

Digital Media Divide and Its Implications for Early Childhood Educational Quality in Rural Areas: A Case Study in Jember

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Abstract

Abstract (English)

Digital inequality in early childhood education (ECE) poses a critical barrier to learning quality in rural Indonesia, where infrastructure, teacher capacity, and institutional support are severely limited. This qualitative multiple-case study examined digital media disparity across ten ECE institutions in six rural sub-districts of Jember Regency, analyzing how disparities shape learning quality as operationalized through the three dimensions of the process standard in Permendikbud No. 137/2014: learning planning, implementation, and developmental assessment. Thirty purposively sampled participants institutional heads, teachers, and parents contributed data through semi-structured interviews, classroom observations, and document reviews, analyzed using Miles, Huberman, and Saldaña's interactive model with source and method triangulation. Three interconnected dimensions of digital disparity emerged: (1) infrastructure and device access, (2) teacher digital literacy and pedagogical confidence, and (3) institutional and policy support. The study's central contribution is the empirical identification of teacher pedagogical confidence distinct from technical competence as the primary mediating variable linking digital access to learning process quality. Teachers lacking pedagogical confidence avoided digital tools even when devices were accessible, directly constraining learning implementation quality. Sustainable improvement in rural ECE quality requires an ecosystem-based intervention framework addressing infrastructure, teacher capacity-building, and institutional governance simultaneously, aligned with Indonesia's RPJMN 2025–2029 equity agenda.

Abstrak (Indonesia)

Ketimpangan digital dalam pendidikan anak usia dini (PAUD) merupakan hambatan kritis terhadap mutu pembelajaran di pedesaan Indonesia, terutama di wilayah dengan keterbatasan infrastruktur, kapasitas guru, dan dukungan kelembagaan. Studi kasus kualitatif ganda ini mengkaji kesenjangan media digital pada sepuluh lembaga PAUD di enam kecamatan pedesaan Kabupaten Jember, menganalisis bagaimana kesenjangan tersebut membentuk mutu pembelajaran melalui tiga dimensi standar proses Permendikbud No. 137/2014: mutu (1) perencanaan pembelajaran, (2) pelaksanaan pembelajaran, dan (3) penilaian perkembangan anak. Tiga puluh partisipan kepala lembaga, guru, dan orang tua memberikan data melalui wawancara

semi-terstruktur, observasi kelas, dan telaah dokumen, dianalisis menggunakan model interaktif Miles, Huberman, dan Saldaña dengan triangulasi sumber dan metode. Tiga dimensi kesenjangan digital yang saling terkait berhasil diidentifikasi: (1) akses infrastruktur dan perangkat, (2) literasi digital dan kepercayaan diri pedagogis guru, serta (3) dukungan kelembagaan dan kebijakan. Kontribusi utama penelitian ini adalah identifikasi empiris kepercayaan diri pedagogis guru berbeda dari kompetensi teknis sebagai variabel mediasi utama antara akses digital dan mutu proses pembelajaran. Guru yang kurang percaya diri menghindari perangkat digital meski tersedia, langsung membatasi mutu pelaksanaan pembelajaran. Peningkatan mutu PAUD pedesaan memerlukan kerangka intervensi berbasis ekosistem yang menangani infrastruktur, kapasitas guru, dan tata kelola kelembagaan secara simultan, selaras dengan RPJMN 2025–2029.



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1. INTRODUCTION

Early childhood education (ECE) plays an irreplaceable role in laying the foundations of human development. Between birth and six years of age, the developing brain forms millions of neural connections every day in response to environmental stimulation, establishing the neurological infrastructure upon which all subsequent learning depends (Center on the Developing Child, 2021). The quality of stimulation received during this critical period is a determining factor in children's cognitive, language, socio-emotional, and physical-motor development (Mauluddia & Yulindrasari, 2024; Shonkoff & Phillips, 2020). When used purposefully, responsively, and under the guidance of competent educators, digital learning media have been shown to substantially enrich the quality of stimulation available to young children (Blackwell, Lauricella, & Wartella, 2014; Palaiologou, 2016; Liu et al., 2024).

Yet the transformative potential of digital media in ECE is not uniformly accessible. The digital divide the persistent structural inequality in access to and meaningful use of information and communication technology remains a serious challenge in rural Indonesia (Van Dijk, 2020; Warschauer, 2018). Rural ECE institutions do not merely face shortages of devices and internet connectivity; they contend with a more fundamental challenge: the low digital literacy of educators and the fragile institutional support systems that should underpin pedagogical transformation (Radiyah et al., 2023; Novitasari & Fauziddin, 2022; Ambariani & Suryana, 2022). Beyond first-order access inequalities (device and connectivity gaps), scholars have identified second-level divides in digital skills and third-level divides in the beneficial outcomes of technology use (Scheerder, van Deursen, & van Dijk, 2017) a framework particularly relevant to rural ECE settings where all three levels are simultaneously deficient. Critically, a teacher's belief in their capacity to enact technology-integrated instruction their pedagogical self-efficacy is a prerequisite for translating device availability into meaningful learning experiences (Bandura, 1997; Ertmer & Ottenbreit-Leftwich, 2010).

Jember Regency offers a representative and pressing case for investigation. Spanning 31 sub-districts from the southern coastline to the northern mountain slopes, Jember harbors sharp disparities between urban and rural areas in educational infrastructure. Data from the Jember Regency Education Office (2024) and BPS Kabupaten Jember (2024) indicate that of 1,247 registered ECE institutions, only approximately 31% reported having an active internet connection, while the proportion actually integrating digital media into daily instruction is considerably lower. This gap is compounded by the structural heterogeneity of ECE institution types in Indonesia, including Pos PAUD (community-based early stimulation posts), Kelompok

Bermain (KB; play groups), Taman Kanak-kanak (TK; kindergartens), and Raudhatul Athfal (RA; Islamic kindergartens), each operating under distinct governance and resource conditions.

