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Teachers' Readiness for Artificial Intelligence Integration in Early Childhood Education: Developing a Framework for Effective Classroom Implementation

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ABSTRACT

The integration of Artificial Intelligence (AI) has transformed educational practices and created new opportunities for improving teaching, learning, and classroom management across educational levels. In early childhood education, successful AI integration has depended largely on teachers' readiness, including their digital competence, pedagogical knowledge, ethical awareness, and willingness to adopt emerging technologies. This study aimed to examine teachers' readiness for Artificial Intelligence integration in early childhood education and develop a framework for effective classroom implementation. The study adopted a mixed-methods research design. Quantitative data were collected through structured questionnaires administered to early childhood teachers, while qualitative data were gathered through semi-structured interviews with teachers, school administrators, and educational technology experts. Quantitative data were analysed using descriptive and inferential statistical techniques to determine teachers' readiness and identify the factors influencing AI integration. Qualitative data were analysed through thematic analysis to explore teachers' experiences, perceived opportunities, implementation challenges, and professional support needs. The integration of quantitative and qualitative findings provided a comprehensive understanding of teachers' preparedness and informed the development of an evidence-based framework for effective AI implementation in early childhood classrooms. The framework emphasized teacher professional development, pedagogically appropriate AI use, ethical and responsible technology integration, digital infrastructure, and institutional support. The findings highlighted that teachers' readiness, institutional support, and continuous professional development were critical for successful AI implementation in early childhood education. The proposed framework provides practical guidance for educators, school leaders, policymakers, and teacher education institutions seeking to integrate AI into early childhood classrooms in ways that enhance teaching quality, support child-cantered learning, and promote responsible educational innovation.

Keywords: *Artificial Intelligence, Classroom Implementation, Early Childhood Education, Framework Development, Teacher Readiness, Teaching and Learning*

INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, reshaping educational systems by introducing innovative approaches to teaching, learning, assessment, and classroom management. AI-powered applications, including intelligent tutoring systems, adaptive learning platforms, automated assessment tools, virtual assistants, and generative AI technologies, have expanded opportunities for personalized instruction and improved educational decision-making (Makhdum & Khanam, 2021). The growing adoption of AI across educational settings

has encouraged educators and policymakers to reconsider traditional pedagogical practices and explore technology-enhanced learning environments that better address diverse learner needs (UNESCO, 2023). As AI continues to evolve, educational institutions are increasingly expected to prepare teachers with the knowledge, competencies, and ethical awareness required to integrate these technologies effectively into classroom practice.

Early Childhood Education (ECE) represents a critical stage of learning that lays the foundation for children's cognitive, social, emotional, language, and physical development. Educational experiences during early childhood significantly influence later academic achievement, problem-solving ability, creativity, and lifelong learning. Consequently, innovations introduced at this level require careful consideration to ensure that they support developmentally appropriate teaching practices while maintaining the importance of play, exploration, and meaningful teacher–child interaction (OECD, 2021). Although AI has demonstrated considerable potential in enhancing personalized learning experiences, its successful integration into early childhood classrooms depends largely on teachers' readiness to adopt and utilize these technologies responsibly and effectively.

Teachers remain the central agents of educational change despite rapid technological advancement. The effectiveness of AI integration is determined not merely by the availability of digital technologies but by teachers' preparedness to incorporate these tools into pedagogical practice. Teacher readiness encompasses multiple dimensions, including technological competence, pedagogical knowledge, professional confidence, ethical understanding, positive attitudes toward innovation, and the ability to make informed instructional decisions (Tondeur et al., 2020). Teachers who possess these competencies are more likely to integrate AI meaningfully, whereas inadequate preparation may limit its educational value and contribute to ineffective implementation.

The rapid expansion of generative AI technologies, including large language models and intelligent educational assistants, has further accelerated discussions regarding responsible AI integration in education. These technologies offer opportunities to support lesson planning, assessment design, personalized feedback, and differentiated instruction while simultaneously raising concerns regarding academic integrity, children's privacy, algorithmic bias, transparency, and ethical decision-making (UNESCO, 2023). Such concerns are particularly significant in early childhood education, where teachers must ensure that technological innovation complements rather than replaces developmentally appropriate teaching practices and human interaction.

