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Research Article

Enhancing Teachers' Digital Pedagogy through ICT-Based Training at MIN 1 Padangsidimpuan

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Abstract: The integration of information and communication technology (ICT) is essential for supporting student-centered learning and developing 21st-century skills. However, many primary school teachers still experience difficulties in implementing ICT meaningfully due to limited digital pedagogical competence and a lack of contextualized professional development, particularly in primary and Islamic school contexts. This study aims to explore the implementation and outcomes of an ICT-based teacher training programs conducted through a field study approach, focusing on its influence on teachers' digital pedagogical competence and instructional practices. A qualitative descriptive field study design was employed. Participants were primary school teachers from an Islamic public school in Indonesia who took part in a six-session ICT training programs. Data were collected through observations, documentation of teachers' digital products, and reflective field notes, and analyzed using thematic analysis. The findings reveal improvements in teachers' pedagogical understanding of ICT, technical skills, and readiness for classroom implementation. Teachers produced various ICT-based learning media aligned with instructional objectives, including interactive quizzes, game-based activities, visual materials, animated videos, and digital classrooms. High levels of engagement and collaboration were observed despite infrastructural challenges. Field-based, practice-oriented ICT training effectively bridges technological skills and pedagogical application, supporting sustainable digital pedagogy in primary education.

Keywords: Digital Pedagogy; ICT Integration; Primary Education; Teacher Professional Development; Technology-enhanced Learning

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1. Introduction

The integration of information and communication technology (ICT) in education has become a core component of modern teaching and learning in response to rapid digital transformation and the demand for 21st-century skills. ICT integration supports student-centered learning, fosters engagement, and enhances instructional effectiveness by enabling diverse instructional strategies such as digital simulations, blended learning, and interactive assessments (Caviglia et al., 2024; Moran et al., 2023). Well-designed digital pedagogy can improve teachers' instructional practices, facilitate differentiated learning, and support inclusive education outcomes worldwide.

Despite its potential, many primary school contexts still face persistent challenges in effectively incorporating ICT into everyday teaching. Teachers often lack sufficient digital pedagogical competence and confidence, which constrains their ability to adopt technology meaningfully in classrooms (Alférez-Pastor et al., 2023). A systematic review of primary teacher ICT integration highlights that although ICT tools are widely available, teachers' actual classroom practice frequently remains traditional and teacher-centered, reflecting a gap between policy aspirations and instructional reality.

The professional development of teachers is widely acknowledged as a critical lever for bridging this gap. Empirical studies reveal that generic or one-off training programmes tend to improve technical skills only superficially and do not consistently translate into sustained pedagogical innovation (Dilling et al., 2024; Moran et al., 2023). Furthermore, there is evidence that effective professional development must go beyond technology use to include structured opportunities for reflection, collaborative learning, mentorship, and ongoing support tailored to teachers' specific instructional contexts.

Although research on digital competence training is expanding, several research gaps persist, particularly in primary education contexts. First, most existing studies concentrate on secondary or higher education settings, leaving primary education underexplored in terms of pedagogical change and ICT capacity building (Alférez-Pastor et al., 2023; Norhagen et al., 2024). Second, many studies adopt quantitative measures of competence without qualitatively examining how teachers internalize and apply ICT strategies in authentic classroom environments. Third, limited research has documented field-based, hands-on professional development models such as those conducted through real-world teacher training field studies that can reveal contextual enablers and barriers to ICT adoption in classroom practice.

Moreover, the digital competence gap between inservice and pre-service teachers remains an important issue, with in-service teachers often demonstrating higher digital readiness due to ongoing professional development, but still lacking integrated pedagogical strategies to utilise digital tools effectively. Given these gaps, field-based teacher training models that emphasise practical application, collaborative development of digital materials, and iterative feedback hold promise for enhancing meaningful ICT integration in primary classrooms. However, systematic evidence on such models especially in Islamic primary school settings in developing countries is still limited.

Therefore, this study aims to explore the implementation and outcomes of an ICT-based teacher training programme conducted through a field study at a primary Islamic school in Indonesia, with particular focus on how training influences teachers' digital pedagogical competence and instructional practices in a real world educational context.

2. Research Method

This study employed a qualitative descriptive field study design to examine the implementation and outcomes of an ICT-based teacher training programme in a natural school setting. This design enabled an in-depth exploration of teachers' experiences, engagement, and competence development during structured ICT training activities. A qualitative descriptive approach was selected to capture contextual pedagogical changes that could not be adequately measured through quantitative indicators alone.

