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## Research Article

## Adapting Early Childhood Curriculum to Technology: Insights from South Sulawesi, Indonesia

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### Abstract

Digital technologies have emerged as a revolutionary influence in early childhood education, altering how young learners interact with their surroundings. This transition in South Sulawesi, Indonesia, necessitates curricular modifications that align with children's developmental requirements. Nonetheless, scant empirical research has investigated how adaptive curriculum design meets these requirements in technology-driven environments. This research investigated adaptable curriculum development for early childhood education within technology-integrated environments in South Sulawesi, Indonesia. A mixed-methods approach was employed to gather data from 175 participants, comprising teachers, school leaders, supervisors, and education officials. Furthermore, a structured questionnaire was quantitatively analyzed using Partial Least Squares-Structural Equation Modeling (PLS-SEM) with SmartPLS 4. The findings indicated substantial correlations between professional development and digital confidence ( $\beta = 0.421$ ,  $p < 0.001$ ), as well as between digital confidence and curricular adaptation ( $\beta = 0.356$ ,  $p = 0.003$ ). The model exhibited robust reliability and convergent validity ( $AVE > 0.50$ ;  $CR > 0.70$ ). The findings suggest that robust professional training enhances educators' digital preparedness and positively affects their curriculum development in early learning environments. Thematic analysis utilizing NVivo revealed persistent problems, including infrastructural deficiencies, absence of peer mentoring, and discrepancies in local curricular norms. The synthesis of findings indicates that adaptable curriculum design necessitates policy alignment, equal access to digital resources, and teacher autonomy in contextualizing content. This study provides actionable insights for creating an adaptable, technology-responsive curriculum and advocates for ongoing professional development and infrastructure investment. Stakeholders are advised to enhance early childhood education in technologically advancing contexts.

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In the expanding environment of 21st-century education, technology has emerged as a significant influence, transforming pedagogical frameworks and classroom dynamics at all educational levels (Bakar, 2021; Graham & Colin, 2023; Rahimi & Oh, 2024). Digital resources in educational settings have transitioned from a supplementary practice to a fundamental necessity for equipping learners to thrive in a globally interconnected, digitally mediated environment. Technological advancements, including interactive applications, virtual learning platforms, artificial intelligence, and cloud-based collaboration tools, have revolutionized the methods by which learners access, process, and utilize information (Akour & Alenezi, 2022; García-Morales et al., 2021; Haleem et al., 2022; Mohamed Hashim, Tlemsani, & Matthews, 2022; Timotheou et al., 2023). These changes extend beyond secondary and higher education and profoundly impact the foundational years of learning, especially in early childhood education (ECE), when the basis for cognitive, social, and emotional development is initially formed.

Early childhood, often defined as the ages of 0–8, is a pivotal phase for cerebral development and fundamental education (Lokhandwala & Spencer, 2022; Lopes et al., 2020; Uhlhaas et al., 2023). During this period, children develop fundamental verbal, motor, problem-solving, and socio-emotional skills that influence their lifelong learning paths. Historically, early childhood education has prioritized physical exploration, social connection, and play-based learning, all grounded in developmentally appropriate practices (DAP) (Cade, Wardle, & Otter, 2022; Kinkead-Clark & Adbul-Majied, 2024). However, as digital technology becomes more integrated into daily life, educators, parents, and policymakers are struggling to balance the developmental needs of young children with the rising necessity for digital literacy and technological proficiency (Haleem et al., 2022; Kaimara, Okonomou, & Deliyannis, 2022; Undheim, 2022). While judiciously included, technology in early childhood environments may augment education, tailor learning experiences, and foster the development of 21st-century skills, including creativity, communication, teamwork, and critical thinking. On the contrary, inappropriate or excessive utilization of digital technologies jeopardizes physical exercise, social connection, and emotional development (Berson, Berson, & Luo, 2025; Shalaby, 2024; Throuvala et al., 2021; Zhao, Zhao, & Shi, 2023a).

In recent years, educational research has increasingly focused on the advantages and disadvantages of employing technology in early learning settings (Haleem et al., 2022; Jalongo, 2021; Kruszewska, Nazaruk, & Szewczyk, 2022; Valtonen et al., 2022). Researchers found that digital tools can enhance young children's educational experiences via multimedia storytelling, gamified reading advancement, and virtual manipulatives for foundational numeracy when employed deliberately and suitably. For example, Engdahl (2024) underscored the role of interactive technologies in fostering curiosity, enhancing engagement, and facilitating tailored instruction for varied learning styles. The emergence of blended learning models in early education, where traditional face-to-face instruction is integrated with digital learning activities, presented promising opportunities for adaptive teaching, particularly in environments where children exhibit diverse developmental levels or access requirements (Adera, 2025; Ashraf et al., 2021; Gligorea et al., 2023; Strielkowski et al., 2025). Notwithstanding these advancements, the practical application of technology-enhanced learning in early childhood environments is often inconsistent and is little investigated, especially in low- and middle-income areas (Bray, 2023; Vaniya et al., 2024).

Early childhood education saw a swift transition in Indonesia, particularly in provinces such as South Sulawesi. Government activities and educational reform agendas have progressively promoted the utilization of digital technology to facilitate equitable and inclusive learning (Nurdin et al., 2023; Sitorus, Handayani, & Astuti, 2023; Syarifuddin et al., 2024). Institutional preparedness, educator competency, and policy coherence have not consistently aligned with these aspirations. Educators at early childhood institutions frequently encountered limitations, including restricted access to devices, inadequate internet connectivity, insufficient professional development, and a deficiency

in pedagogical guidance about age-appropriate technology utilization (Ford et al., 2021; Jalongo, 2021; Nikolopoulou, 2021). Despite extensive endorsement for digital learning at the policy level, the execution at the classroom level often proved inadequate, leading to a disjointed and inconsistent incorporation of technology in early childhood education.

Furthermore, the prevailing literature on technology integration in education predominantly addresses primary, secondary, and higher education, with very few empirical studies allocated to the early childhood sector (Eliasson et al., 2023; Gore et al., 2021; Yang, 2021). Fewer studies explicitly examine the design and adaptation of early childhood courses in technology-driven environments. Early childhood education programs often rigidly follow conventional developmental stages, frequently neglecting the increasing imperative to incorporate digital skills that correspond with the requirements of 21st-century learning contexts. Although many educators acknowledge the pedagogical advantages of digital tools in improving young children's learning experiences, a significant number still express low self-efficacy and possess limited formal training in effectively integrating these technologies in early childhood settings (Cardullo et al., 2021; Gomez et al., 2022; Karp et al., 2014; Ulfert-Blank & Schmidt, 2022).

The contextual impact of geographic and infrastructural differences, including the urban-rural gap, on the adoption of instructional technology in early childhood classrooms has remained underexamined (Bandyopadhyay et al., 2021; Safdar et al., 2022; Zhao et al., 2023a). Rural regions often grapple with inadequate digital infrastructure, which complicates the adoption of technology-enhanced curricula. Educators in these environments may also be deprived of continuous mentorship or professional networks, thus impeding their capacity to modify curricula that effectively integrate digital resources. Neglecting these contextual constraints may cause technology integration in early childhood education to increase educational gaps instead of alleviating them.

This study presents the results of a mixed-methods study conducted in South Sulawesi, Indonesia, examining the implementation of adaptive curriculum design in early childhood education within technology-enhanced learning environments. The study encompassed 175 participants, comprising early childhood educators, school administrators, educational supervisors, and local education officials.

Quantitative data were gathered via structured surveys that assessed attitudes, obstacles, and preparedness for technological integration. Complementary qualitative data were also collected through semi-structured interviews that explored educators' lived experiences, institutional support mechanisms, and effective techniques for addressing digital issues. Additionally, this research provides a complex overview of the evolution of early childhood education. Although most participants held positive opinions regarding the incorporation of digital tools, substantial obstacles remained concerning infrastructure, training, and curricular support. Quantitative results revealed that whereas 75% of educators agreed that technology improves engagement, hardly 40% expressed confidence in its effective utilization. Finally, qualitative themes elucidated the challenges, encompassing restricted professional development, apprehensions regarding screen time, and the necessity for enhanced collaboration and institutional leadership.