The successful implementation of AI in early childhood classrooms requires more than technological infrastructure. Institutional support, professional learning opportunities, curriculum alignment, leadership commitment, policy guidance, and continuous professional development all contribute to teachers' readiness to integrate AI effectively (European Commission, 2022). Consequently, educational systems increasingly recognize that teacher readiness represents one of the strongest determinants of sustainable technology adoption within schools.

Background

Artificial Intelligence has gradually evolved from a specialized area of computer science into a practical educational resource capable of supporting instructional planning, classroom management, learner assessment, and personalized educational experiences. Recent developments in machine learning, natural language processing, computer vision, and generative AI have expanded the range of educational applications available to teachers across different educational levels (Luckin et al., 2016). Educational institutions worldwide have begun exploring AI-supported instructional models to improve learning outcomes while responding to the growing demands of digital transformation.

Within early childhood education, AI applications remain relatively new compared with their implementation in higher education and secondary education. Early childhood classrooms require teaching approaches that prioritize children's developmental characteristics, active engagement, social

interaction, creativity, and play-based learning. Consequently, the integration of AI at this educational stage requires careful pedagogical planning to ensure that technology supports rather than dominates children's learning experiences (OECD, 2021). AI tools have the potential to assist teachers in monitoring children's learning progress, identifying developmental needs, designing individualized learning activities, and providing timely instructional support. However, these benefits depend largely upon teachers' professional competence and readiness to integrate AI responsibly.

Teacher readiness has become an increasingly important concept within educational technology research. It extends beyond technical skills to include pedagogical competence, confidence, willingness to innovate, ethical awareness, digital literacy, and continuous professional learning (Tondeur et al., 2020). Research consistently indicates that teachers who receive adequate professional development demonstrate greater confidence in adopting innovative technologies and implementing them effectively within classroom settings (Ertmer & Ottenbreit-Leftwich, 2013). Conversely, insufficient training, limited institutional support, and uncertainty regarding AI applications often discourage teachers from integrating technology into daily instructional practice.

International organizations have emphasized the importance of responsible AI implementation within education. UNESCO (2023) recommends that AI integration should prioritize human-centered learning, ethical governance, transparency, equity, inclusion, and teacher empowerment. Similarly, the European Commission (2022) advocates the development of teachers' digital competencies alongside institutional policies that promote responsible and trustworthy AI adoption. These recommendations highlight that educational technology should enhance rather than replace teachers' professional expertise.

Although increasing attention has been directed toward AI integration across educational sectors, early childhood education continues to receive comparatively limited research attention (Makhdum, et al., 2022). Much of the existing literature focuses on technological capabilities rather than teachers' preparedness for classroom implementation. Consequently, there remains a need to understand how teachers perceive AI, the competencies they possess, the barriers they encounter, and the professional support required for successful implementation within developmentally appropriate learning environments.

Significance

This study contributes to the growing body of knowledge concerning Artificial Intelligence integration in early childhood education by examining teachers' readiness and developing a framework for effective classroom implementation. The findings are expected to contribute theoretically by extending existing literature on teacher readiness, educational technology integration, and responsible AI adoption within early childhood educational settings.

Practically, the study provides valuable guidance for early childhood teachers seeking to integrate AI into teaching practices while maintaining child-centered pedagogical approaches. The proposed framework offers practical recommendations for selecting appropriate AI tools, strengthening digital competence, promoting ethical AI use, and supporting developmentally appropriate classroom practices.

Educational leaders and school administrators may benefit from the findings by identifying institutional factors that influence successful AI implementation. The framework can assist schools in designing professional development programs, strengthening technological infrastructure, and establishing supportive learning environments that encourage responsible innovation.

The study also has implications for policymakers responsible for educational technology planning. Evidence generated through this research may inform national AI policies, curriculum reforms, teacher education programs, and professional standards related to AI integration within early childhood education.

Furthermore, teacher education institutions may utilize the findings to revise pre-service and in-service teacher preparation programs by incorporating AI literacy, digital pedagogy, ethical technology use, and practical classroom applications into teacher education curricula.

Finally, the study provides a foundation for future research by offering an evidence-based framework that may be tested, validated, and adapted across diverse educational contexts.