Learning quality in Indonesian ECE is operationalized through eight nationally mandated standards articulated in Permendikbud No. 137/2014. Among these, the process standard is the dimension most directly shaping children's day-to-day learning experiences. Specifically, the process standard encompasses three measurable dimensions: (1) the quality of learning planning reflected in the design of developmentally appropriate, stimulating lesson plans (RPPH); (2) the quality of learning implementation evidenced by the richness of multisensory stimulation, active child engagement, and pedagogical responsiveness during instruction; and (3) the quality of developmental assessment demonstrated through the consistency and comprehensiveness of monitoring children's developmental progress (KKTP). Digital media contribute to all three dimensions, but only when teachers have the capacity and confidence to deploy them purposefully (Kemendikbudristek, 2023). Research on teacher digital literacy in Indonesian ECE reveals a consistent pattern: most educators possess sufficient competency to access and share information online, yet lack the capacity to create content and integrate technology pedagogically within their instructional practice (Novitasari & Fauziddin, 2022; Hardiyanti & Alwi, 2022). This limitation is exacerbated by sporadically available, technically-oriented professional development programs that provide little sustained follow-up in the classroom (Winarti et al., 2022; Anggita et al., 2022; Kennedy, 2016).

Prior studies on the digital divide in Indonesian ECE have largely concentrated on the pandemic period (Rodiyah et al., 2023; Winarti et al., 2022), while research that systematically maps the multilayered dimensions of the digital gap across ECE institution types in rural sub-districts and examines its relationship to post-pandemic learning process quality through the process standard framework remains very limited. Moreover, no prior study in the Indonesian context has empirically isolated teacher pedagogical confidence (as distinct from technical competence) as an analytical dimension and examined its mediating role between digital access and learning quality.

This study addresses this gap. Its novelty lies in two interrelated contributions: (1) the development of an integrative three-dimensional analytical framework encompassing infrastructure, teacher capacity (with pedagogical confidence as a theoretically grounded, operationally distinct dimension), and institutional support applied simultaneously across multiple ECE institution types in a post-pandemic rural context; and (2) the empirical identification, grounded in Bandura's (1997) self-efficacy theory, that teacher pedagogical confidence rather than technical competence alone constitutes the primary mediating variable explaining why device availability does not automatically translate into improvements in all three dimensions of learning process quality as defined by Permendikbud No. 137/2014. No prior study in the Indonesian ECE context has empirically isolated pedagogical confidence as a distinct analytical dimension and examined its mediating role between digital access and learning quality. The study pursues three objectives: (1) to analyze the patterns and dimensions of the digital media gap in rural ECE institutions in Jember Regency; (2) to identify the dimension most strongly associated with learning process quality; and (3) to derive implications for more equitable ECE development policy aligned with RPJMN 2025–2029 targets.

LITERATURE REVIEW

The Digital Divide in ECE: A Multilayered Structural Phenomenon

The concept of the digital divide has evolved considerably beyond its original framing as a simple binary between those with and without internet access. Van Dijk's (2020) four-barrier model comprising motivational, material, skills-based, and usage-based access provides a theoretical foundation for understanding digital inequality as a sequential and cumulative process. Extending this framework, Scheerder, van Deursen, and van Dijk (2017), in a systematic review of second- and third-level digital divides, demonstrated that inequalities in digital skills and in the beneficial outcomes of technology use persist independently of material access gaps a perspective directly applicable to rural ECE settings where teachers may possess a basic device but remain unable to translate that access into pedagogically meaningful practice. Palaiologou (2016), in a study of ECE settings in England, found that children under five engage spontaneously with digital technologies at home, yet these experiences remain disconnected from classroom practice due to teachers' limited confidence and insufficient institutional support. In ECE

settings, this multilayered character is particularly pronounced because the teacher functions as the primary mediating agent between the institution's digital resources and children's developmental experiences (Plowman, 2016; Petersen, 2020). Research by Rodiyah, Driana, and Yuliawati (2023), examining blended learning amid digital inequality in Raudhatul Athfal institutions in Bekasi Regency, found that the primary obstacle was not device availability but variation in teachers' instructional capacity, compounded by socioeconomic constraints on families. Similarly, Dolan (2016), reviewing research on the evolving digital divide among K–12 students, observed that access inequalities are increasingly overshadowed by skill-based and usage-based divides a pattern with important implications for teacher preparation in resource-limited contexts. This finding underscores the multilayered and context-dependent nature of the digital divide in ECE settings.

From the perspective of teachers, Novitasari and Fauziddin (2022), in a study conducted with ECE educators in Riau, found that teachers' average digital literacy was classified as 'sufficiently good' with respect to accessing and disseminating information, but remained weak in selecting and evaluating digital content appropriate for stimulating young children's development. Hardiyanti and Alwi (2022) corroborated this picture through their investigation of 13 ECE institutions in Gorontalo Regency, finding that while teachers recognized the shifting digital demands of their profession, they lacked both the confidence and the capacity to respond effectively. Collectively, these studies position teacher pedagogical confidence as the critical bottleneck in digital ECE implementation a gap that Van Dijk's (2020) skills-access barrier specifically identifies as requiring structural, not individual, solutions.

Technology and ECE Teachers: Self-Efficacy as the Critical Variable

Bandura's (1997) social cognitive theory, and specifically its self-efficacy construct, provides the theoretical anchor for understanding why teacher confidence operates as a critical mediating variable between digital access and learning quality. Self-efficacy refers to an individual's belief in their capacity to execute courses of action required to produce given attainments. In technology integration, teachers with high self-efficacy are more likely to attempt innovative instructional approaches, persist through technical difficulties, and ultimately realize the developmental affordances of digital media for young children (Voogt et al., 2013). Ertmer and Ottenbreit-Leftwich (2010) demonstrated that teachers' beliefs about technology including their confidence in its pedagogical value constitute a more fundamental barrier to technology integration than external constraints such as lack of equipment or time. This insight is particularly significant for rural ECE in Indonesia, where even when devices become available, their integration into learning practice may remain limited without parallel attention to belief change and confidence development. Hatlevik and Hatlevik (2018), in a study of Norwegian teachers, found that ICT self-efficacy for educational purposes was significantly associated with frequency and quality of technology use in teaching, and that collegial collaboration was a stronger predictor of self-efficacy than individual training directly supporting the community-based coaching approach recommended in this study. Lucas, Bem-Haja, Siddiq, Moreira, and Redecker (2021) found that organizational support and collaborative professional learning rather than teachers' personal technological knowledge alone constituted the most significant contextual factors predicting digital competence in practice. A systematic literature review by Luo, Berson, Berson, and Li (2021) examining ECE teacher readiness for digital transformation in China found that teacher self-efficacy and institutional support consistently emerged as stronger determinants of technology integration than device availability alone. Nikolopoulou and Gialamas (2015), in a study of ECE teachers in Greece, found that teachers' beliefs about ICT and their confidence in using it were the strongest predictors of actual technology integration in preschool classrooms providing important cross-cultural corroboration for the present study's findings. Complementing this, Luo, Berson, and Berson (2021), in an empirical study of digital technology integration within ECE teacher preparation programs in China, found that positive teacher attitudes toward technology were undermined by barriers including limited technical support, a shortage of technology-integrated instructional models to emulate, and insufficient time for guided practice. These findings are directly pertinent to rural Indonesia, where access to professional development resources is severely restricted.