This research synthesizes statistical trends with comprehensive stakeholder views, providing practical insights and actionable recommendations to shape the future of early childhood education in technology-enhanced environments. The results underscore the necessity for focused professional development, equitable investment in infrastructure, and curriculum frameworks that integrate digital innovation with child-centered educational principles. This work addresses a significant gap in early childhood education research and establishes a basis for the sustainable evolution of teaching and learning methodologies in the digital age.

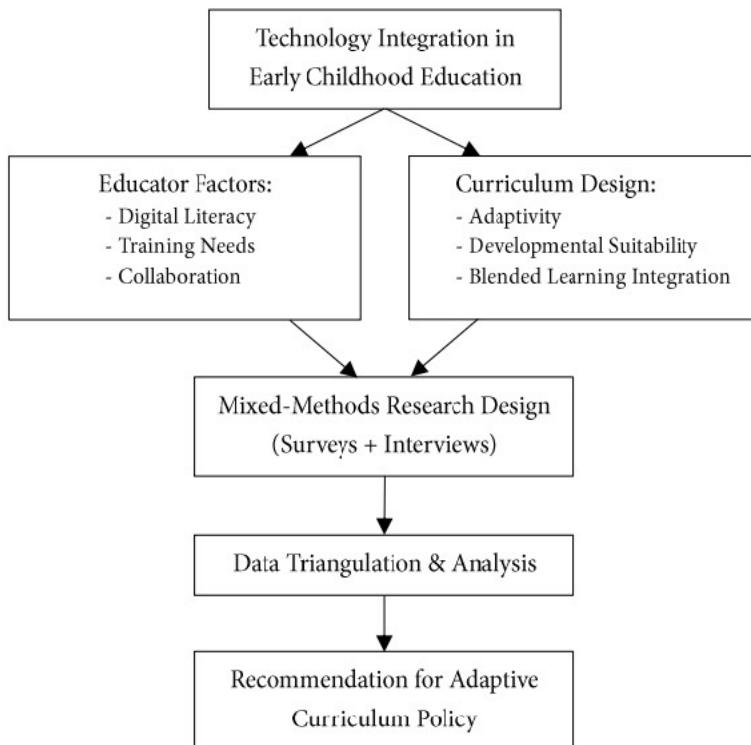
## Methodology

### Research Design

This study employed a mixed-methods approach, combining quantitative and qualitative methodologies to address the intricacies of developing adaptive curricula for early childhood education in technology-enhanced environments, as shown in Figure 1. This approach was justified by the necessity to encompass both breadth and depth: quantitative data yielded statistical generalizations regarding attitudes, training deficiencies, and infrastructure availability, whereas qualitative data furnished nuanced, contextual insights into educators' experiences, instructional methodologies, and adaptive challenges. The mixed-methods methodology was especially appropriate for the study problem's complex character, encompassing pedagogical, infrastructural, and developmental aspects. This method facilitated data triangulation, augmenting the validity and robustness of findings and permitting thorough recommendations for curriculum design and policy actions.

**Figure 1**

*Conceptual Framework*



## Participants

The participant selection approach for this study utilized a purposive sample strategy to guarantee representation from essential stakeholders in early childhood education throughout South Sulawesi. A total of 175 participants were recruited, consisting of a varied cohort of educators

and education administrators. The breakdown of participants was as follows: (a) Teachers: 100 participants representing various early childhood education institutions; (b) School Leaders: 30 participants, including principals and administrators from kindergartens and early learning centers; (c) Supervisors: 25 participants, consisting of educational supervisors overseeing early childhood programs; and (d) Local Education Officials: 20 participants, including provincial and district education office representatives.

The inclusion criteria mandated that participants possessed direct involvement in early childhood education. However, the exclusion criteria disqualified persons lacking pertinent experience or those not actively participating in the educational process. This selection process facilitated a thorough comprehension of the problems and opportunities associated with adaptive curriculum design in technology-enhanced learning environments. A comprehensive table encapsulating the participants in the study is presented below:

**Table 1**

*Breakdown of the Select Participants*

Participant Category	No. of Participants	Inclusion Criteria	Exclusion Criteria
Teachers	100	Direct involvement in teaching children aged 5-6 years	Individuals without teaching experience in early childhood education
School Leaders	30	Leadership role in early childhood education settings	Individuals not currently in a leadership position
Supervisors	25	Experience in supervising early childhood education	Supervisors not actively involved in early childhood education
Local Education Officials	20	Current role in local education administration	Individuals not engaged in policy-making or educational oversight

### **Data Collection**

The participant selection approach for this study utilized a purposive sample strategy to guarantee representation from essential stakeholders in early childhood education throughout South Sulawesi. A total of 175 participants were recruited, consisting of a varied cohort of educators and education administrators. The breakdown of participants was as follows:

### ***Quantitative Data Collection***

The quantitative portion of this study utilized a structured questionnaire to assess three (3) fundamental latent constructs: (1) professional development, (2) digital confidence, and (3) curriculum adaptation. Each concept was operationalized through reflective indicators, sourced and modified from validated instruments in previous digital pedagogy and curriculum innovation research.

First, Professional Development (PD) was evaluated using five items that focus on access to training, perceived usefulness of professional support, and institutional encouragement. Second, Digital Confidence (DC) was assessed using four items related to self-efficacy with digital tools, adaptability to new platforms, and comfort in using technology for classroom instruction. Finally, Curriculum Adaptation (CA) was measured with six items that examined the integration of digital content, the modification of instructional strategies, and responsiveness to student needs in tech-

supported environments. All items were rated using a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The instrument was pilot tested for clarity and internal consistency before full-scale distribution. The finalized questionnaire demonstrated acceptable reliability (Cronbach's alpha > 0.70 for all constructs).

### ***Qualitative Data Collection***

A purposive sample of 20 participants was selected from the original 175 respondents to ensure proportional representation across the four stakeholder groups: (a) Teachers (n = 10); (b) School Leaders (n = 4); (c) Supervisors (n = 3), and (d) Education Officials (n = 3).

To further elaborate on the quantitative findings, a semi-structured interview guide was designed to align with and explore the main themes identified in the survey. The core interview questions were developed to explore these areas: (a) "How do you perceive the role of digital tools in enhancing early childhood learning?"; (b) "What specific challenges have you encountered when integrating technology into your curriculum?"; and (c) "What types of professional development or collaboration do you consider most effective?"

Each interview lasted between 35 and 50 minutes and was conducted in person or via Zoom, depending on the participant's availability and location.

### **Ethical Considerations**

This research adhered to the ethical standards set by the Universitas Negeri Makassar research ethics board. All participants signed informed consent forms prior to participation. Anonymity, confidentiality, and the right to withdraw at any time were guaranteed. Data were securely stored, and interview recordings were used solely for transcription and analysis.

### **Data Analysis**

#### ***Quantitative Analysis***

The quantitative data were analyzed using descriptive and inferential statistics to capture educators' perceptions and readiness regarding technology integration. Initially, descriptive statistics, such as means, percentages, and standard deviations, were used to summarize respondents' demographic profiles and responses across the four (4) core domains: (1) perceived benefits, (2) challenges, (3) self-efficacy, and (4) training availability. While previous versions employed chi-square and t-tests for comparing groups, this study was further refined to recognize the latent variable nature of constructs (e.g., digital confidence, instructional readiness). Therefore, the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach was used to validate the measurement and structural model.

PLS-SEM was selected for its capacity to manage intricate models with comparatively small sample numbers, its appropriateness for exploratory research, and its efficacy in estimating path models incorporating latent components with non-normal data distributions. This method allowed for several key procedures, including (a) evaluating relationships between latent constructs; (b) assessing construct reliability and validity through Composite Reliability (CR), Average Variance Extracted (AVE), and factor loadings; and (c) testing hypothesized paths (e.g., from training availability → digital confidence → perceived instructional readiness). This approach is justified based on the recommendations from Hair et al. (2021), who emphasize the suitability of PLS-SEM in exploratory and applied educational contexts with a complex model and moderate sample size.