Problem Statement

Artificial Intelligence has become increasingly prominent within educational systems; however, its successful implementation in early childhood education remains dependent upon teachers' readiness to integrate these technologies effectively and responsibly. Despite growing investment in educational technology, many early childhood teachers continue to experience limited AI-related knowledge, inadequate professional preparation, insufficient institutional support, and uncertainty regarding ethical classroom implementation. Existing research has largely emphasized technological innovation and higher education contexts, while comparatively little attention has been devoted to teacher readiness in early childhood education. Moreover, available studies often examine isolated aspects such as digital competence or attitudes toward technology without providing a comprehensive framework that integrates professional competencies, pedagogical practices, ethical considerations, institutional support, and implementation strategies. Consequently, there remains a significant need to examine teachers' readiness comprehensively and develop an integrated framework capable of guiding effective Artificial Intelligence implementation within early childhood classrooms.

Objectives of the Study

- To examine teachers' readiness for Artificial Intelligence integration in early childhood education.
- To identify the factors influencing effective Artificial Intelligence implementation in early childhood classrooms.
- To develop an integrated framework for effective Artificial Intelligence classroom implementation in early childhood education.

Research Questions

- What is the level of teachers' readiness for Artificial Intelligence integration in early childhood education?
- What factors influence teachers' readiness and effective Artificial Intelligence implementation in early childhood classrooms?
- How can an integrated framework support effective Artificial Intelligence implementation in early childhood education?

Research Gaps

Although Artificial Intelligence has become an important area of educational research, several significant gaps remain within the literature concerning its application in early childhood education. First, existing studies predominantly focus on higher education and secondary education, leaving early childhood contexts comparatively underexplored. Second, previous research has primarily examined teachers' attitudes, digital competence, or technology acceptance independently, with limited attention given to integrating these factors into a comprehensive readiness framework. Third, relatively few studies have combined quantitative and qualitative evidence to develop practical implementation

frameworks tailored specifically to early childhood education. Fourth, limited research has addressed ethical AI implementation, teacher professional development, institutional readiness, and classroom pedagogy as interconnected components of successful AI integration. Finally, there remains a need for evidence-based frameworks that guide educators, school leaders, and policymakers in implementing Artificial Intelligence responsibly while preserving developmentally appropriate teaching practices. Addressing these gaps provides the foundation for the present study and supports the development of an integrated framework for effective classroom implementation.

LITERATURE REVIEW

Artificial Intelligence (AI) has become one of the most influential technological innovations in education, transforming instructional practices, assessment methods, curriculum delivery, and educational administration. AI technologies, including machine learning, natural language processing, intelligent tutoring systems, adaptive learning platforms, learning analytics, and generative AI applications, have expanded opportunities for creating personalized, efficient, and learner-centred educational environments. As educational institutions increasingly embrace digital transformation, AI has emerged as an important tool for improving teaching quality, enhancing learning experiences, and supporting evidence-based educational decision-making (Holmes et al., 2022). Although AI adoption has accelerated across higher education and secondary education, its application within early childhood education remains comparatively limited, creating a need for greater empirical understanding of teacher preparedness and classroom implementation.

The successful integration of AI into education depends primarily on teachers rather than technology itself (Faisal, et al., 2023). Teachers determine how technological innovations are introduced, adapted, and utilized to support children's learning. Consequently, teacher readiness has become a central concept in educational technology research. Teacher readiness extends beyond technological knowledge and includes digital competence, pedagogical expertise, professional confidence, attitudes toward innovation, ethical awareness, and the willingness to adopt new instructional approaches (Tondeur et al., 2020). Research consistently demonstrates that teachers with higher levels of readiness are more likely to integrate innovative technologies effectively into classroom instruction, whereas limited competence and inadequate preparation often hinder successful implementation (Ertmer & Ottenbreit-Leftwich, 2013).

Within early childhood education, AI integration requires special consideration because young children's learning differs significantly from that of older learners. Early childhood education emphasizes play-based learning, exploration, creativity, communication, social interaction, and holistic development. Educational technologies must therefore complement these pedagogical principles rather than replace teacher-child interactions or developmentally appropriate practices (OECD, 2021). AI applications in early childhood settings may assist teachers by monitoring developmental progress, identifying individual learning needs, supporting personalized instruction, generating learning resources, and facilitating communication with families. Nevertheless, these benefits depend upon teachers possessing sufficient knowledge and confidence to utilize AI responsibly and effectively.