The participants were teachers from Madrasah Ibtidaiyah Negeri (MIN) 1 Padangsidimpuan, Indonesia, who voluntarily took part in a six-session ICT-based training programme. The participants had varied teaching experience and digital competence levels, providing a diverse context for observing ICT integration.

Data were collected using ICT training tools (Quizizz, Wordwall, Canva, Powtoon, and Google Classroom), observation guidelines, documentation records (training schedules, attendance, photos, and teachers' digital products), and reflective field notes to capture both process and outcomes of the training.

Data collection was conducted during six training sessions held between November and December 2025. Each session included material delivery, guided practice, independent practice, and reflection. The researcher conducted direct observations and collected documentation and reflective notes throughout the training process.

Data were analyzed using qualitative thematic analysis. Observation notes, documentation, and reflective field notes were coded and categorized to identify key themes related to teachers' digital pedagogical competence, instructional innovation, and implementation challenges.

3. Results and Discussion

This section presents comprehensive findings from the field study, focusing on changes in teachers' digital pedagogical competence following participation in the ICT-based training programme. The results are organized into several subsections to illustrate baseline conditions, cognitive and technical development, types of ICT-based learning media produced, teacher engagement, challenges encountered, and teachers' readiness for classroom implementation.

Initial observations conducted prior to the implementation of the ICT-based training programme indicated that the integration of ICT into classroom instruction was still limited. Most teachers predominantly relied on conventional teaching approaches, such as lecturing and textbook-based instruction, with minimal use of digital tools. ICT was generally perceived as a supplementary resource rather than an integral component of instructional planning and delivery.

Teachers' use of technology was largely confined to basic presentation tools, and interactive digital applications were rarely employed. This condition was influenced by limited prior exposure to educational technology, a lack of structured training, and uncertainty regarding the pedagogical value of ICT. Consequently, teachers showed hesitation in experimenting with digital media during classroom instruction.

Table 1. Teachers' Initial ICT Competence Before Training

Aspect	Observed Condition
Knowledge of ICT-based media	Limited to basic concepts
Practical ICT skills	Minimal hands-on experience
Pedagogical integration	Rarely embedded in lesson plans
Use of interactive applications	Almost never used
Attitude toward ICT	Hesitant and cautious

These baseline findings demonstrate that while teachers possessed basic technological awareness, they lacked the pedagogical competence and confidence necessary for meaningful ICT integration**.**

Changes in Teachers' Cognitive Understanding of ICT Integration

Following participation in the training programme, teachers demonstrated a significant improvement in their cognitive understanding of ICT integration. Teachers became more aware of the pedagogical roles of digital tools, particularly in enhancing student engagement, facilitating formative assessment, and supporting differentiated instruction. ICT was no longer viewed merely as a presentation aid but as a strategic component of instructional design.

Teachers also developed a clearer understanding of how specific digital applications could address particular learning objectives. For example, interactive quizzes were recognized as effective tools for providing immediate feedback, while visual and animated media were perceived as helpful in explaining abstract or complex concepts.

Table 2. Changes in Teachers' Cognitive Understanding of ICT Pedagogy

Indicator	Before Training	After Training
Awareness of ICT pedagogical roles	Low	Moderate to high
Alignment with learning objectives	Limited	Improved and contextual
Understanding of engagement strategies	Minimal	Clearly articulated

These results indicate a shift in teachers' pedagogical perspectives, highlighting the impact of training on conceptual understanding.

In addition to cognitive development, teachers exhibited notable improvement in their technical and practical ICT skills. During the initial sessions, several participants required close guidance to operate digital applications. However, continuous practice and guided support enabled teachers to gradually become more independent in navigating application features and completing tasks.

By the end of the programme, most teachers were able to independently create simple ICT-based learning media, including interactive quizzes, digital worksheets, and visual instructional materials. This progression underscores the importance of hands-on training in developing teachers' practical competence.

Table 3. Development of Teachers' ICT Practical Skills

Skill Aspect	Initial Observation	Final Observation
Application navigation	Required assistance	Mostly independent
Media creation	Very limited	Able to create simple media
Troubleshooting	Dependent on trainer	Basic self-problem solving

4 Types and Pedagogical Functions of ICT-Based Learning Media Produced

One of the most tangible outcomes of the field study was the diversity, quality, and pedagogical relevance of ICT-based learning media produced by teachers. The training programme resulted in the development of multiple digital products that were not only technically functional but also aligned with instructional objectives, curriculum demands, and classroom realities in primary education

Teachers demonstrated the ability to select ICT tools based on pedagogical needs rather than technological novelty. Interactive quizzes created using Quizizz were primarily used for

formative assessment purposes. These quizzes enabled teachers to monitor students' understanding in real time, provide immediate feedback, and create a competitive yet enjoyable learning atmosphere that increased student motivation.