Yang and Hong (2022), in a qualitative study of ECE teachers' professional learning about ICT in kindergarten curricula in China, found that existing training programs tended to focus on the technical operation of devices rather than on how technology could be meaningfully integrated into pedagogical practice. Sang et al. (2022) extend this framework by demonstrating that ICT self-efficacy partially mediates the relationship between constructivist beliefs and technology integration. Tondeur, Scherer, Baran, Siddiq, Valtonen, and Sointu (2019), examining teacher educators' role in preparing the next generation of teachers for technology integration, found that teacher educators themselves required systematic support in modeling technology-integrated pedagogy suggesting that the confidence deficit identified in this study extends beyond in-service teachers to the pre-service education system. Kulaksız and Toran (2022) found that a praxeological approach combining theoretical understanding with supervised practice significantly enhanced pedagogical confidence beyond technical skill acquisition alone. Dong, Xu, Chai, and Zhai (2020) further demonstrated that teachers' ICT self-efficacy and school support are structural mediators in the relationship between pedagogical beliefs and actual technology integration behaviors, consistent with the ecosystem-based intervention framework proposed in this study. These international findings converge on a shared conclusion: effective digital capacity-building for ECE teachers requires structured opportunities to develop pedagogical confidence in authentic classroom contexts, not merely technical training.

ECE Learning Quality: Operationalization within the Process Standard

For the purposes of this study, learning quality is operationalized through the three dimensions of the process standard of Permendikbud No. 137 of 2014. Dimension 1 quality of learning planning is assessed by the presence of complete, developmentally appropriate daily lesson plans (RPPH) incorporating varied and stimulating activities. Dimension 2 quality of learning implementation is assessed by the richness of multisensory stimulation, the degree of active child engagement, and the responsiveness of pedagogical practice, including the purposeful use of digital media where available. Dimension 3 quality of developmental assessment is assessed by the consistency, completeness, and evidence-based character of developmental progress monitoring (KKTP). Papadakis, Kalogiannakis, and Zaranis (2018), in a study of computer and tablet-assisted intervention in early childhood settings, found significant improvements in children's learning only when teachers were adequately supported and confident in using technology underscoring teacher confidence as a prerequisite for realizing the learning quality benefits of digital media. Digital learning media contribute to all three dimensions, but their contribution is contingent on teachers' pedagogical confidence to deploy them purposefully (Petersen, 2020; Liu et al., 2024).

Suharyat et al. (2023), in research on the challenges of parental empowerment in improving ECE service quality in the digital era, argued that parental involvement in the digital ECE ecosystem is more complex than mere participation in school activities. Parents serve as a bridge between the digital world children encounter at home and learning experiences designed at school. Dong, Cao, and Li (2020), in a study of Chinese parents' beliefs about young children's online learning during COVID-19, found that parental attitudes toward digital learning were shaped by perceived educational quality, trust in teachers, and access to institutional communication all of which were constrained in rural settings by the same structural factors identified in the present study. This bridging role is frequently constrained in rural settings where hierarchical communication patterns persist (Hornby & Lafaele, 2011).

Policy Context: RPJMN 2025–2029 and the ECE Digitalization Agenda

The Indonesian government has prioritized equitable education quality in the National Medium-Term Development Plan (RPJMN) 2025–2029, with the digitalization of educational institutions including ECE as a key strategy (Kemendikbudristek, 2023). However, top-down digitalization policies risk overlooking the diversity of conditions on the ground, particularly in areas with constrained infrastructure and limited human resource capacity (Van Dijk, 2020; Warschauer, 2018). Experience from the pandemic demonstrated that when digitalization programs are launched without adequate ecosystem preparation, existing gaps can widen rather than narrow (Rodiyah et al., 2023). Kennedy (2016), in a comprehensive review of professional development research, established that effective professional development must

be sustained, content-specific, coherent with institutional goals, and involve active teacher participation criteria rarely met by the short-course training formats that characterize ECE digital literacy programs in rural Indonesia. This evidence base provides the theoretical justification for the ecosystem-based intervention approach recommended in this study.

2. METHODS

METHODS

Research Design

This study employed a qualitative approach with a descriptive multiple-case study design (Yin, 2018). This choice rests on the premise that the digital divide in rural ECE is a complex, context-dependent phenomenon that cannot be fully understood through numerical data alone. Following Yin's (2018) typology, this is classified as a multiple-case, holistic design with embedded units of analysis. Each of the ten ECE institutions constitutes a bounded case. The primary unit of analysis is the institution-level digital media implementation ecosystem operationally defined as the interplay of three dimensions: (1) physical and connectivity infrastructure, (2) teacher digital literacy and pedagogical confidence, and (3) institutional and policy support mechanisms. The secondary unit of analysis is the learning process quality of each institution, operationalized through the three dimensions of the process standard of Permendikbud No. 137/2014: learning planning quality, learning implementation quality, and developmental assessment quality. Cross-case analysis enables identification of patterns and variations across institution types, sub-district geographies, and digital readiness levels (Creswell & Poth, 2018).