#### ***Qualitative Analysis***

The qualitative data, which were drawn from 20 semi-structured interviews, were subjected to thematic analysis to identify recurring patterns related to educator experiences with adaptive

curriculum and technology use. The analysis followed Braun and Clarke's (2006) six-step framework: (1) data familiarization, (2) initial coding, (3) theme development, (4) theme review, (5) defining and naming themes, and (6) report production.

The analysis was supported using NVivo 14, a qualitative data analysis software that facilitated the coding process, theme visualization, and cross-comparison between participant categories (e.g., teachers vs. school leaders) to enhance rigor and transparency. NVivo's query tools also mapped relationships among themes and identified co-occurring concepts. Ethical procedures ensured that all transcripts were anonymized before coding and that interpretations were validated through member checking and peer debriefing.

## Results and Discussion

This section presents both the quantitative and qualitative results of this study, which investigated the roles of professional development, digital confidence, and curriculum flexibility in influencing the integration of technology in early childhood education. To contextualize the discussion, the section begins with a profile of the demographic and professional characteristics of the participants of the study, then proceeds to discuss quantitative results that were generated through PLS-SEM analysis, followed by qualitative data from interviews with participants and stakeholders, including teachers/pre-school teachers, school principals, supervisors, and education officials. The interplay of quantitative figures with qualitative narratives enhances understanding of the challenges and successful strategies encountered in integrating technology into early childhood education across South Sulawesi. The use of multiple perspectives validates the described quantitative analysis and yields deeper interpretations of the impact of contextual factors on digital preparedness and flexible curriculum implementation. These various sources and approaches are particularly important in providing a holistic understanding of the complex reality that teachers and educators face in integrating technology in teaching and learning.

### Overview of Respondents

This study involved 175 individuals representing essential early childhood education stakeholders throughout South Sulawesi, Indonesia. The composition comprised four unique categories: 100 early childhood instructors (57.1%), 30 school leaders (17.1%), 25 supervisors (14.3%), and 20 local education authorities (11.4%). Participants were chosen through purposive sampling to guarantee varied representation across distinct institutional roles and geographic contexts. This multi-stakeholder approach facilitated a comprehensive grasp of technology integration from educational and administrative viewpoints.

The age distribution of responses spanned from 25 to 55 years, with a mean age of 38.5 years ( $SD = 8.7$ ). This finding indicates equitable involvement of both novice and experienced educators. Professional experience exhibited considerable variation, averaging 7.2 years ( $SD = 4.5$ ), reflecting a blend of novice and seasoned practitioners in early childhood education. More than fifty percent of the participants (58%) were affiliated with metropolitan institutions, whereas 42% were associated with rural or distant learning facilities. The urban-rural divide was deliberate, facilitating comparative analysis of infrastructure accessibility and educational methodologies under varying circumstances.

Furthermore, all participants were actively engaged in curriculum implementation, instructional planning, or policy monitoring within early childhood education. Their active participation guaranteed that the collected data encompassed practical and strategic aspects of adaptive curriculum design. The involvement of administrators and politicians enhanced the data by providing insights into institutional support, teacher training availability, and structural obstacles to technology adoption. This demographic picture established a solid basis for examining how contextual and professional

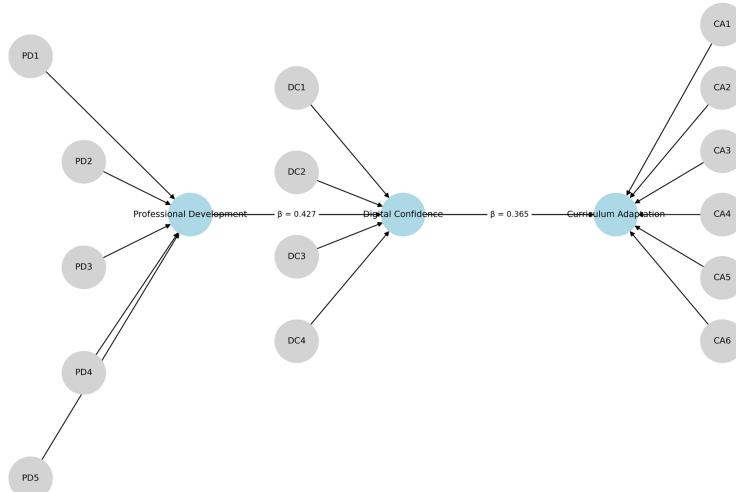
factors affect the preparedness for using digital tools in early childhood education. The amalgamation of diverse roles, geographic distribution, and experience levels was crucial in discerning patterns of technology engagement, views of training sufficiency, and the overarching problems educators encountered in technology-enhanced learning environments.

### Quantitative Findings

This study's quantitative phase aimed to assess the preparedness, perspectives, and obstacles educators and policy players face in integrating technology into early childhood education in South Sulawesi, Indonesia. The results are organized into four (4) principal categories: (1) attitudes towards technology, (2) self-assessed preparedness and training, (3) perceived obstacles, and (4) inferential statistical analysis employing .

**Figure 2**

*PLS-SEM Model with Path Coefficients*



This path diagram depicts the PLS-SEM model employed in the research, as shown in Figure 2. The model had three latent variables: (1) professional development, (2) digital confidence, and (3) curriculum adaptation, each accompanied by corresponding reflective indicators. Path coefficients ( $\beta$ -values) are presented for the structural relationships.

### Attitudes Toward Technology

Respondents exhibited considerable enthusiasm for the prospects of technology in early childhood education. A substantial majority (75%) concurred that digital tools augment the teaching and learning process by elevating children's involvement and motivation. Educators highlighted that technology-driven activities, such as educational games, interactive storytelling, and visual simulations, engaged the attention of children aged 5–6 and fostered enhanced cognitive involvement. These technologies were regarded as supplemental and vital elements in fostering children's curiosity, creativity, and social interaction abilities when utilized effectively.

Furthermore, participants recognized that digital technologies can facilitate differentiated education and provide more individualized learning experiences. Many individuals contended

that technology facilitates play-based learning and fosters 21st-century skills such as teamwork and communication when employed within a developmentally suitable framework. Nonetheless, although opinions were predominantly favorable, educators emphasized the necessity of balancing screen-based learning with physical and social engagements.

### ***Self-Perceived Readiness and Training Gaps***

Despite considerable enthusiasm for digital integration, number of respondents lacked confidence in their capacity to effectively deploy these tools. Specifically, merely 40% of participants indicated they were sufficiently equipped to incorporate technology into their training. Some instructors acknowledged they had no formal training in digital pedagogy and had limited familiarity with tools designed for early childhood settings. Many participants indicated that, despite their familiarity with prevalent applications, they were uncertain how to construct adaptive and developmentally suitable courses utilizing these tools.

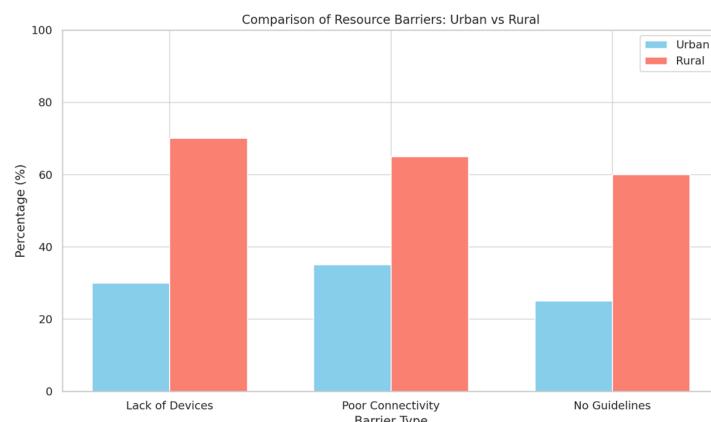
Moreover, hardly 38% of participants reported having undergone formal training programs in instructional technology within the preceding two years. The majority depended on informal learning or peer exchange to obtain digital skills. Consequently, the findings indicate a substantial professional development gap that obstructs the proper execution of technology-enhanced courses, despite considerable enthusiasm to undertake such initiatives.