Game-based learning activities developed through Wordwall were utilized to reinforce key concepts and promote active participation. Teachers designed matching tasks, multiple-choice games, and word puzzles that supported repetitive practice in a playful format. Such activities were considered particularly effective for younger learners due to their simplicity, visual appeal, and interactivity.

Teachers also produced visually rich instructional materials using Canva, including posters, presentation slides, and infographics. These materials were used to support concept explanation and visualization, especially for abstract topics. Teachers showed increasing awareness of visual design principles, such as clarity, readability, and age-appropriate content representation.

Animated instructional videos created with Powtoon functioned mainly as motivational and introductory media at the beginning of lessons. The combination of animation, narration, and text was used to attract students' attention and provide contextual overviews of learning topics. Teachers reported that these videos helped stimulate curiosity and prepare students cognitively for core learning activities.

In addition, teachers established digital classrooms using Google Classroom to organize learning materials, manage assignments, and provide feedback. The use of this platform indicated teachers' readiness to adopt blended learning practices and extend learning interactions beyond face-to-face classroom settings.

Table 4. Conceptual Mapping of ICT-Based Learning Media and Pedagogical Functions

ICT-Based Learning Media	Pedagogical Function	Instructional Phase
Quizizz	Formative assessment, immediate feedback	Assessment and review
Wordwall	Practice, reinforcement, engagement	Core learning activities
Canva	Visualization, concept explanation	Core learning activities
Powtoon	Motivation, concept introduction	Lesson opening
Google Classroom	Learning management, communication	Pre- and post-instruction

Overall, the variety and pedagogical alignment of the ICT-based learning media indicate that teachers were able to move beyond basic technology use toward purposeful digital pedagogy. Observational data revealed high levels of teacher engagement throughout the six training sessions. Teachers actively participated in discussions, asked questions related to classroom application, and demonstrated enthusiasm during hands-on practice. Attendance remained consistently high, indicating strong commitment to professional development activities.

Teachers frequently collaborated with peers by sharing ideas, offering technical assistance, and reflecting on potential classroom implementation. This collaborative learning environment contributed positively to teachers' confidence and accelerated skill acquisition.

Table 5. Level of Teacher Engagement During ICT Training Sessions

Engagement Indicator	Observation Description	Engagement Level
Attendance consistency	Teachers attended all sessions	High
Participation in discussion	Active questioning and responses	High
Hands-on practice involvement	Direct practice of ICT tools	High
Peer collaboration	Sharing and assisting colleagues	Moderate to high

Despite the overall positive outcomes, several challenges emerged during the implementation of the ICT-based training programme. One major constraint was unstable internet connectivity, which occasionally disrupted access to online platforms. Limited availability of digital devices also restricted opportunities for independent practice among some participants. In addition, variations in teachers' initial digital literacy levels required differentiated support and additional guidance. Nevertheless, these challenges did not significantly reduce teachers' motivation or participation.

Table 5. Challenges Encountered During ICT Training

Challenge	Description
Internet connectivity	Unstable during some sessions
Device availability	Limited access to laptops or tablets
Digital literacy gaps	Varied initial competence levels

By the end of the training programme, teachers demonstrated increased readiness and confidence to implement ICT-based learning media in their classrooms. Teachers were able

to explain how the digital media they created would be integrated into lesson plans, including introductory activities, core instructional phases, and assessment stages.

Teachers also expressed clear intentions to continue using ICT tools and to gradually expand their repertoire of digital teaching strategies. This readiness indicates that the training programme successfully supported the transition from training contexts to real classroom practice.

Table 6. Indicators of Teachers' Readiness for ICT Classroom Implementation

Readiness Indicator	Description
Lesson integration	ICT media aligned with lesson phases
Tool selection	Appropriate tools selected based on objectives
Confidence level	Teachers reported confidence to apply ICT
Sustainability intention	Willingness to continue ICT use in future lessons

A comparative analysis of teachers' competence before and after the ICT-based training programme reveals substantial improvement across cognitive, technical, and attitudinal dimensions.