Participants

The study was conducted across ten ECE institutions distributed among six rural sub-districts in Jember Regency. Sub-districts were selected purposively to represent geographical variation, accessibility levels, and the range of ECE institution types. The distribution was as follows: Panti sub-district (2 institutions: 1 TK, 1 KB), a plantation-agriculture area on the northern slopes; Tempurejo sub-district (2 institutions: 1 RA, 1 Pos PAUD), bordering the Meru Betiri National Park with extremely limited internet access; Wuluhan sub-district (1 institution: 1 TK), a lowland agricultural area in the south; Bangsalsari sub-district (2 institutions: 1 KB, 1 RA), in the central regency with varied infrastructure conditions; Sumberjambe sub-district (2 institutions: 1 TK, 1 Pos PAUD), an isolated northern highland area; and Puger sub-district (1 institution: 1 TK), a southern coastal area.

Thirty participants were drawn from three groups of ten: (1) ECE institutional heads, (2) classroom teachers, and (3) parents or guardians. All participants were selected through purposive sampling based on: direct involvement in institutional management or instructional processes, voluntary informed consent, and capacity to provide information-rich accounts of actual digital media implementation practices. Information redundancy across interviews was monitored throughout data collection; by the ninth and tenth institution visits, no new thematic dimensions or sub-codes emerged across all three thematic domains. This pattern of information redundancy, combined with the bounded multiple-case design that defined the sample frame in advance, provides sufficient justification for analytical saturation within this study's scope (Creswell & Poth, 2018; Saldaña, 2021). The researchers acknowledge that saturation in qualitative case study research applies to the theoretical dimensions within the bounded sample, not to statistical generalizability.

Instruments

Data were collected through three complementary techniques. First, semi-structured in-depth interviews were conducted with all 30 participants using an interview guide developed through three stages of validation: (a) initial item generation based on Van Dijk's (2020) four-barrier model and the three dimensions of the process standard of Permendikbud No. 137/2014; (b) expert review of content relevance, clarity, and developmental appropriateness by two ECE specialists and one educational technology expert, who evaluated each item on a four-point scale and provided written comments; and (c) pilot testing on two ECE teachers from outside the main study sample, with revisions based on participant feedback regarding comprehensibility and estimated response time. The final interview guide comprised 18 open-ended questions covering all three thematic dimensions. Each interview lasted between 45 and 90 minutes and was conducted at participants' respective institutions between March and April 2026 with recorded informed consent. Second, classroom observations were

conducted for a minimum of two learning sessions per institution using a structured observation protocol adapted from Plowman's (2016) framework for digital technology use in ECE and supplemented with indicators derived from the three dimensions of the process standard (Permendikbud No. 137/2014). The protocol included 24 items organized around: (a) the presence and type of digital tools in the classroom; (b) teacher behaviors related to digital media integration during learning planning, implementation, and assessment; and (c) child engagement patterns during digital and non-digital instructional activities. Third, document review was applied to daily lesson plans (RPPH), facility and equipment inventories, children's developmental progress reports (KKTP), and annual work plans (RKT). Documents were analyzed using a structured review protocol aligned with the three dimensions of the process standard, enabling systematic comparison of documentary evidence across all ten institutions and cross-verification of interview and observation data.

Data Analysis

Data analysis followed the interactive model of Miles, Huberman, and Saldaña (2014), comprising four concurrent components: data collection, data condensation (multi-level thematic coding), data display (descriptive narratives and cross-case comparison matrices), and conclusion drawing and verification. Coding proceeded through three explicitly differentiated levels: (a) first-cycle descriptive coding, in which each data segment was assigned a code capturing its surface content (e.g., 'no devices available,' 'fear of making mistakes'); (b) pattern coding, in which descriptive codes sharing thematic overlap were grouped into emergent patterns (e.g., 'technology avoidance despite device access,' 'absence of structured professional learning'); and (c) focused coding, in which the most analytically salient and frequently occurring pattern codes were consolidated into the three final thematic dimensions (Saldaña, 2021). The coding process was conducted collaboratively by all three researchers. Inter-coder agreement was assessed using discussion-to-consensus: where discrepancies arose, researchers reviewed the relevant data segment together, referenced the codebook definitions, and reached a shared decision before proceeding. Data trustworthiness was established through Lincoln and Guba's (1985) four criteria. Credibility was addressed through source triangulation (interviews, observations, and document review), method triangulation, and member checking with five key participants who reviewed and confirmed the accuracy of their attributed quotes and the researchers' interpretations. Transferability was supported through thick description of each institution's context. Dependability was established through an audit trail documenting all analytical decisions, codebook revisions, and consensus outcomes. Confirmability was supported through reflexive memoing throughout fieldwork. Informed consent was secured from all 30 participants using written consent forms that explained the study's purpose, the voluntary nature of participation, the right to withdraw at any time without consequence, and the procedures for ensuring confidentiality. All participants are identified in this report by institutional role and sub-district only; no personal identifying information is disclosed.

Researcher Reflexivity

All three researchers are affiliated with Universitas PGRI Argopuro Jember and have prior professional relationships with rural ECE institutions in the region. To mitigate confirmatory bias, the researchers maintained individual reflexive journals throughout fieldwork, documenting pre-existing assumptions about digital inequality in rural ECE, emotional responses during data collection (particularly in severely limited institutions), and the reasoning behind analytical decisions. Peer debriefing sessions were conducted after each field visit, during which researchers examined their field notes and preliminary interpretations for signs of confirmation bias or over-generalization. These procedures follow Creswell and Poth's (2018) recommendations for establishing confirmability and credibility in qualitative case study research.

3. RESULTS

This section presents findings from the cross-case analysis of ten ECE institutions, organized around the three thematic dimensions that emerged from the coding process. Consistent with the methodological principle of separating empirical findings from theoretical interpretation, this section presents results exclusively through descriptive narratives, verbatim participant quotes, cross-case comparison tables, and triangulated observational evidence. Theoretical interpretation is reserved for the Discussion section. Findings related to learning quality are drawn from triangulated evidence classroom observation data,

developmental progress reports (KKTP), and institutional document analysis rather than interview responses alone, in order to minimize social desirability bias and strengthen empirical grounding.

