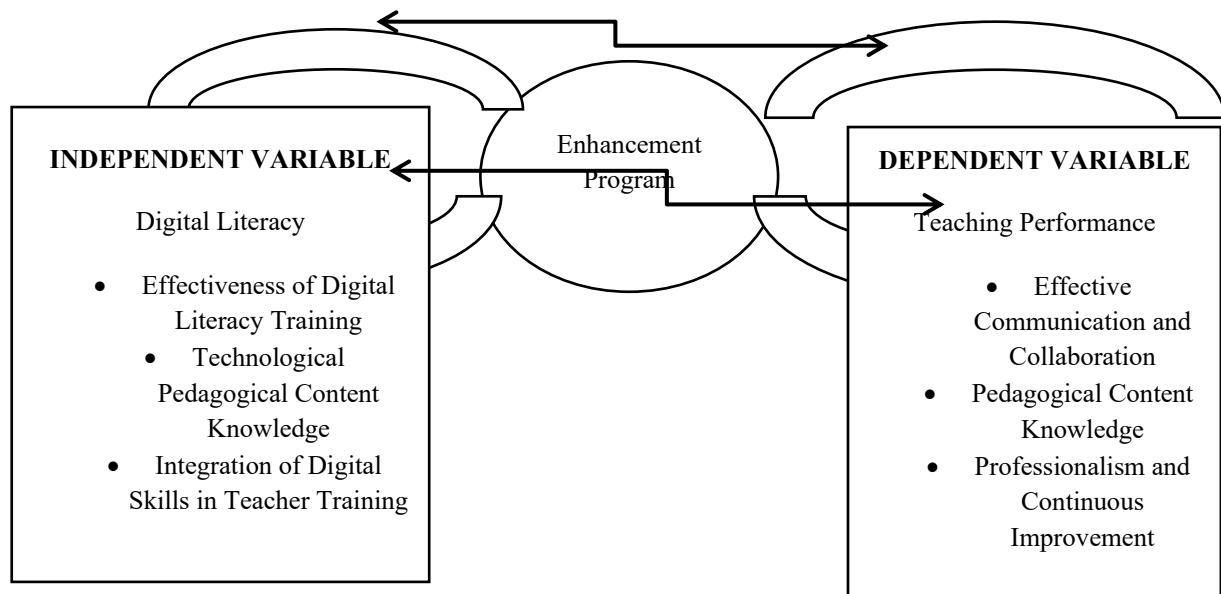


Figure 1: Conceptual Framework

Methodology

Research Design. The study utilized a quantitative descriptive-correlational research design. This design was employed to describe the characteristics of the population and determine the extent of the relationship between the study's variables. The correlational approach provided essential insights into digital literacy levels and teaching approaches, highlighting the need for ongoing professional training to smoothly incorporate technology in early childhood classrooms.

Research Participants. The respondents of this study were Early Childhood Education teachers from both public and private schools in Tubod, Lanao Del Norte. The sample size was determined using purposive sampling, focusing specifically on teachers who actively utilize technology in their teaching practice.

Research Instrument The study employed a **researcher-made questionnaire** as the primary data collection tool. This instrument was structured into three key sections. The first part gathered respondents' demographic information, including educational attainment, years of teaching experience, educational background, and any prior training in digital literacy. The second section assessed digital literacy levels, using items adapted from validated digital literacy frameworks to measure teachers' proficiency in utilizing digital tools, online resources, and educational technologies



in their practice. The final part evaluated teaching performance, drawing from the Teacher Performance Evaluation Rubric, which examined aspects such as instructional planning, classroom management, student engagement, and the integration of technology into lesson delivery. To ensure reliability and validity, the questionnaire was reviewed and validated by experts in the fields of education and research.

Results

1. What is the profile of the respondents in terms of:

Table 1: Respondents' Profile

| | Profile | Frequency | Percent |
|-----------------------------|--|-----------|---------|
| Educational Attainment | Highschool Diploma | 0 | 0 |
| | Child Development Associate | 0 | 0 |
| | Associate degree | 0 | 0 |
| | Bachelor's Degree | 16 | 53.3 |
| | Continuing Education and Certification | 2 | 6.7 |
| | Licensing and Regulation | 12 | 40.0 |
| Number of years' experience | 1-3 years | 4 | 13.3 |
| | 4-6 years | 12 | 40.0 |
| | 7-10 years | 4 | 13.3 |
| | 11+ | 10 | 33.3 |
| Trainings received | Basic Child Development | 12 | 40.0 |
| | Health and Safety Training | 3 | 10.0 |
| | Childcare and Nurturing Skills | 2 | 6.7 |
| | Curriculum and Activity Planning | 2 | 6.7 |
| | Inclusion and Diversity | 1 | 3.3 |
| | Communication with Families | 4 | 13.3 |
| | Professionalism and Ethics | 0 | 0 |
| | Implementing Technology in Early Childhood | 5 | 16.7 |
| Practical Experience | 1 | 3.3 | |