Table 7. Summary of Teachers' ICT Competence Development (Before–After Comparison)

Dimension	Before Training	After Training
Pedagogical understanding of ICT	Fragmented and limited	Integrated and purposeful
Technical skills	Basic and dependent	Functional and semi-independent
Variety of media used	Very limited	Diverse and contextual
Confidence in ICT use	Low	Moderate to high
Willingness to innovate	Minimal	Clearly expressed

Further evidence from observations and teacher reflections indicates that ICT integration was increasingly aligned with instructional objectives. Teachers demonstrated the ability to match specific digital tools with learning goals, student characteristics, and lesson structures. This alignment reflects emerging pedagogical intentionality, where technology use is driven by instructional needs rather than convenience. Teachers' reflections suggested growing awareness of student-centered learning principles, such as engagement, accessibility, and differentiation, supported through ICT-based media.

Collectively, Sections 7.1 to 7.9 demonstrate that the ICT-based training programme generated multidimensional outcomes. These outcomes include enhanced pedagogical understanding, improved technical competence, positive attitudinal change, high engagement levels, and strong readiness for classroom implementation. The results provide empirical evidence that structured, field-based ICT training can effectively support sustainable digital pedagogy in primary education contexts.

Discussion

This section interprets the findings of the study by situating them within the broader body of international research on ICT integration and teacher professional development. The discussion addresses three main aspects: interpretation and comparison with previous studies, theoretical contributions and practical implications, and the novelty of the present research.

The results demonstrate that ICT-based training conducted through a field study approach significantly enhanced teachers' digital pedagogical competence, particularly in terms of pedagogical alignment, technical skills, and readiness for classroom implementation. These findings are consistent with previous international studies indicating that structured professional development programmes can positively influence teachers' ICT integration practices (Scherer et al., 2019; Tondeur, 2017). However, the present study adds depth to this line of research by showing how such improvements emerge through direct engagement with authentic classroom tasks rather than through abstract or decontextualized training.

The ability of teachers to align specific digital tools such as Quizizz, Wordwall, Canva, Powtoon, and Google Classroom with instructional objectives reflects a transition from technology-centered adoption toward pedagogy-driven integration. This pattern supports earlier research emphasizing pedagogical intentionality as a critical determinant of effective technology use (Koehler et al., 2019; Mishra & Warr, 2021). In line with Ertmer & Ottenbreit-Leftwich (2019), the findings indicate that when teachers experience success in using ICT tools meaningfully, their confidence increases and resistance to innovation decreases.

Moreover, the observed use of digital tools for formative assessment and learning reinforcement aligns with international evidence highlighting the pedagogical value of technology-enhanced assessment. Studies have demonstrated that digital formative

assessment tools can provide timely feedback, increase learner engagement, and support adaptive instruction (Schindler, 2020; Viberg et al., 2021). In this study, teachers' strategic placement of such tools within lesson phases suggests an emerging understanding of assessment as an integral component of learning rather than a separate evaluative activity.

The high level of teacher engagement documented during the training process further reinforces findings from prior research on effective professional development. Collaborative learning, peer support, and hands-on experimentation have been widely recognized as key features of impactful teacher learning experiences (Darling-Hammond et al., 2017; Tondeur, 2020). The present findings demonstrate that these features are equally relevant in ICT-focused training, particularly in contexts where teachers have heterogeneous levels of prior digital competence.

Nevertheless, the challenges identified such as disparities in teachers' initial digital literacy and limitations in technological infrastructure mirror constraints reported in other developing and transitional educational contexts (OECD, 2020; Scherer et al., 2019). These similarities suggest that while ICT training can effectively build teacher capacity, its long-term impact is contingent upon systemic and institutional support, including access to resources, leadership commitment, and sustained follow-up mechanisms.

From a theoretical perspective, this study contributes to the literature on Technological Pedagogical Content Knowledge (TPACK) by providing empirical evidence of how field-based ICT training facilitates the integration of technological and pedagogical knowledge in authentic educational settings. While many TPACK studies rely on self-reported perceptions or cross-sectional survey data, this research documents observable changes in teachers' instructional practices, tool selection, and pedagogical reasoning, thereby offering a richer account of TPACK development in practice.

The findings suggest that TPACK should be understood as a dynamic and context-sensitive construct that evolves through iterative cycles of practice, reflection, and feedback. This perspective aligns with recent theoretical work that calls for moving beyond static representations of teacher knowledge toward models that account for contextual influences and professional learning processes (Mishra & Warr, 2021).