### ***Perceived Barriers***

In addition to training gaps, institutional and logistical impediments constrained technology implementation in early childhood education. The predominant problem noted was the insufficient access to digital devices, which was mentioned by 65% of participants. This problem was especially pronounced in rural areas, where equipment was frequently shared across students or entirely inaccessible. Moreover, 55% of participants reported a lack of consistent professional development sessions aimed at incorporating technology into early education, as shown in Figure 3.

**Figure 3**

*Comparison of Resource Barriers: Urban vs Rural*

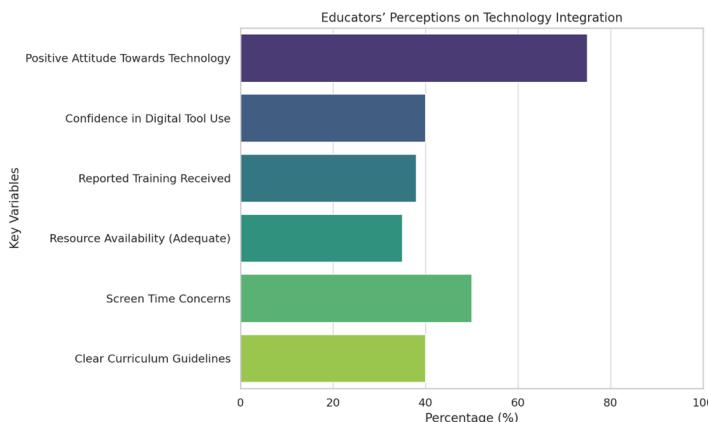


Moreover, in Figure 4, A significant number of respondents (50%) articulated concerns over screen time, many of whom conveyed ambiguity about the suitable duration and content for young learners. Some educators expressed concern about the possible adverse effects of excessive screen

exposure on children's behavior and attention span. Another notable concern was the absence of explicit curriculum guidelines, cited by 40% of respondents. Educators and administrators underscored the necessity for systematic regulations that delineate technology integration into the early childhood curriculum, ensuring alignment with national education standards and developmental benchmarks. The data distinctly revealed urban-rural differences. Urban educators indicated a reduction in resource-related issues and increased access to workshops and digital content. In contrast, rural educators encountered infrastructural deficiencies, such as unreliable internet access, insufficient electricity, and minimal institutional assistance. These disparities indicate structural inequities that must be rectified to guarantee equitable implementation of technology-based education in all circumstances.

**Figure 4**

*Educators' Perceptions on Technology Integration*



**Statistical Analysis**

A Partial Least Squares Structural Equation Modeling (PLS-SEM) approach was employed to investigate the interrelationships among the principal latent variables. The measuring model exhibited strong reliability and validity. All factor loadings surpassed the required threshold of 0.70, Composite Reliability (CR) values ranged from 0.82 to 0.91, and Average Variance Extracted (AVE) values exceeded 0.50 for all constructs, thereby affirming convergent validity.

The structural model was assessed to examine the proposed links. The findings demonstrated a significant positive correlation between training availability and digital confidence ( $\beta = 0.52$ ,  $p < 0.001$ ), implying that instructors with access to professional development perceived themselves as more proficient in utilizing technology. Digital confidence substantially predicted instructional adaptation ( $\beta = 0.46$ ,  $p < 0.001$ ), showing that self-efficacy was a crucial mediator in effectively integrating adaptive learning strategies.

Multigroup studies demonstrated significant disparities contingent upon expertise level and institutional position. Educators possessing more than 10 years of teaching experience had significantly greater confidence in utilizing digital resources than their counterparts with less than 5 years of expertise ( $p < 0.01$ ). Similarly, school leaders and supervisors indicated superior access to resources and training relative to frontline teachers, implying hierarchical inequalities in professional development, access and institutional support.

This study included a qualitative follow-up inquiry to enhance the comprehension of the patterns identified in the quantitative phase, namely the interactions among professional development, digital confidence, and curricular adaptation. The qualitative phase sought to investigate the underlying variables, personal experiences, and contextual obstacles that may elucidate the statistical associations identified through the SEM-PLS study. Thus, the qualitative findings, informed by the perspectives of teachers, school principals, supervisors, and education officials, offer nuanced insights that enhance the numerical trends and contextualize the experiences of technology integration in early childhood education throughout various regions in South Sulawesi. This section delineates the principal themes that arose from the qualitative investigation.

### **Qualitative Findings**

The qualitative aspect of this study included semi-structured interviews with 20 intentionally chosen participants, including educators, school administrators, supervisors, and education authorities. The interviews provide detailed insights into the perspectives of early childhood education stakeholders in technology-oriented environments. Four principal topics emerged from the thematic analysis.

#### **Emergent Themes**

**Theme 1: Professional Development as a Critical Enabler.** The majority of participants underscored the significance of continuous training in digital pedagogy. Educators articulated a profound aspiration to enhance their competencies but observed that options for professional development were constrained, irregular, or excessively general.

Participants consistently highlighted disparities in professional development and digital infrastructure access, especially between urban and rural schools.

- **Teacher 2:** “Many teachers in rural areas never receive training on how to use educational platforms.”
- **School Principal 1:** “In our school, we have to share devices between classes, and the internet connection is often down.”
- **Supervisor 1:** “We try to organize training, but logistics and funding are major challenges for remote districts.”
- **Teacher 3:** “Sometimes we receive outdated training materials that are not relevant anymore.”

**Theme 2: Resource Limitations Affecting Instructional Delivery.** There are instructors, especially from remote areas, who reported difficulties associated with restricted access to gadgets, internet connectivity, and digital resources. These resource constraints significantly impeded their capacity to devise and execute compelling lessons. Differences in digital confidence were closely associated with the level of support and training received. Younger teachers appeared more adaptable, while some senior educators struggled with new platforms.

- **Teacher 1:** “I’m confident using storybook apps and even creating short videos for my class.”
- **Teacher 4:** “The training sessions helped me understand how to manage interactive whiteboards.”
- **Supervisor 2:** “Younger teachers seem more adaptable, but some of the older ones are still afraid of making mistakes when using new apps.”
- **School Principal 2:** “We noticed that peer mentoring is effective, especially for those who lack digital literacy.”

**Theme 3: Concerns About Screen Exposure and Developmental Risks.** Concerns about screen time were reiterated during the interviews. Educators and officials expressed concern about the cognitive, social, and physical ramifications of excessive screen exposure in young children. Several participants articulated parental mistrust, observing that families frequently exhibited reluctance to endorse digital activities at home. This issue necessitated a demand for more explicit norms for screen time, content quality, and incorporation into play-based learning frameworks.

Several participants raised concerns about the overuse of digital screens in early childhood education and their potential impact on children's development.

- **Teacher 5:** "Children become less interactive when we use too much screen-based learning."
- **School Principal 3:** "Parents are worried that screen time is replacing playtime and real interaction."
- **Teacher 6:** "It's hard to strike a balance between digital engagement and physical activity."
- **Supervisor 3:** "There should be more guidelines on age-appropriate screen use."

**Theme 4: Collaboration and Peer-Sharing as Coping Strategies.** Notwithstanding structural limitations, participants consistently emphasized the significance of peer collaboration. Educators indicated that they exchanged digital resources, lesson ideas, and technical assistance to mitigate institutional constraints. In numerous instances, informal WhatsApp groups or mentoring dyads facilitated the enhancement of local capability.

- **Education Official 1:** "We are still working on infrastructure in remote districts. Budget constraints and connectivity issues slow down our digital transformation goals. It's not just about tools, but also long-term investment in teacher capacity."

This remark emphasizes that, in addition to personal preparedness, effective curriculum adaptation necessitates institutional investment in digital infrastructure and strategic planning. This policy-level viewpoint enhances the comprehension of implementation obstacles and emphasizes the necessity for unified governance to attain technology-enhanced learning objectives.