Table 2 Scoring Procedure and Interpretation

| Rating | Scoring Scale | Qualitative Description | Qualitative Interpretation |
|--------|---------------|-------------------------|----------------------------|
| 5 | 4.20 – 5.00 | Strongly Agree | Very High |
| 4 | 3.40 – 4.19 | Agree | High |
| 3 | 2.60 – 3.39 | Neutral | Moderate |
| 2 | 1.80 – 2.59 | Disagree | Low |
| 1 | 1.00 – 1.79 | Strongly Disagree | Very Low |

Legend: 4.20-5.00- Strongly Agree 3.40- 4.19- Agree 2.60-3.39 –Neutral
 1.80- 2.59 – Disagree 1.00-1.79- Strongly Disagree

Table 3: Level of digital literacy among Early Childhood Education teachers

| Variables | Min | Max | Mean | SD | Qualitative Interpretation |
|-----------|-----|-----|------|----|----------------------------|
|-----------|-----|-----|------|----|----------------------------|





| | | | | | |
|---|------|------|------|-------|-----------|
| Effectiveness of Digital Literacy Training | 3.40 | 5.60 | 4.64 | 0.497 | Very High |
| Technological Knowledge | 3.80 | 5.00 | 4.73 | 0.387 | Very High |
| Pedagogical Knowledge | 3.20 | 5.00 | 4.67 | 0.550 | Very High |
| Content Knowledge | | | | | |
| Integration of Digital Skills in Teacher Training | 3.20 | 5.00 | 4.67 | 0.550 | Very High |
| Level of digital literacy (Total) | 3.53 | 5.00 | 4.68 | 0.416 | Very High |

Table 4: Challenges that Early Childhood Education Teachers face in strengthening their teaching performance

| Variables | Min | Max | Mean | SD | Qualitative Interpretation |
|---|------|------|------|------|----------------------------|
| Effective Communication and Collaboration | 1.80 | 5.00 | 3.92 | 1.11 | High |
| Pedagogical Knowledge and Practice | 1.00 | 5.00 | 3.67 | 1.35 | High |
| Professionalism and Continuous Improvement | 1.00 | 5.00 | 3.36 | 1.52 | High |
| Challenges of Early Childhood Education teachers (Total) | 1.40 | 5.00 | 3.65 | 1.27 | High |

Legend: 4.20-5.00- Strongly Agree 3.40- 4.19- Agree 2.60-3.39 –Neutral
 1.80- 2.59 – Disagree 1.00-1.79- Strongly Disagree

Table 5: Relationship between digital literacy and teaching performance

| Variable | Correlation Coefficient (Spearman's rho) | Effect size | p-value | Remarks |
|---|--|-------------|----------|-------------|
| Digital literacy and teaching performance | 0.589 | Moderate | < 0.001* | Significant |

*Correlation is significant at the 0.05 level

Discussion

The findings of this study indicate that early childhood education teachers in Tubod, Lanao del Norte, reported generally high levels of digital literacy, alongside a moderate positive relationship between digital literacy and teaching performance. Rather than merely restating these descriptive results, this discussion situates the findings within relevant theoretical frameworks and prior empirical studies, while also considering alternative explanations and study limitations.

From the perspective of the Technological Pedagogical Content Knowledge (TPACK) framework, the observed association between digital literacy and teaching performance is theoretically plausible. TPACK emphasizes that effective teaching in digital environments depends not only on technical skills but also on the integration of pedagogy and content knowledge. Teachers who reported higher digital literacy may therefore be better equipped to select appropriate digital tools, design developmentally appropriate activities, and support student engagement, which may contribute to stronger teaching performance. This interpretation aligns with previous studies suggesting that pedagogically grounded digital competence is more influential than isolated technical proficiency.