In addition, the study extends professional development theory by illustrating how field study–based training functions as an effective bridge between theoretical knowledge and classroom practice. By situating learning within teachers' real instructional environments, the training enabled participants to translate abstract pedagogical principles into concrete instructional decisions. This supports contemporary views that emphasize situated learning and contextualized professional development as key drivers of sustainable pedagogical change (Darling-Hammond et al., 2017; Tondeur, 2020).

The results of this study offer several practical implications for policymakers, school leaders, and teacher educators. First, ICT training programmes should prioritize pedagogical alignment rather than focusing solely on technical skill acquisition. Training designs that explicitly link digital tools to instructional objectives, learning activities, and assessment practices are more likely to foster meaningful and sustained ICT integration.

Second, the findings underscore the importance of collaborative and experiential learning in teacher professional development. Providing opportunities for teachers to work together, share challenges, and reflect on practice can enhance engagement and accelerate competence development. Such approaches are particularly important in contexts where teachers exhibit diverse levels of digital literacy.

For schools, the results highlight the need for continuous institutional support, including access to reliable infrastructure, technical assistance, and time allocation for professional learning. School leadership plays a crucial role in creating conditions that encourage experimentation and reduce the perceived risks associated with instructional innovation.

For higher education institutions and teacher education programmes, embedding field-based ICT training within pre-service and in-service curricula can help bridge the gap between theory and practice. This approach ensures that teachers enter and remain in the profession with pedagogically grounded digital competence that is responsive to evolving educational demands.

Despite its contributions, this study has several limitations that should be considered when interpreting the findings. The research was conducted in a single primary Islamic school, which may limit the generalizability of the results to other educational contexts. Variations in institutional culture, resource availability, and policy environments could influence the effectiveness of similar ICT training programmes elsewhere.

Additionally, the qualitative descriptive design employed in this study did not directly measure student learning outcomes or long-term changes in instructional practice. As a result, the findings primarily reflect teachers' professional growth rather than the broader impact on student achievement.

Future research could adopt mixed-methods or longitudinal designs to examine how improvements in teachers' ICT competence translate into sustained pedagogical change and measurable student learning gains. Comparative studies across different regions, school types, or educational levels would also contribute to a more comprehensive understanding of contextual factors influencing ICT integration, thereby enriching the existing literature.

The novelty of this study lies in its field-based approach to ICT training situated within a primary Islamic education context, an area that remains underrepresented in international research. Unlike many studies that address ICT integration in generalized or technologically advanced settings, this research provides detailed empirical evidence from a context characterized by limited resources and diverse teacher competence levels.

By systematically documenting the pedagogical functions of specific digital tools and their alignment with instructional objectives, this study moves beyond descriptive accounts of ICT use toward a practice-oriented and analytically grounded understanding of digital pedagogy. The integration of field study methodology with teacher professional development offers a replicable and context-sensitive model for sustainable ICT integration in similar educational environments, particularly in primary education settings.

Overall, this discussion has demonstrated that the findings of the present study are consistent with, and extend, existing international research on ICT integration and teacher professional development. The study contributes theoretically by enriching the application of the TPACK framework through field-based evidence, offers practical implications for sustainable ICT training design, and highlights the novelty of contextualized ICT integration in primary Islamic education settings.

4. Conclusion

This study aimed to examine the outcomes of ICT-based teacher training implemented through a field study approach in a primary education context. The findings demonstrate that the training programme successfully enhanced teachers' digital pedagogical competence, particularly in aligning ICT tools with instructional objectives, improving technical skills, and increasing readiness for classroom implementation. Teachers were able to design and utilize diverse ICT-based learning media such as interactive quizzes, game-based activities, visual materials, animated videos, and digital classrooms in a pedagogically meaningful manner.

The results further indicate that field-based, practice-oriented ICT training promotes high levels of teacher engagement and supports the development of pedagogical intentionality in technology use. By situating professional development within authentic classroom contexts, the training facilitated the transition from technology-centered adoption toward pedagogy-driven ICT integration. These outcomes address the research objectives and provide empirical evidence that contextualized ICT training can contribute to sustainable digital pedagogy in primary education.

Based on these findings, it is recommended that future ICT professional development programmes emphasize pedagogical alignment, collaborative learning, and continuous institutional support. Policymakers and school leaders should ensure the availability of adequate infrastructure and provide ongoing opportunities for teacher collaboration and reflection. For future research, longitudinal and mixed-methods studies are recommended to investigate the long-term impact of ICT-based training on instructional practices and student learning outcomes across diverse educational contexts.

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