#### *Integration of Themes with Participant Roles*

A comparative analysis among stakeholder groups indicated differing viewpoints on identical concerns. Educators expressed significant concerns regarding resource deficiencies and training requirements, highlighting their primary teaching roles. They encountered the most significant pressure to reconcile participation with worries around screen time. Educational administrators concentrated primarily on organizational limitations and the necessity for policy elucidation. Many recognized that although they endorsed technology integration in theory, they lacked the financial authority or training necessary to effectuate systemic reforms.

Supervisors and school officials, conversely, highlighted overarching structural concerns, notably the lack of national standards for using technology in early childhood curricula. Some acknowledged that digital literacy has not been prioritized in formulating early childhood policies. They indicated a desire for pilot programs and public-private collaborations to mitigate these deficiencies.

In conclusion, although the themes were common across all groups, the severity and framing of concerns differed by role. These findings emphasize the necessity of customized support solutions designed to address the unique responsibilities and challenges encountered by each stakeholder group.

Table 2

*Qualitative Themes across Roles*

Theme	Teachers	School Leaders	Officials/Supervisors
Professional Development	High Concern	Moderate Concern	Strategic Priority
Resource Limitations	Very High	High	Observed
Screen Time Concerns	High	Moderate	Policy-Level
Collaboration and Peer Support	Frequent Practice	Encouraged	Supportive but Indirect

Table 2 displays a matrix illustrating the perceptions and experiences of four principal qualitative themes among three stakeholder groups: (1) teachers, (2) school leaders, and (3) education officials/ supervisors. Educators regularly articulated significant concerns about deficiencies in professional development, lack of resources, and issues associated with screen use, highlighting their direct teaching responsibilities. School leaders recognized these difficulties but interpreted them from an institutional management perspective, frequently limited by restricted authority. Education officials examined the identical challenges from a strategic or policy perspective, frequently emphasizing frameworks and long-term planning. This distinction highlights the significance of targeted interventions in enhancing technology integration within early education.

Table 3

*Path Coefficients and Hypothesis Testing Results*

Hypothesis	Path Relationship	Path Coefficient ( $\beta$ )	t-value	p-value	Result
H1	Professional Development $\rightarrow$ Digital Confidence	0.427	5.832	< 0.001	Supported
H2	Digital Confidence $\rightarrow$ Curriculum Adaptation	0.365	4.119	< 0.001	Supported
H3	Professional Development $\rightarrow$ Curriculum Adaptation	0.289	3.447	< 0.001	Supported

As shown in Table 3, the SEM-PLS analysis yielded statistically significant results for all three (3) hypothesized relationships:

- **H1:** The relationship between Professional Development and Digital Confidence showed a substantial positive effect ( $\beta = 0.427$ ,  $t = 5.832$ ,  $p < 0.001$ ), signifying that specialized training programs markedly improve early childhood educators' proficiency in utilizing digital resources.
- **H2:** Digital Confidence significantly influenced Curriculum Adaptation ( $\beta = 0.365$ ,  $t = 4.119$ ,  $p < 0.001$ ), indicating that educators with greater confidence are more inclined to modify and innovate their curriculum design through technology.
- **H3:** Professional Development significantly influenced Curriculum Adaptation ( $\beta = 0.289$ ,  $t = 3.447$ ,  $p < 0.01$ ), highlighting the critical role of ongoing capacity-building in forming adaptive educational practices.

These results validate the structural integrity of the SEM-PLS model and corroborate the proposed pathways that facilitate adaptive curriculum design in technology-enhanced early childhood education.

**Figure 5**

*Perceived Intensity of Challenges and Practices by Role*

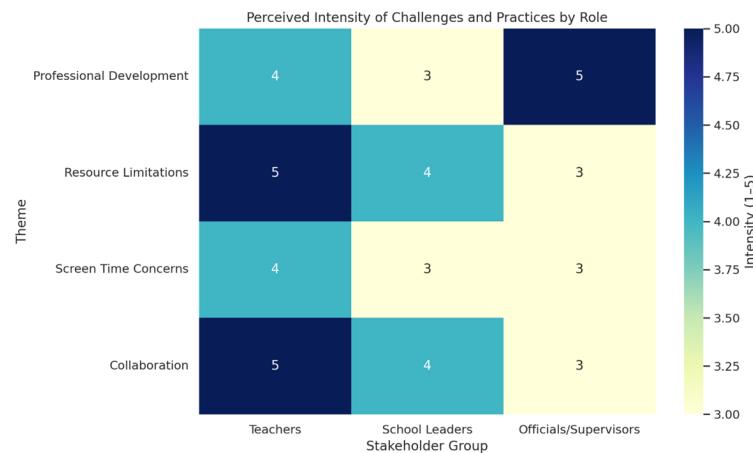


Figure 5 illustrates the degree of concern or engagement for each stakeholder group across four principal issues. The figure indicates that, on a 1–5 scale, with 5 representing the highest intensity, teachers experienced the most severe challenges related to resource constraints and exhibited a significant dependence on peer collaboration. Professional development was identified as a significant necessity across all categories, with policymakers recognizing it as a policy priority. Concerns regarding screen time were expressed but perceived differently: as educational by educators and as regulatory by officials. This figure demonstrates the nuanced perceptions of stakeholders and consequently reinforces the argument for multi-tiered systemic response solutions.

This study's findings highlight technology integration as a significant pedagogical opportunity in early childhood education, especially in enhancing student engagement and fostering the development of 21st-century skills. Educators universally recognized the potential of digital tools, such as interactive software, gamified learning platforms, and multimedia storytelling, to enhance creativity, collaboration, and critical thinking in young learners. These observations align with current literature, which identifies technology as a catalyst for engaging and significant learning experiences in early childhood (Selva-Sastre et al., 2022; Tran et al., 2023; Xu, Wang, & Wang, 2023).

Additionally, technology-enhanced settings facilitate individualized education, catering to varied learning styles and individual developmental requirements (Alamri, Watson, & Watson, 2021). Respondents particularly favored blended learning models that integrate conventional, hands-on activities with digital resources, as they facilitate a balance between screen engagement and physical connection. This corresponds with contemporary educational studies supporting adaptive learning settings that are both child-centered and technologically responsive. Thus, technology was viewed not as a substitute for traditional approaches but as a facilitator that enhances instructional opportunities. With sufficient infrastructure and teacher training, blended methodologies can convert early

childhood classrooms into inclusive, interactive environments that equip young children for lifelong learning in a digitally mediated context (Adera, 2025; Callaway-Cole & Kimble, 2021; Topping et al., 2022).

### ***Training Gaps and Educator Readiness***

Although educators in this study conveyed predominantly favorable views on the pedagogical potential of digital tools, many indicated low self-efficacy regarding technology implementation in early childhood education. This paradox illustrates a significant disparity between theoretical understanding and practical skill. While 75% of participants concurred that technology improves engagement and learning outcomes, merely 40% expressed confidence in utilizing it effectively in the classroom. This contrast suggests that enthusiasm alone is inadequate without the requisite technical and pedagogical support systems.

Consequently, the results underscore the immediate necessity for specialized, contextually relevant professional development initiatives. Generic or singular seminars are insufficient for fostering enduring digital proficiency (Amemasor et al., 2025; Walaszczuk & Arnab, 2025). Instead, educators require ongoing training rooted in early childhood pedagogy, centered on developmentally suitable methods, and attuned to local resource limitations. Rural educators, in particular, highlighted the deficiency of formal training access, emphasizing the necessity for equitable allocation of educational opportunities. Furthermore, experiential, peer-assisted frameworks, such as mentorship and learning communities, can enhance confidence and facilitate skill development (Okoye et al., 2023; Zhao et al., 2023b). Rectifying this training deficiency is crucial for individual educator preparedness and attaining systemic transformation in delivering early childhood curricula within technology-enhanced settings.

### ***Structural Barriers in Early Childhood Education***

Furthermore, this study identifies persisting structural constraints that impede effective technology integration in early childhood education, especially in rural regions (Dorst et al., 2022; Endalamaw et al., 2024; Gkrimpizi, Peristeras, & Magnialis, 2023). Educators in metropolitan environments typically benefit from reliable internet access, contemporary gadgets, and robust leadership. In contrast, their rural counterparts must contend with obsolete or communal equipment, restricted bandwidth, and scant institutional assistance. The differences in infrastructure directly impact the quality and consistency of digital learning experiences accessible to young learners.