However, the coexistence of high self-reported digital literacy and substantial reported challenges warrants careful interpretation. Drawing on Cognitive Load Theory, teachers may perceive themselves





as digitally competent in general terms but have trouble managing the cognitive demands of integrating technology into instructional practice. Digital tools, when not fully aligned with pedagogical goals, may increase extraneous cognitive load, particularly in early childhood settings where learners require structured, developmentally appropriate support. This tension between perceived competence and having trouble echoes findings from prior research (e.g., Casillas Martín et al. 2020), which caution that self-assessments of digital competence may overestimate actual pedagogical effectiveness.

Social Cognitive Theory further helps explain the relationship between digital literacy and teaching performance by highlighting the role of self-efficacy. Teachers who believe they are digitally competent may demonstrate greater confidence and willingness to experiment with digital tools, which could positively influence classroom practices. At the same time, reliance on self-report measures introduces the possibility of social desirability bias, whereby respondents may rate their abilities more favorably due to professional expectations or perceived norms. This limitation is particularly relevant given the purposive sampling and localized context of the study.

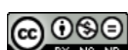
The correlation analysis revealed a moderate positive association between digital literacy and teaching performance; however, this relationship should not be interpreted as causal. Reverse causality is a plausible alternative explanation, as teachers with stronger teaching performance may be more motivated to seek digital training opportunities and develop their digital skills. Additionally, unmeasured contextual factors—such as institutional support, access to digital infrastructure, leadership practices, and availability of professional development—may simultaneously influence both digital literacy and teaching performance. While these factors were acknowledged conceptually, they were not directly measured in the present study and should be addressed in future research.

Taken together, the findings suggest that digital literacy is meaningfully associated with teaching performance among early childhood educators, but this relationship is shaped by pedagogical, psychological, and contextual factors. Rather than concluding that digital literacy predicts teaching performance, a more cautious interpretation is that higher levels of digital literacy are associated with better self-reported teaching performance within this specific context. Future studies employing larger, randomly selected samples, objective performance measures, and multivariate analyses are recommended to further clarify the direction and strength of these relationships.

This Enhancement Program is a **conceptual intervention** derived from the empirical findings of the present study, which revealed (a) generally high self-reported digital literacy among early childhood education teachers, (b) persistent challenges in communication, collaboration, and ethical digital use, and (c) a moderate positive correlation between digital literacy and teaching performance. The program aims to address the gap between perceived digital competence and actual pedagogical challenges by strengthening pedagogically grounded, ethically informed, and context-sensitive digital practices.

Table 6 Logic Model Linking Findings, Program Components, and Outcomes

| Key Empirical Findings | Program Component | Targeted Program Goals | Measurable Outcomes |
|--|---|---|---|
| High digital literacy ratings but continued difficulties in instructional communication and the classroom. | Pedagogical Digital Competence | Enhance teachers' ability to apply digital tools in developmentally appropriate and pedagogically sound ways. | Improved classroom communication strategies; higher post-training pedagogical competence ratings. |
| Limited emphasis on digital ethics, safety, and critical evaluation of digital content. | Critical Digital Literacy and Safety | Strengthen teachers' awareness and application of ethical, safe, and critical digital practices. | Increased knowledge of digital ethics; reduced reported challenges related to |





| Key Empirical Findings | Program Component | Targeted Program Goals | Measurable Outcomes |
|---|---|--|---|
| | | | online safety and misinformation. |
| Digital skills are reported, but inconsistent transfer to real teaching contexts. | Practical Skill Transfer and Application | Bridge the gap between digital knowledge and actual classroom implementation. | Increased frequency of technology-integrated lessons; improved self-reported teaching performance indicators. |
| Need for broader support systems in digital learning environments. | School–Home Partnerships | Promote collaboration between schools and families to support digital learning continuity. | Enhanced parent–teacher communication; improved student engagement in digital activities. |

Description of Program Components

1. Pedagogical Digital Competence

This component focuses on strengthening teachers’ ability to integrate digital tools with pedagogy and content knowledge, consistent with the TPACK framework. Training activities emphasize lesson design, classroom communication, and learner engagement rather than isolated technical skills.

2. Critical Digital Literacy and Safety

Grounded in the finding that ethical and safety-related challenges persist despite high digital literacy, this component addresses responsible technology use, data privacy, digital citizenship, and age-appropriate online practices in early childhood education.

3. Practical Skill Transfer and Application

To address the discrepancy between digital knowledge and classroom practice, this component provides hands-on workshops, peer mentoring, and guided lesson implementation. Digitally proficient teachers mentor colleagues to support the transfer of skills into real instructional contexts.