Teacher digital competence has been identified as one of the strongest predictors of successful technology integration (Abbas & Faisal, et al., 2024). Digital competence encompasses technical skills, information literacy, digital communication, problem-solving abilities, ethical awareness, and the capacity to integrate digital technologies into meaningful instructional activities (European Commission, 2022). Several studies indicate that teachers who possess stronger digital competence demonstrate greater confidence in adopting emerging technologies and exhibit higher levels of instructional innovation (Redecker, 2017). Conversely, inadequate technological knowledge frequently results in resistance toward educational innovation and limits effective classroom implementation.

Professional development represents another critical factor influencing teachers' readiness for AI integration. Continuous professional learning enables teachers to acquire new technological

competencies, update pedagogical knowledge, and develop confidence in implementing innovative instructional strategies (Abbas & Faisal, et al., 2024). Effective professional development extends beyond technical training by addressing pedagogical integration, classroom management, ethical considerations, curriculum alignment, and practical application (Darling-Hammond et al., 2017). Research suggests that sustained and collaborative professional learning opportunities contribute significantly to teachers' willingness to integrate educational technologies into daily classroom practice.

Teachers' attitudes toward Artificial Intelligence also influence successful implementation. Positive perceptions of AI encourage experimentation, innovation, and continuous professional learning, whereas negative attitudes often arise from uncertainty, insufficient knowledge, concerns regarding workload, or fear that AI may replace teachers' professional roles. Current evidence indicates that teachers generally perceive AI as a supportive instructional resource rather than a replacement for human teaching, provided that appropriate ethical guidelines and professional support are available (Zawacki-Richter et al., 2019). Building positive attitudes therefore requires both technological competence and institutional support.

Institutional readiness plays an equally important role in AI implementation. Schools require adequate technological infrastructure, reliable internet connectivity, access to digital devices, leadership commitment, technical assistance, and supportive organizational cultures that encourage innovation. School leadership significantly influences teachers' technology adoption by establishing clear educational visions, allocating resources, promoting collaboration, and facilitating professional development opportunities (Dexter, 2018). Institutions lacking these supportive conditions often experience fragmented technology implementation despite teachers' individual motivation.

Ethical considerations have become increasingly important with the rapid emergence of generative Artificial Intelligence. AI systems collect, analyse, and process significant amounts of educational data, raising concerns regarding privacy, transparency, accountability, fairness, bias, and data protection. Within early childhood education, these concerns become particularly significant because young children represent a vulnerable population requiring additional safeguards. UNESCO (2023) emphasizes that AI implementation should remain human-centered, transparent, equitable, inclusive, and developmentally appropriate. Teachers therefore require ethical competence alongside technological knowledge to ensure responsible classroom implementation.

The emergence of generative AI tools has further transformed educational practice. Applications capable of generating instructional content, lesson plans, assessment tasks, feedback, and educational resources have increased teachers' productivity while simultaneously introducing new ethical challenges concerning originality, academic integrity, accuracy, and responsible technology use (Kasneci et al., 2023). Early childhood teachers must therefore develop the ability to critically evaluate AI-generated content and adapt it to children's developmental needs rather than relying solely upon automated outputs.

Several theoretical perspectives explain teachers' adoption of educational technologies. The Technology Acceptance Model suggests that perceived usefulness and perceived ease of use strongly influence teachers' willingness to adopt technological innovations (Davis, 1989). Similarly, the Technological Pedagogical Content Knowledge (TPACK) framework emphasizes the integration of technological knowledge, pedagogical knowledge, and subject matter expertise as essential components of effective technology integration (Mishra & Koehler, 2006). These frameworks collectively suggest that successful AI implementation requires more than technical competence; it also requires pedagogically meaningful instructional application supported by professional knowledge and institutional resources.