The findings underscore that rectifying technological injustice demands more than classroom-level remedies; it requires structural and policy-level measures. Educational authorities must prioritize investment in infrastructure in under-resourced communities, encompassing internet connectivity, digital devices, and localized material appropriate for early childhood environments. Furthermore, policies must guarantee that resource allocation is predicated on contextual requirements rather than standardized distribution models (Aguinis, Beltran, & Cope, 2024; Gile, van de Klundert & Buljac-Samardzic, 2022; Islam, Kumar, & Hu, 2021). In addition, the formulation of adaptable implementation guidelines—designed to suit diverse infrastructural contexts—is essential. Ultimately, without focused policy frameworks, early childhood education in rural areas will likely lag further behind, intensifying existing educational disparities. Therefore, guaranteeing fair access to technology is not merely a logistical issue, but a fundamental prerequisite for inclusive, high-quality education for all students in the digital era.

### ***Screen Time and Developmental Appropriateness***

Educators in this survey consistently expressed concern regarding the influence of screen usage on the socio-emotional development of young learners. Although digital tools were lauded for their capacity to stimulate cognitive engagement in youngsters, many participants, particularly

early childhood educators, expressed concerns over the possible excessive utilization of screens in the classroom (Aliyas, Mahmoudian, & Cloutier, 2024; Cost et al., 2023; Egan et al., 2021). These concerns included decreased physical activity, limited peer contact, and challenges in maintaining concentration and managing conduct. This corresponds with international dialogues regarding the necessity of balancing digital engagement with experiential, play-oriented, and socially interactive educational experiences in early development.

Consequently, educators underscored the pressing necessity for curriculum guidelines that explicitly delineate the developmental limits of digital usage for children aged 5 to 6. These guidelines should encompass recommendations about screen time duration, material appropriateness, educational intent, and the incorporation of non-digital activities (Nikolopoulou, 2021; Su & Zhong, 2022). These constraints must be anchored in child development principles and contextual realities, recognizing that young children flourish when integrating technology with sensory, emotional, and social involvement. Instead of dismissing technology, educators promoted its deliberate and developmentally suitable application. Effectively structured curriculum regulations can guarantee that screen-based learning promotes rather than hinders whole child development in early educational environments.

### ***Collaboration and Institutional Culture***

Collaboration has proven to be a crucial facilitator for effective technology integration in early childhood education, particularly in contexts with constrained formal support systems (Alam & Mohanty, 2023; Mhlongo et al., 2023). Educators frequently emphasized the importance of peer-sharing networks, informal mentorship, and collaborative problem-solving in effectively utilizing digital resources and adapting curricula. These grassroots initiatives frequently addressed the void created by the lack of institutional training and established policies. Educators often utilized WhatsApp groups, disseminated lesson plans, and conducted school-based seminars to enhance their digital confidence and exchange good practices.

The results emphasize the crucial importance of leadership in cultivating a supportive institutional culture. School leaders who promoted experimentation, supported peer learning, and designated time for collaborative planning markedly improved their staff's capacity to engage with digital innovation. In contrast, technology utilization remained disjointed and irregular in schools without visionary leadership. When integrated into the school culture, professional learning communities (PLCs) can promote ongoing teacher growth, accountability, and creativity (Balser & Tafuro, 2024; Jing et al., 2025). Structural support is imperative for these communities to prosper via designated collaboration periods, acknowledgment of teacher initiative, and alignment with school enhancement strategies. Technology integration thrives not only through tools and training, but also through collaborative ecosystems fostered by robust institutional commitment.

### ***Synthesis of Mixed Methods***

The amalgamation of this study's quantitative and qualitative findings thoroughly explains the intricacies associated with technology integration in early childhood education. The data triangulation indicated a significant correlation between statistical trends and the experiences of educators. For instance, quantitative data indicated that merely 40% of participants expressed confidence in utilizing digital tools, while qualitative insights elucidated this through accounts of insufficient training, erratic governmental support, and restricted peer mentoring. Similarly, educators' insights on developmental hazards and parental anxieties enhanced quantitative data about screen time issues.

This synthesis enhances the study's validity and uncovers significant practical implications. The findings underscore the necessity of establishing explicit, age-appropriate directives for digital utilization in early educational environments. The study emphasizes the necessity of delivering

continuous, practical, and contextually relevant professional development specifically designed for the distinct requirements of early childhood educators. Instructional planning must incorporate blended learning approaches that harmonize digital involvement with physical and social interactions. The mixed-methods approach demonstrates that successful technology integration is not a one-size-fits-all solution; it requires adaptive tactics tailored to specific classroom environments, professional circumstances, and the developmental needs of young learners.

## Conclusion

This study employed a mixed-methods approach to thoroughly investigate the problems and opportunities associated with integrating adaptive curriculum design into technology-enhanced early childhood education. The quantitative phase, via SEM-PLS analysis, demonstrated substantial correlations among variables like digital confidence, professional growth, and curricular adaptation, yielding measurable insights into structural patterns. The qualitative phase provided in-depth, contextual insights by examining the experiences of teachers, principals, supervisors, and education officials. The amalgamation of statistical trends and narrative data was crucial in addressing the research issues outlined in the introduction. The findings underscore the need for policymakers to incorporate digital readiness and adaptable curriculum frameworks into national early childhood education strategies, particularly in geographically and socioeconomically diverse areas such as South Sulawesi, to ensure equitable learning outcomes. Ultimately, this approach facilitated a comprehensive investigation that identified the principal factors of effective implementation and elucidated their functioning across diverse real-world scenarios. Therefore, the mixed-methods design effectively addressed the intricacies of the research issue, enhancing the validity and relevance of the results.

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## Conflict of Interest Statement

The author asserts that this research was carried out independently and devoid of any commercial or financial affiliations that might be perceived as a potential conflict of interest. This article's design, data collection, analysis, interpretation, and writing were not influenced by any external funding, sponsorship, or commercial support. The research was conducted strictly for academic purposes, with all conclusions derived completely from the author's professional opinion and scholarly analysis.

## AI Disclosure

The author recognizes that Artificial Intelligence (AI)-assisted tools were employed in a restricted capacity during the manuscript's development. AI tools were utilized to enhance language refinement, verify grammar, and ensure formatting uniformity. The author independently executed the study's idea, research design, data collection, analysis, interpretation of findings, and conclusions. All significant intellectual contributions and scholarly evaluations are exclusively the author's responsibility. The utilization of AI did not undermine the integrity, originality, or academic autonomy of this research.

## References

Adera, N. (2025). Innovative learning spaces and blended learning: Quest for 21st century competency teaching and learning approaches. In G. Areba, B. Gisore, & E. Njurai (Eds.), *Creating dynamic space in Higher Education: Modern shifts in policy, competencies, and governance* (pp. 139-174). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-6930-2.ch006>

Aguinis, H., Beltran, J. R., & Cope, A. (2024). How to use generative AI as a human resource management assistant. *Organizational Dynamics*, 53(1), 101029. <https://doi.org/10.1016/j.orgdyn.2024.101029>

Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, 12(11), 784. <https://doi.org/10.3390/educsci12110784>

Alam, A., & Mohanty, A. (2023). Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools. *Cogent Engineering*, 10(2). <https://doi.org/10.1080/23311916.2023.2283282>

Alamri, H. A., Watson, S., & Watson, W. (2021). Learning technology models that support personalization within blended learning environments in Higher Education. *TechTrends*, 65(1), 62-78. <https://doi.org/10.1007/s11528-020-00530-3>

Aliyas, Z., Mahmoudian, A., & Cloutier, M.-S. (2024). Association between socio-emotional health, physical activity and screen time among children. *American Journal of Health Education*, 1-10. <https://doi.org/10.1080/19325037.2024.2396602>