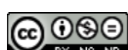
4. School–Home Partnerships

Recognizing the role of contextual and institutional factors, this component encourages collaboration between teachers, parents, and school administrators to reinforce digital learning beyond the classroom and ensure consistent support for young learners.

Knowledge Contribution

This study contributes to the literature on digital literacy and teaching performance by providing context-specific empirical evidence from early childhood education (ECE) teachers in Tubod, Lanao del Norte, a population that remains underrepresented in existing research. While prior studies have largely focused on urban, higher education, or STEM-oriented contexts, this research extends current knowledge by examining digital literacy and teaching performance within a municipal Philippine ECE setting.

The study makes three primary empirical contributions. First, it demonstrates that ECE teachers report very high levels of digital literacy, indicating substantial exposure to and familiarity with digital tools. Second, despite these high self-reported levels, teachers continue to experience notable teaching challenges, particularly in communication, collaboration, and the practical classroom application of digital tools. This finding highlights a misalignment between perceived digital competence and experienced pedagogical challenges, supporting international research that cautions against equating self-reported digital literacy with effective pedagogical digital practice. Third, the study establishes a moderate positive correlation between digital literacy and teaching performance, suggesting that



teachers with higher digital literacy also tend to report stronger teaching performance, while recognizing that this relationship is associative rather than causal.

To integrate these findings coherently, the study advances a clean and unified conceptual model in which Digital Literacy is associated with Teaching Performance, and this relationship informs the design of a contextualized Enhancement Program. The model emphasizes that the Enhancement Program is not an empirically tested intervention, but a conceptual, data-informed output derived from the study's findings and supported by existing literature. The program is intended to address the observed gap between high digital literacy and persistent teaching challenges through targeted professional development.

Importantly, elements such as digital well-being, ethical technology use, and developmentally appropriate digital practices—although not directly measured in this study—are framed as theoretically grounded considerations that strengthen the Enhancement Program, rather than as direct empirical contributions. This distinction preserves conceptual clarity and prevents overextension of the study's claims.

Overall, the contribution of this study lies in (1) providing localized empirical evidence on digital literacy and teaching performance among ECE teachers, (2) identifying a critical gap between perceived digital competence and instructional challenges, and (3) presenting a streamlined conceptual model that translates correlational findings into a practical, context-sensitive professional development framework. These contributions offer a foundation for future research employing more rigorous designs and objective measures, as well as guidance for policymakers and school leaders seeking to enhance digital literacy initiatives in early childhood education contexts like Tubod, Lanao del Norte.

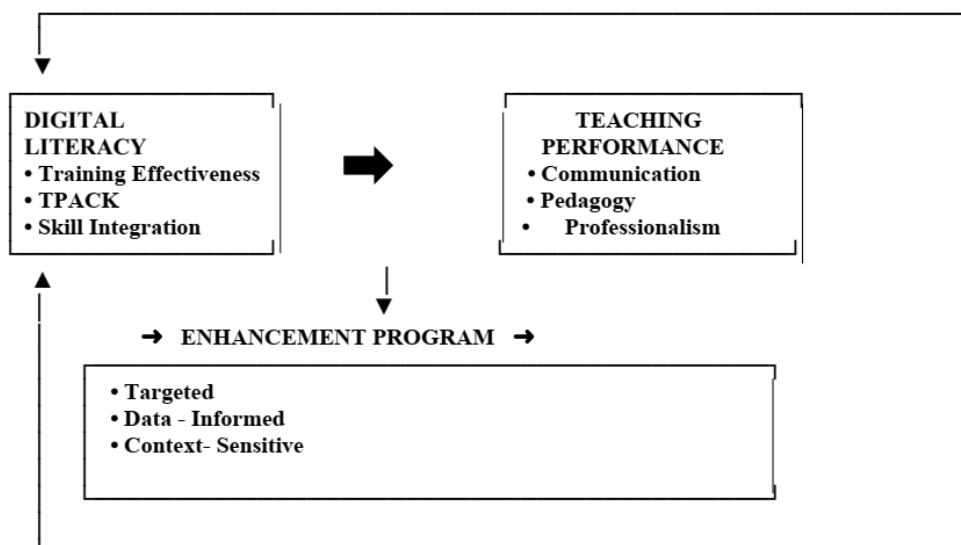


Figure 2: Knowledge Contribution

Recommendations

To enhance clarity and relevance, the recommendations are organized into data-supported recommendations derived directly from the study's findings and literature-informed recommendations that extend beyond the dataset but are grounded in established research.