3.1. Overview: Digital Readiness Classification of Studied Institutions

Based on triangulated evidence from observation, document analysis, and interviews, the ten institutions were classified into three digital readiness categories using a structured classification matrix aligned with the three analytical dimensions of this study. The adequate category refers to institutions with sufficient devices, stable internet connectivity, and teachers demonstrating reasonable pedagogical confidence in technology use. The moderate category refers to institutions with some devices but constrained by connectivity issues or limited teacher capacity. The severely limited category refers to institutions with virtually no devices or connectivity and teachers with very low digital literacy and pedagogical confidence. Table 1 presents the cross-case summary of digital readiness across all ten institutions.

Table 1. Cross-Case Digital Readiness Classification of Studied ECE Institutions Institution

Institution	Sub-district	Category	Devices	Teacher Confidence
TK	Panti	Adequate	Laptop, projector, WiFi	High
KB	Panti	Moderate	1 tablet, limited WiFi	Moderate
RA	Tempurejo	Moderate	1 teacher phone	Moderate
Pos PAUD	Tempurejo	Severely Limited	None	Low
TK	Wuluhan	Adequate	Smart board, laptop, WiFi	High
KB	Bangsalsari	Moderate	1 laptop, no WiFi	Low–Moderate
RA	Bangsalsari	Adequate	Projector, tablet	Moderate–High
TK	Sumberjambe	Moderate	1 laptop, poor signal	Low–Moderate
Pos PAUD	Sumberjambe	Severely Limited	None	Low
TK	Puger	Moderate	1 laptop, intermittent WiFi	Moderate

Source: Primary data, cross-case analysis (March–April 2026)

Of the ten institutions studied, only three (30%) fell into the adequate category: the TK in Panti sub-district, the TK in Wuluhan sub-district, and the RA in Bangsalsari sub-district. Five institutions (50%) were classified as moderate, and two (20%) the Pos PAUD in Sumberjambe and the Pos PAUD in Tempurejo were categorized as severely limited. This distribution indicates that seven out of ten institutions lacked the conditions necessary for optimal digital media use in learning.

3.2. Dimension One: Infrastructure and Device Access Gap

The infrastructure and device access gap constituted the most visible dimension. The three institutions in the adequate category each possessed at least one functional laptop or computer, one or two tablet units or a projector, and reasonably stable internet access via cellular networks. At the other end of the spectrum, the two Pos PAUD institutions in Sumberjambe and Tempurejo had no institution-owned digital devices whatsoever. The head of the Pos PAUD in Sumberjambe sub-district described this condition:

“We really start from zero here. The only device for teaching is my personal phone the only one available. The signal often drops, especially during the rainy season. The children get enthusiastic when I show them a video, but that only happens when there is signal and enough battery.” (Head of Pos PAUD, Sumberjambe sub-district, March 2026)

The use of a personal mobile phone as the sole instructional device was a pattern found in four of the ten institutions, reflecting the extent to which individual teacher initiative compensates

for institutional limitations. Connectivity problems were equally serious. In the part of Tempurejo sub-district bordering the protected forest, cellular signal was highly unstable. A teacher at the RA in that sub-district described her adaptive strategy:

“The internet here is not reliable. Even opening YouTube often takes very long to load. So if I want to use a video, I download it at home when the signal is reasonable, then bring it to school on my phone the next day. But this only works for short videos.” (Teacher, RA, Tempurejo sub-district, March 2026)

The practice of downloading content at home and bringing it to school was also employed by teachers in three other institutions. While this represents a resourceful form of adaptation, it simultaneously reflects a structural constraint that should not be allowed to persist as the normal condition for rural ECE educators.

3.3. Dimension Two: Teacher Digital Literacy and Pedagogical Confidence Gap

This second dimension emerged as the most analytically significant finding of the study. Table 2 presents a cross-case comparison of teacher digital literacy across four sub-dimensions: basic digital skills, digital content selection for ECE, pedagogical integration of digital tools, and overall digital confidence level.

Table 2. Cross-Case Comparison of Teacher Digital Literacy Dimensions

Institution	Sub-district	Basic Digital Skills	Content Selection	Pedagogical Integration	Digital Confidence Level
TK	Panti	High	Moderate–High	Moderate	High
KB	Panti	Moderate	Low–Moderate	Low	Moderate
RA	Tempurejo	Moderate	Low	Low	Moderate
Pos PAUD	Tempurejo	Low	Very Low	Very Low	Low
TK	Wuluhan	High	High	High	High
KB	Bangsalsari	Moderate	Low	Low	Low
RA	BAngsalsari	Moderate–High	Moderate	Moderate	Moderate–High
TK	Sumberjambe	Low–Moderate	Low	Very Low	Low
Pos PAUD	Sumberjambe	Low	Very Low	Very Low	Low
TK	Puger	Moderate	Low–Moderate	Low	Moderate

Source: Primary data, cross-case analysis (March–April 2026)

Of the ten teacher participants, only two (20%) demonstrated a level of digital literacy sufficient to integrate digital media creatively and intentionally into planned instructional activities. The remaining eight were operating at a basic level: capable of using messaging applications and video platforms for personal use, but lacking the confidence to independently design and implement digital media-based learning activities. Critically, consistent with Bandura's (1997) self-efficacy framework, low confidence led teachers to avoid digital tools even when devices were available rendering infrastructure investment insufficient without parallel confidence-building.