Amemasor, S. K., Oppong, S. O., Ghansah, B., Benuwa, B.-B., & Essel, D. D. (2025). A systematic review on the impact of teacher professional development on digital instructional integration and teaching practices. *Frontiers in Education*, 10. <https://doi.org/10.3389/feduc.2025.1541031>

Ashraf, M. A., Yang, M., Zhang, Y., Denden, M., Tlili, A., Liu, J., Huang, R., & Burgos, D. (2021). A systematic review of systematic reviews on blended learning: Trends, gaps and future directions. *Psychology Research and Behavior Management*, 14, 1525-1541. <https://doi.org/10.2147/PRBM.S331741>

Bakar, S. (2021). Investigating the dynamics of contemporary pedagogical approaches in Higher Education through innovations, challenges, and paradigm shifts. *Social Science Chronicle*, 1(1), 1-19. <https://doi.org/10.56106/ssc.2021.009>

Balser, W. F. & Tafuro, V. (2025). Shifting schools from strategy to foresight: Infusing educational leadership with futurist thinking, planning, and action. In J. Bailey Watters, G. Miller, & R. Rhone (Eds.), *Reimagining the P-20 landscape for school leadership learning* (pp. 77-114). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-6220-4.ch004>

Bandyopadhyay, S., Bardhan, A., Dey, P., & Bhattacharyya, S. (2021). Exploring rural-urban education divide in India. In *Bridging the education divide using social technologies* (pp. 163-190). Springer Singapore. [https://doi.org/10.1007/978-981-33-6738-8\\_7](https://doi.org/10.1007/978-981-33-6738-8_7)

Berson, I. R., Berson, M. J., & Luo, W. (2025). Innovating responsibly: Ethical considerations for AI in early childhood education. *AI Brain and Child*, 1. <https://tinyurl.com/35n8y2he>

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>

Bray, M. (2023). Understanding private supplementary tutoring: Metaphors, diversities and agendas for shadow education research (Comprendiendo las clases particulares complementarias: Metáforas, variedades y agendas para la investigación sobre educación en la sombra) *Journal for the Study of Education and Development: Infancia y Aprendizaje*, 46(4), 728–773. <https://doi.org/10.1080/02103702.2023.2194792>

Cade, J., Wardle, F., & Otter, J. (2022). Toddler and preschool teachers' beliefs and perceptions about the use of developmentally appropriate practice. *Cogent Education*, 9(1). <https://doi.org/10.1080/2331186X.2021.2018908>

Callaway-Cole, L., & Kimble, A. (2021). Maintaining professional standards in early childhood teacher preparation: Evaluating adaptations to fieldwork-based experiences during COVID-19. *Early Childhood Education Journal*, 49(5). <https://doi.org/10.1007/s10643-021-01227-9>

Cardullo, V., Wang, C., Burton, M., & Dong, J. (2021). K-12 teachers' remote teaching self-efficacy during the pandemic. *Journal of Research in Innovative Teaching & Learning*, 14(1), 32–45. <https://doi.org/10.1108/JRIT-10-2020-0055>

Cost, K. T., Unternaehrer, E., Tsujimoto, K., Vanderloo, L. L., Birken, C. S., Maguire, J. L., Szatmari, P., & Charach, A. (2023). Patterns of parent screen use, child screen time, and child socio-emotional problems at 5 years. *Journal of Neuroendocrinology*, 35(7). <https://doi.org/10.1111/jne.13246>

Dorst, H., van der Jagt, A., Toxopeus, H., Tozer, L., Raven, R., & Runhaar, H. (2022). What's behind the barriers? Uncovering structural conditions working against urban nature-based solutions. *Landscape and Urban Planning*, 220. <https://doi.org/10.1016/j.landurbplan.2021.104335>

Egan, S. M., Pope, J., Moloney, M., Hoyne, C., & Beatty, C. (2021). Missing early education and care during the pandemic: The socio-emotional impact of the COVID-19 crisis on young children. *Early Childhood Education Journal*, 49(5). <https://doi.org/10.1007/s10643-021-01193-2>

Eliasson, S., Peterson, L., & Lantz-Andersson, A. (2023). A systematic literature review of empirical research on technology education in early childhood education. *International Journal of Technology and Design Education*, 33(3), 793–818. <https://doi.org/10.1007/s10798-022-09764-z>

Endalamaw, A., Khatri, R. B., Erku, D., Zewdie, A., Wolka, E., Nigatu, F., & Assefa, Y. (2024). Barriers and strategies for primary health care workforce development: Synthesis of evidence. *BMC Primary Care*, 25(1), 99. <https://doi.org/10.1186/s12875-024-02336-1>

Engdahl, C. (2024). *Indetermination in creative dance*.

Ford, T. G., Kwon, K.-A., & Tsotsoros, J. D. (2021). Early childhood distance learning in the U.S. during the COVID pandemic: Challenges and opportunities. *Children and Youth Services Review*, 131, 106297. <https://doi.org/10.1016/j.childyouth.2021.106297>

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of Higher Education after the COVID disruption: Emerging challenges in an online learning scenario. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.616059>

Gile, P. P., van de Klundert, J., & Buljac-Samardzic, M. (2022). Human resource management in Ethiopian public hospitals. *BMC Health Services Research*, 22(1), 763. <https://doi.org/10.1186/s12913-022-08046-7>

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of barriers to digital transformation in Higher Education institutions: Systematic literature review. *Education Sciences*, 13(7), 746. <https://doi.org/10.3390/educsci13070746>

Gligoreea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., & Tudorache, P. (2023). Adaptive learning using artificial intelligence in e-learning: A literature review. *Education Sciences*, 13(12), 1216. <https://doi.org/10.3390/educsci13121216>

Gomez, F. C., Trespalacios, J., Hsu, Y.-C., & Yang, D. (2022). Exploring teachers' technology integration self-efficacy through the 2017 ISTE standards. *TechTrends*, 66(2), 159–171. <https://doi.org/10.1007/s11528-021-00639-z>

Gore, J., Fray, L., Miller, A., Harris, J., & Taggart, W. (2021). The impact of COVID-19 on student learning in New South Wales primary schools: An empirical study. *The Australian Educational Researcher*, 48(4), 605–637. <https://doi.org/10.1007/s13384-021-00436-w>

Graham, J., & Colin, C. (2023). Exploring the dynamics of education in Australia: Policies, practices, and progressions in the 21st Century. *International Journal Publishing INFLUENCE: International Journal of Science Review*, 5(3). <https://doi.org/10.54783/influencejournal.v5i3.178>

Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook (Classroom Companion: Business)*. Springer Cham. <https://doi.org/10.1007/978-3-030-80519-7>

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>

Islam, M. S. U., Kumar, A., & Hu, Y.-C. (2021). Context-aware scheduling in Fog computing: A survey, taxonomy, challenges and future directions. *Journal of Network and Computer Applications*, 180, 103008. <https://doi.org/10.1016/j.jnca.2021.103008>

Jalongo, M. R. (2021). The effects of COVID-19 on early childhood education and care: Research and resources for children, families, teachers, and teacher educators. *Early Childhood Education Journal*, 49(5), 763–774. <https://doi.org/10.1007/s10643-021-01208-y>

Jing, M., Guo, Z., Wu, X., Yang, Z., & Wang, X. (2025). Higher education digital academic leadership: Perceptions and practices from Chinese university leaders. *Education Sciences*, 15(5), 606. <https://doi.org/10.3390/educsci15050606>

Kaimara, P., Oikonomou, A., & Deliyannis, I. (2022). Could virtual reality applications pose real risks to children and adolescents? A systematic review of ethical issues and concerns. *Virtual Reality*, 26(2), 697–735. <https://doi.org/10.1007/s10055-021-00563-w>

Karp, T., Gale, R., Tan, M., & Burnham, G. (2014). Hosting a pipeline of K-12 robotics competitions at a College of Engineering – A review of benefits and challenges. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*,

406–423. <https://doi.org/10.24908/ijsls.v0i0.5560>

Kinkead-Clark, Z., & Abdul-Majied, S. (2024). Contextualising developmentally appropriate practice (DAP): Considering Caribbean countries. *International Journal of Early Years Education*, 32(3), 720–734. <https://doi.org/10.1080/09669760.2024.2364605>