1. Data-Supported Recommendations

These recommendations are directly informed by the empirical findings of the study.

1.1. Targeted Professional Development Beyond Basic Digital Skills

Although teachers reported very high levels of digital literacy, the presence of persistent teaching challenges—particularly in communication, collaboration, and instructional application—indicates a need to move beyond basic digital skills training. Professional development programs



should focus on pedagogically meaningful integration of digital tools, rather than technical proficiency alone.

1.2. TPACK-Embedded Training for Early Childhood Educators

Given the moderate association between digital literacy and teaching performance, professional development initiatives should explicitly integrate Technological Pedagogical Content Knowledge (TPACK). Emphasis should be placed on developmentally appropriate digital pedagogy suited to early childhood learners.

1.3. Inclusion of Digital Pedagogical Competence in Performance Reviews

The variability observed in professionalism and continuous improvement scores suggests inconsistent application of digital competencies. Schools may consider incorporating digital pedagogical indicators—such as effective digital communication and instructional design—into teacher performance evaluations.

1.4. Structured Support for Communication and Collaboration Skills

Since communication and collaboration emerged as areas of challenge despite high digital literacy, targeted mentoring or peer-coaching initiatives may help teachers translate digital competence into improved professional interaction and classroom practice.

2. Literature-Informed Recommendations

These recommendations are informed by broader research and theory and are proposed as strategic extensions rather than direct outcomes of the study.

2.1. Integration of Digital Ethics and Safety in Teacher Training

Although not directly measured, existing literature highlights the importance of digital ethics, online safety, and responsible technology use, particularly in early childhood education. Training modules addressing these areas may strengthen teachers' holistic digital competence.

2.2. Continuous, School-Based Professional Learning Models

Rather than isolated workshops, schools are encouraged to adopt ongoing, school-based professional development models, such as learning communities or coaching systems, to sustain improvements in digital pedagogical practice.

2.3. Institutional Support and Resource Provision

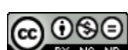
Educational leaders and policymakers should ensure that teachers have adequate access to digital resources, instructional materials, and technical support, as institutional conditions play a critical role in effective technology integration.

2.4. Evaluation and Refinement of the Enhancement Program

The proposed Enhancement Program should be treated as a conceptual framework and subjected to future piloting and evaluation to assess its effectiveness and scalability within early childhood education contexts.

References

- Abedi, E. A. (2024). "We [teachers] first require basic technical [skills] training": Investigating formal professional development pathways and knowledge needs of teachers for technology integration. *Education and Information Technologies*, 29(10), 11793–11814. <https://doi.org/10.1007/s10639-023-12344-w>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.
- Casillas Martín, S., Cabezas González, M., & García-Peñalvo, F. J. (2020). Digital competence of early childhood education teachers: Attitude, knowledge, and use of ICT. *European Journal of Teacher Education*, 43(2), 210–223. <https://doi.org/10.1080/02619768.2019.1681393>
- Hyytinen, H., Jämsä, M., Tuononen, T., & Kleemola, K. (2025). A systematic-narrative review of performance-based assessments of critical thinking in higher education. *Assessment & Evaluation in Higher Education*, 50(8), 1293–1310. <https://doi.org/10.1080/02602938.2025.2553341>
- Irwanto, I. (2021). Research trends in technological pedagogical content knowledge (TPACK): A systematic review. *European Journal of Educational Research*, 10(4), 2049–2054. <https://www.eu-jer.com/>





- Ji, L., Aziku, M., Qiang, F., & Zhang, B. (2024). Exploring the potential of digital resources and tools in STEM instruction. *International Journal of STEM Education*, 11, Article 56. <https://doi.org/10.1186/s40594-024-00513-3>
- Luo, W., Berson, I. R., Berson, M. J., & Park, S. (2023). *An exploration of early childhood teachers' technology, pedagogy, and content knowledge (TPACK) in mainland China. Early Education and Development*, 34(4), 963–978. <https://doi.org/10.1080/10409289.2022.2079887>
- Sari, N. K., Marmoah, S., Nurhasanah, F., Wicaksana, M. F., & Hassaouna, A. T. (2023). Elementary school teachers' reflection activities and feedback in the context of lesson study. *Teknodika*, 21(2), 188–197. <https://doi.org/10.20961/teknodika.v21i2.77989>
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