Critically, the low digital literacy observed in this study does not reflect indifference or unwillingness to learn. Almost all teachers expressed genuine motivation to improve their digital competence. The primary barrier they identified was the absence of structured, facilitated learning opportunities. A teacher from the TK in Panti sub-district recounted:

“I want to be able to do it. But where do I learn? The last training I attended was during COVID two days on how to use Zoom. Nothing since then. I try to look things up on YouTube,

but I get confused, and there is no one to guide me directly. When something goes wrong, I do not know what to do.” (Teacher, TK, Panti sub-district, March 2026)

This pattern recurred across nearly all teacher interviews. Professional development programs were described as sporadic, brief, and unsupported by in-classroom coaching. Moreover, available training was frequently misaligned with the actual instructional needs of ECE teachers. A teacher from the KB in Bangsalsari sub-district reflected:

“There was once a computer training from the district office, but it covered Microsoft Office how to write letters and make tables. That is useful, but it is not what I need for teaching young children. I need to know how to choose appropriate videos, or which applications suit their developmental age. That has never been provided.” (Teacher, KB, Bangsalsari sub-district, April 2026)

This lack of confidence had direct consequences for instructional practice. Teachers who felt incompetent with technology tended to avoid it, even when devices were available. A teacher from the TK in Puger sub-district described this dynamic:

“Honestly, I am afraid. Afraid of making mistakes in front of the children, afraid the device might get damaged because I am using it incorrectly. So, I just use what I already know what feels safe. But actually, I really want to be able to do more.” (Teacher, TK, Puger sub-district, April 2026)

The anxieties voiced by these teachers point to a need that goes beyond technical training. They require a psychologically safe space to experiment and learn from mistakes, empathetic and contextually grounded mentoring, and supportive professional learning communities composed of peers who share their challenges.

3.4. Dimension Three: Institutional and Policy Support Gap

The third dimension concerns the availability and consistency of institutional support, both from within the institutions and from the local government. Of the ten institutions studied, only two had a documented digital media development program in their Annual Work Plans (RKT). The remaining eight had no systematic plan; digital media use depended entirely on the individual initiative and personal resources of individual teachers.

The head of the TK in Wuluhan sub-district, whose institution fell in the adequate category, described the strategy they pursued:

“We received a smart board from the government because we submitted a formal proposal. But we did not wait passively for government assistance. We discussed the situation with the school committee. Alhamdulillah, a partnership between parents and the committee allowed us to purchase additional digital media equipment.” (Head of TK, Wuluhan sub-district, April 2026).

Parental perspectives contributed an equally important dimension. Most parents interviewed were aware of the gap between their children’s ECE experience and what they observed at better-resourced institutions. A mother from Bangsalsari sub-district expressed her hopes:

“My child is very fond of pictures on the phone. At home, she can sit quietly for a long time watching videos. I often think that if school also had videos for learning, she would be more enthusiastic about attending. But I also worry videos at school, videos at home. I notice that the teacher does not always use a video, a laptop, or a phone.” (Parent, Bangsalsari sub-district, April 2026)

Parents’ reluctance to raise concerns with the institution reflected the persistently hierarchical nature of school-family communication in these settings. Regarding local government support, virtually all institutional heads reported that the last equipment assistance they received came from the emergency distance learning program during the COVID-19 pandemic in 2021. The head of the RA in Tempurejo sub-district noted:

“During COVID there was data quota assistance from the government. But now, subscribing to Wi-Fi is something we struggle to afford. (Head of RA, Tempurejo sub-district, April 2026)”

3.5. Implications for Learning Process Quality: Triangulated Evidence

Triangulated evidence classroom observations, KKTP analysis, and document review consistently demonstrated that the three dimensions of the digital gap collectively constrained learning process quality across all three dimensions of the process standard of Permendikbud No. 137/2014. Table 3 presents a systematic comparison of learning quality indicators across the three digital readiness categories.

Table 3. Learning Process Quality Indicators Across Digital Readiness Categories

Category (n)	Planning Quality	Implementation Quality	Assessment Quality	Overall Process Standard
Adequate (n=3)	Well-structured RPPH; digital media integrated in weekly plan	Rich multisensory stimulation; active child engagement; digital tools used purposefully	Consistent digital learning evidence documented	Consistently meets process standard
Moderate (n=5)	RPPH present but limited digital planning; conventional dominant	Partial digital use; conventional activities (colouring, songs) predominant	Irregular minimal digital learning evidence	Partially meets process standard
Severely Limited (n=2)	RPPH absent or minimal; no digital planning whatsoever	No digital stimulation; rote activities only; zero device use	Absent or incomplete KKTP	Does not meet process standard

Source: Primary data, cross-case analysis (March–April 2026)

In the seven institutions with digital limitations, instructional activities were dominated by conventional approaches—coloring worksheets, song memorization, and rote exercises—with minimal variation in multisensory stimulation and limited alignment with the process standard's requirements for varied and developmentally responsive learning implementation. Analysis of KKTP reports from all ten institutions revealed a consistent pattern: children in the three adequately-resourced institutions more frequently attained 'Developing as Expected' (BSH) and 'Developing Very Well' (BSB) ratings on language and cognitive development indicators than their counterparts in digitally limited institutions. It is important to note that this association cannot be interpreted as causal, given multiple confounding variables including teacher qualification, class size, and family socioeconomic background. These patterns are presented as convergent observational signals within a triangulated evidence base, not as causal claims.

By contrast, the three institutions with better digital conditions demonstrated noticeably greater variety: animated videos as thematic introductions, digital interactive games to practice fine motor skills, and digital photo presentations to stimulate children's narrative abilities all reflecting richer implementation of the process standard. Analysis of children's KKTP reports from all ten institutions revealed a consistent pattern: children in the three adequately-resourced institutions more frequently attained the 'Developing as Expected' (BSH) and 'Developing Very Well' (BSB) ratings on language and cognitive development indicators than their counterparts in digitally limited institutions. It is important to note that this association cannot be interpreted as causal, given multiple confounding variables including teacher qualification, class size, and family socioeconomic background. These patterns are presented as convergent observational signals within a triangulated evidence base, not as causal claims, and should be interpreted with appropriate caution.

Table 4 synthesizes the key findings across the three thematic dimensions and their observed relationships to learning process quality.