Kruszewska, A., Nazaruk, S., & Szewczyk, K. (2022). Polish teachers of early education in the face of distance learning during the COVID-19 pandemic – the difficulties experienced and suggestions for the future. *Education 3-13*, 50(3), 304–315. <https://doi.org/10.1080/03004279.2020.1849346>

Lokhandwala, S., & Spencer, R. M. C. (2022). Relations between sleep patterns early in life and brain development: A review. *Developmental Cognitive Neuroscience*, 56, 101130. <https://doi.org/10.1016/j.dcn.2022.101130>

Lopes, L., Santos, R., Coelho-e-Silva, M., Draper, C., Mota, J., Jidotseff, B., Clark, C., Schmidt, M., Morgan, P., Duncan, M., O'Brien, W., Bentsen, P., D'Hondt, E., Houwen, S., Stratton, G., De Martelaer, K., Scheuer, C., Herrmann, C., García-Hermoso, A., ... Agostinis-Sobrinho, C. (2020). A narrative review of motor competence in children and adolescents: What we know and what we need to find out. *International Journal of Environmental Research and Public Health*, 18(1), 18. <https://doi.org/10.3390/ijerph18010018>

Mhlongo, S., Mbatha, K., Ramasetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, 9(6), e16348. <https://doi.org/10.1016/j.heliyon.2023.e16348>

Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, 27(3), 3171–3195. <https://doi.org/10.1007/s10639-021-10739-1>

Nikolopoulou, K. (2021). Mobile devices in early childhood education: Teachers' views on benefits and barriers. *Education and Information Technologies*, 26(3), 3279–3292. <https://doi.org/10.1007/s10639-020-10400-3>

Nurdin, N., Hamlan, H., Syahid, A., Anirah, A., Olvianty, O., Nasrul, N., & Aco, S. (2023). Digital skill development through community service program to increase independence in the digital economy era for Islamic boarding school students in Palu City, Central Sulawesi. *Proceeding of International Conference on Islamic and Interdisciplinary Studies (ICIIS)*. <https://tinyurl.com/7yfbvv2x>

Okoye, K., Hussein, H., Arrona-Palacios, A., Quintero, H. N., Ortega, L. O. P., Sanchez, A. L., Ortiz, E. A., Escamilla, J., & Hosseini, S. (2023). Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks. *Education and Information Technologies*, 28(2), 2291–2360. <https://doi.org/10.1007/s10639-022-11214-1>

Rahimi, R. A., & Oh, G. S. (2024). Rethinking the role of educators in the 21st century: Navigating globalization, technology, and pandemics. *Journal of Marketing Analytics*, 12(2), 182–197. <https://doi.org/10.1057/s41270-024-00303-4>

Safdar, S., Ren, M., Chudhery, M. A. Z., Huo, J., Rehman, H.-U., & Rafique, R. (2022). Using cloud-based virtual learning environments to mitigate increasing disparity in urban-rural

academic competence. *Technological Forecasting and Social Change*, 176, 121468. <https://doi.org/10.1016/j.techfore.2021.121468>

Selfa-Sastre, M., Pifarré, M., Cujba, A., Cutillas, L., & Falguera, E. (2022). The role of digital technologies to promote collaborative creativity in language education. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.828981>

Shalaby, A. (2024). Classification for the digital and cognitive AI hazards: Urgent call to establish automated safe standard for protecting young human minds. *Digital Economy and Sustainable Development*, 2(1), 17. <https://doi.org/10.1007/s44265-024-00042-5>

Sitorus, O. F., Handayani, T., & Astuti, S. (2023). Implementation of digital-based approaches in early childhood education supervision amidst the COVID-19 pandemic. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7(5), 6085–6100. <https://doi.org/10.31004/obsesi.v7i5.5398>

Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2025). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, 33(2), 1921–1947. <https://doi.org/10.1002/sd.3221>

Su, J., & Zhong, Y. (2022). Artificial Intelligence (AI) in early childhood education: Curriculum design and future directions. *Computers and Education: Artificial Intelligence*, 3, 100072. <https://doi.org/10.1016/j.caai.2022.100072>

Syarifuddin, S., Tahir, A., Fatimah, F., Abidin, K., & Syarifuddin, F. (2024). School and family partnerships: Contribution of transformational teachers in implementing the autonomous learning curriculum educational institutions in Bone, Indonesia. *Samarah: Jurnal Hukum Keluarga Dan Hukum Islam*, 8(3), 1476. <https://doi.org/10.22373/sjhlk.v8i3.22584>

Throuvala, M. A., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2021). Perceived challenges and online harms from social media use on a severity continuum: A qualitative psychological stakeholder perspective. *International Journal of Environmental Research and Public Health*, 18(6), 3227. <https://doi.org/10.3390/ijerph18063227>

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies*, 28(6), 6695–6726. <https://doi.org/10.1007/s10639-022-11431-8>

Topping, K. J., Douglas, W., Robertson, D., & Ferguson, N. (2022). Effectiveness of online and blended learning from schools: A systematic review. *Review of Education*, 10(2). <https://doi.org/10.1002/rev3.3353>

Tran, H., Cunningham, K. M. W., Hardie, S., Taylor, T., & Sauls, R. (2023). Seeing the visibly invisible: An intersectional analysis of the employee experiences of black female rural educators. *Teachers College Record: The Voice of Scholarship in Education*, 125(1), 28–55. <https://doi.org/10.1177/01614681231153699>

Uhlhaas, P. J., Davey, C. G., Mehta, U. M., Shah, J., Torous, J., Allen, N. B., Avenevoli, S., Bella-Awusah, T., Chanen, A., Chen, E. Y. H., Correll, C. U., Do, K. Q., Fisher, H. L., Frangou, S., Hickie, I. B., Keshavan, M. S., Konrad, K., Lee, F. S., Liu, C. H., ... Wood, S. J. (2023). Towards a youth mental health paradigm: A perspective and roadmap. *Molecular Psychiatry*, 28(8),

3171–3181. <https://doi.org/10.1038/s41380-023-02202-z>

Ulfert-Blank, A.-S., & Schmidt, I. (2022). Assessing digital self-efficacy: Review and scale development. *Computers & Education*, 191, 104626. <https://doi.org/10.1016/j.compedu.2022.104626>

Undheim, M. (2022). Children and teachers engaging together with digital technology in early childhood education and care institutions: A literature review. *European Early Childhood Education Research Journal*, 30(3), 472–489. <https://doi.org/10.1080/1350293X.2021.1971730>

Valtonen, T., López-Pernas, S., Saqr, M., Vartiainen, H., Sointu, E. T., & Tedre, M. (2022). The nature and building blocks of educational technology research. *Computers in Human Behavior*, 128, 107123. <https://doi.org/10.1016/j.chb.2021.107123>

Vaniya, J., Gandhi, N. V., Patel, K. P., Bhatt, C., & Kaur, K. P. (2024). Role and scope of artificial intelligence in physiotherapy: A literature review. *Research Journal of Medical Sciences*, 18(12), 399–412. <https://doi.org/10.36478/makrjms.2024.12.399.412>

Walaszczyk, L., & Arnab, S. (2025). Open-source gamification plug-ins: A study on usability and user preferences. *Electronic Journal of E-Learning*, 23(1). <https://doi.org/10.34190/ejel.23.1.3618>

Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications*, 10(1), 16. <https://doi.org/10.1057/s41599-023-01508-1>

Yang, S. (2021). The long-run effects of early childhood education and care—An empirical analysis based on the China family panel studies survey. *Child Indicators Research*, 14(5), 2021–2044. <https://doi.org/10.1007/s12187-021-09839-8>

Zhao, Y., Zhao, M., & Shi, F. (2023a). Integrating moral education and educational information technology: A strategic approach to enhance rural teacher training in universities. *Journal of the Knowledge Economy*, 15(3), 15053–15093. <https://doi.org/10.1007/s13132-023-01693-z>