Table 4. Summary of Thematic Findings and Implications for Learning Process Quality

Dimension	Key Empirical Findings	Implications for Learning Process Quality
1. Infrastructure & Device Access	3 of 10 institutions (30%) adequate; 2 Pos PAUD had zero institutional devices; personal phones the sole instructional tool in 4 institutions; internet unstable in Tempurejo and Sumberjambe	Constrains teachers' ability to plan and implement digital media-based learning; limits multisensory stimulation; directly prevents fulfilment of Dimension 1 (planning) and Dimension 2 (implementation) of process standard
2. Teacher Digital Literacy & Pedagogical Confidence	Only 2 of 10 teachers (20%) demonstrated sufficient pedagogical confidence for creative digital integration; motivation high but structured learning opportunities absent; technology avoidance observed even when devices available	Primary mediating variable between device availability and learning quality; low confidence causes avoidance regardless of infrastructure; directly undermines richness of Dimension 2 (implementation) of process standard
3. Institutional & Policy Support	Only 2 of 10 institutions had digital media plans in Annual Work Plan (RKT); 8 dependent on individual teacher initiative; last government equipment assistance in 2021; no sustained post-pandemic support	Without systemic support, neither infrastructure nor teacher confidence develops sustainably; absence of planning prevents consistent improvement across all three dimensions of process standard

Source: Primary data, cross-case analysis (March–April 2026)

Analysis of children’s developmental progress reports from all ten institutions also revealed a consistent pattern: children in the three adequately-resourced institutions more frequently attained the “Developing as Expected” (BSH) and “Developing Very Well” (BSB) ratings on language and cognitive development indicators than their counterparts in digitally limited institutions. While causality cannot be exclusively attributed to digital media given the multiple variables involved, the consistency of this pattern provides a meaningful signal regarding its contribution.

4. DISCUSSION

Teacher Pedagogical Confidence as the Key Mediating Variable

The central finding of this study that teacher pedagogical confidence, not device availability, functions as the most influential variable mediating the relationship between digital access and learning quality constitutes the study's principal theoretical contribution. Ertmer and Ottenbreit-Leftwich (2010) characterized this as the persistence of second-order barriers (teachers' beliefs and confidence) that remain unresolved even when first-order barriers (external constraints such as device availability) are addressed a framing with critical implications for intervention design. This finding is best understood through Bandura's (1997) self-efficacy framework. Teachers with high self-efficacy for technology integration are more likely to persist through technical difficulties, innovate instructional approaches, and leverage digital affordances to support children's development. Conversely, technology anxiety drives avoidance even when devices are available a behavioral pattern directly observed across six of the ten study institutions.

Previous research on ECE teacher digital literacy in Indonesia has tended to measure technical competence without explicitly isolating pedagogical confidence as a distinct analytical dimension (Novitasari & Fauziddin, 2022; Hardiyanti & Alwi, 2022). The present study demonstrates that this distinction is both theoretically and practically consequential. Nikolopoulou and Gialamas (2015) established that teachers' confidence in ICT is a stronger predictor of actual classroom technology use than technical knowledge corroborated in this study where teachers with moderate technical skills avoided technology due to low pedagogical confidence, while highly confident teachers integrated technology creatively despite modest device availability.

This finding converges with Luo, Berson, and Berson's (2021) demonstration that teacher self-efficacy is a stronger predictor of meaningful technology use than technical skill alone. It also aligns with Sang et al.'s (2022) structural equation modeling evidence that ICT self-efficacy mediates the relationship between constructivist beliefs and technology integration behaviors. Hatlevik and Hatlevik (2018) provide an important structural insight: collegial collaboration and facilitated learning communities were the strongest organizational predictors of ICT self-efficacy more influential than access to training or availability of technology directly supporting the community-based coaching model recommended in this study. Critically, Yang and Hong (2022) identify the mechanism: professional development focused on technical operation, without helping teachers develop a pedagogical understanding of how technology supports children's holistic development, risks creating technically competent but pedagogically unconfident teachers precisely the profile observed in eight of the ten study institutions. Tondeur, Scherer, Baran, Siddiq, Valtonen, and Sointu (2019) extended this analysis by demonstrating that teacher educators who are not themselves confident in modeling technology-integrated pedagogy cannot prepare confident teacher graduates suggesting that intervention must operate at both in-service and pre-service levels.

Structural Interconnection of the Three Dimensions

The three identified dimensions do not operate independently; they function as an interlocking system of mutual reinforcement, consistent with Van Dijk's (2020) multi-barrier model. Without adequate infrastructure, teachers cannot practice and consolidate digital skills acquired in training, thereby preventing confidence development. Without teacher confidence, available devices remain underutilized as observed in three institutions with moderate infrastructure but low teacher confidence. Without consistent institutional support, neither infrastructure nor teacher capacity develops sustainably. The Pos PAUD cases exemplify the multiplicative effect of all three dimensions operating simultaneously at their lowest levels: total digital exclusion that individual teacher motivation alone could not overcome.

This interconnected dynamic has direct implications for intervention design. Falloon's (2020) teacher digital competency framework argues that digital competence is not a property of individuals but an emergent property of individuals-in-context: the same teacher may perform very differently depending on the organizational support, professional learning community, and technological infrastructure available to them. This context-dependence underscores the inadequacy of individual-focused interventions. Programs addressing only one dimension distributing devices without capacity-building, or organizing training without ensuring infrastructure for practice will not yield lasting change (Voogt et al., 2013; Petersen, 2020). Effective intervention must operate simultaneously across all three dimensions within a coherent, ecosystem-oriented framework. The experience recounted by the RA head in Tempurejo of pandemic-era data quota assistance giving way to an inability to sustain a Wi-Fi subscription exemplifies how non-systemic interventions can deepen institutional frustration and helplessness, consistent with the warnings of Rodiyah et al. (2023) about poorly prepared digitalization programs.

Dong, Xu, Chai, and Zhai (2020) demonstrated, in a structural equation model, that teachers' ICT self-efficacy and perceived school support are mutually reinforcing: higher self-efficacy leads teachers to seek and utilize institutional support more effectively, while stronger institutional

support builds self-efficacy through structured opportunities for practice. This virtuous cycle is entirely absent in the severely limited institutions in this study, where the absence of institutional support has produced a persistent low-confidence equilibrium that individual motivation cannot disrupt.

Untapped Social Capital of Parents

One finding that warrants particular attention is the untapped potential of parents as active partners in the digital ECE ecosystem. Suharyat et al. (2023) documented four key roles parents play: financial support, provision of facilities, human resource contribution, and support for character development. The present study confirms their finding that one-directional communication is a major barrier to parental empowerment (Hornby & Lafaele, 2011). Parents in rural Jember demonstrated substantial concern for the quality of their children's learning, yet the absence of open, two-way communication channels prevented this social capital from being mobilized. Dong, Cao, and Li (2020) found that parental attitudes toward digital learning were shaped by perceived educational quality, trust in teachers, and access to institutional communication suggesting that when institutions actively communicate about digital learning practices, parents become allies rather than bystanders. The TK in Wuluhan demonstrates that when institutions actively structure parental engagement mechanisms, parents prove willing and able to contribute materially suggesting that cultivating institutional-family dialogue is a cost-effective lever that is being systematically underutilized.

The present study confirms this dynamic. Parents in rural Jember demonstrated substantial concern for the quality of their children's learning, including the use of digital media. Yet the absence of open, two-way communication channels between parents and institutions prevented this social capital from being mobilized. Where more open communication prevailed as in the TK in Wuluhan parents proved willing and able to contribute materially. This suggests that cultivating institutional-family dialogue is a cost-effective lever that is being systematically underutilized.

Relevance to National Policy and Practical Implications

The empirical data from this study speak directly to the equitable education quality targets of RPJMN 2025–2029. Existing ECE digitalization programs require scrutiny not only in terms of device distribution, but also from the standpoint of ecosystem development. Three directions are recommended. First, needs mapping must be more granular and contextual moving beyond connectivity percentages to understanding how infrastructure interacts with teacher confidence and institutional governance. Second, teacher training models should transition from short-course formats to community-based coaching and lesson study, where teachers learn from one another within authentic instructional contexts (Kennedy, 2016; Kulaksız & Toran, 2022; Tondeur et al., 2019). Kennedy's (2016) review established that effective professional development must be sustained, content-specific, coherent with institutional goals, and involve active teacher participation criteria that community-based pedagogical coaching models are uniquely positioned to meet. Third, parental engagement should be structured through institutionalized forums and equitable communication mechanisms. University ECE programs, including those at Universitas PGRI Argopuro Jember, can deliver research-based community service programs in which faculty and students directly mentor rural ECE teachers providing the sustained, contextually embedded support that Bandura's (1997) theory and international evidence identify as essential for self-efficacy development.

At the regency level, these findings provide a strong empirical basis for the Jember Regency Education Office to redesign its ECE development approach. Three directions are recommended. First, needs mapping must be more granular and contextual moving beyond counting the percentage of institutions with internet access to understanding how that condition interacts with teacher capacity and institutional governance. Second, teacher training models should transition from short-course formats to community-based coaching and lesson study, where teachers can learn from one another within authentic instructional contexts. Third, parental engagement should be structured through institutionalized forums and equitable communication mechanisms, rather than confined to top-down parent-teacher meetings.

The implications of this study also extend to higher education institutions running ECE teacher education programs, including Universitas PGRI Argopuro Jember. Research-based community service programs in which ECE faculty and students directly mentor rural ECE teachers offer a mutually beneficial model: teachers receive contextually appropriate support, while students gain authentic and meaningful field experience.

Limitations and Future Research

This study is subject to several limitations. First, the sample comprised only ten institutions across six sub-districts, limiting the generalizability of the findings to the broader population of rural ECE settings in Jember Regency, let alone at the provincial or national level. Second, the cross-sectional design does not allow for the examination of developmental changes or institutional dynamics over time. Third, although data credibility was enhanced through systematic triangulation and member checking, the possibility of social desirability bias among participants cannot be entirely excluded. Consequently, the associations identified between ecosystem characteristics and children's developmental outcomes should be interpreted as convergent patterns rather than evidence of causal relationships.

Future research should employ mixed-methods designs with broader geographical coverage and longitudinal approaches to strengthen the robustness and transferability of these findings. Particular attention should be given to studies that move beyond problem identification toward the design, implementation, and evaluation of ecosystem-based intervention programs for rural ECE. Two especially promising directions include the development and validation of community-based pedagogical coaching models for rural ECE teachers and the creation of culturally responsive digital learning media that reflect the lived experiences, local contexts, and cultural environments of rural children.

5. CONCLUSION

This study provides an in-depth, empirically grounded mapping of the digital media gap in rural ECE institutions in Jember Regency. Three structurally interlocked dimensions were identified: limited infrastructure and device access, low teacher digital literacy and pedagogical confidence, and weak institutional and policy support. Grounded in Bandura's (1997) self-efficacy framework and consistent with international evidence from Luo, Berson, and Berson (2021), Yang and Hong (2022), Sang et al. (2022), Hatlevik and Hatlevik (2018), and Tondeur et al. (2019), the study's principal theoretical contribution is the empirical identification of teacher pedagogical confidence as distinct from technical competence as the critical mediating variable linking digital access to learning process quality across all three dimensions of the ECE process standard of Permendikbud No. 137/2014. Teachers who lacked pedagogical confidence avoided digital tools even when devices were available, directly constraining the richness of learning implementation and thus the quality of children's developmental stimulation.

The gap is not merely about the absence of devices. It is, more fundamentally, an inequity in access to adequate professional learning: in who receives sustained pedagogical mentoring, who gains access to relevant training, and who benefits from a supportive institutional ecosystem that enables professional growth. Three principal recommendations are advanced. First, ECE teacher capacity-building in rural areas must adopt community-based pedagogical coaching models sustained, contextually responsive, and peer-supported rather than isolated technical training events (Kennedy, 2016; Kulaksız & Toran, 2022; Tondeur et al., 2019). Second, the digital ECE ecosystem must actively structure parental engagement through institutionalized, equity-oriented communication mechanisms (Hornby & Lafaele, 2011; Dong, Cao, & Li, 2020). Third, budgetary and policy commitments at the regency level must be directed specifically toward the most disadvantaged ECE institutions through integrated, long-term ecosystem approaches rather than one-off equipment distributions.

Based on these findings, three principal recommendations are advanced. First, ECE teacher capacity-building programs in rural areas must be designed with sustained, empathetic, and contextually responsive mentoring approaches not isolated, short-term training events. Second, the development of the digital ECE ecosystem must actively engage parents as partners with clearly defined roles and contribution channels. Third, budgetary and policy commitments at the regency level must be

directed specifically toward the most disadvantaged ECE institutions, through integrated, long-term approaches rather than one-off interventions.

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