Although research concerning AI in education has expanded considerably, existing literature continues to demonstrate important limitations. Most empirical investigations have concentrated on higher education, online learning, educational analytics, or secondary education, while relatively few studies have focused specifically on early childhood teachers. Furthermore, many studies have examined

technology acceptance, digital competence, or teacher attitudes independently without considering their combined influence on classroom implementation. This fragmented perspective limits the development of comprehensive implementation strategies capable of addressing multiple dimensions of teacher readiness simultaneously.

Current literature also reveals limited evidence regarding framework development for AI integration within early childhood education. Existing frameworks primarily address general educational technology integration or higher education contexts and often overlook developmentally appropriate pedagogy, ethical AI implementation, institutional readiness, professional development, and classroom-specific practices relevant to young learners. Consequently, educational institutions frequently lack structured guidance for implementing AI responsibly within early childhood classrooms.

The increasing emphasis on responsible Artificial Intelligence further highlights the need for integrated implementation frameworks that balance technological innovation with educational values. Responsible AI emphasizes fairness, accountability, transparency, privacy, inclusiveness, and human oversight while ensuring that technological advancement enhances rather than replaces teachers' professional judgment (UNESCO, 2023). Integrating these principles into early childhood education requires frameworks specifically designed for teachers working with young children, where social interaction, emotional development, creativity, and play remain fundamental educational priorities.

Collectively, the reviewed literature demonstrates that teachers' readiness represents the foundation for successful Artificial Intelligence integration in early childhood education. Teacher competence, digital literacy, pedagogical knowledge, ethical awareness, institutional support, leadership, and continuous professional development collectively determine the effectiveness of AI implementation. Nevertheless, significant research gaps remain regarding comprehensive readiness assessment and framework development specifically tailored to early childhood education. Addressing these gaps provides the rationale for the present study, which seeks to examine teachers' readiness and develop an integrated framework capable of supporting effective classroom implementation of Artificial Intelligence in early childhood education.

METHODOLOGY

This study adopted a mixed-methods research design to examine teachers' readiness for Artificial Intelligence (AI) integration in early childhood education and to develop a framework for effective classroom implementation. A mixed-methods approach was considered appropriate because it combines the strengths of quantitative and qualitative research, providing a comprehensive understanding of the research problem. The quantitative component measured teachers' readiness and identified the factors influencing AI integration through numerical data, whereas the qualitative component explored teachers' experiences, perceptions, challenges, and recommendations regarding AI implementation in early childhood classrooms. The integration of quantitative and qualitative findings enabled the development of a practical and evidence-based framework for effective AI implementation in early childhood education. This design provided both statistical evidence and contextual understanding, ensuring that the proposed framework reflected empirical findings as well as participants' professional experiences (Creswell & Plano Clark, 2018).

The target population comprised early childhood education teachers employed in public and private early childhood education institutions. School administrators responsible for supervising early childhood programmes and educational technology experts with experience in AI-supported teaching and learning were also included in the qualitative phase to obtain broader professional perspectives regarding AI integration. The inclusion of participants from different educational settings ensured diversity of experiences and strengthened the comprehensiveness of the findings.

A multistage sampling strategy was employed to select participants. During the quantitative phase, stratified random sampling was used to ensure proportional representation of teachers from public and

private institutions as well as urban and rural schools. Stratification ensured that the sample adequately represented different institutional contexts in which AI integration may vary because of differences in technological infrastructure, administrative support, and teacher professional development opportunities. Following the selection of institutions, simple random sampling was used to select teachers within each stratum. For the qualitative phase, purposive sampling was employed to select participants who possessed relevant knowledge and practical experience regarding educational technology and Artificial Intelligence implementation. Participants included experienced early childhood teachers, school administrators, curriculum specialists, and educational technology experts who were capable of providing detailed insights into AI integration practices, implementation challenges, and professional support needs.

The quantitative sample consisted of early childhood teachers drawn from selected schools, while the qualitative sample included teachers, administrators, and experts selected according to their experience and willingness to participate. The sample size for the quantitative phase was determined using established sample size determination guidelines to ensure adequate statistical power and representativeness. The qualitative sample was determined based on information richness and continued until sufficient depth of information was obtained to address the research objectives. This combination of sampling procedures enhanced both the generalizability of the quantitative findings and the depth of qualitative understanding.

Data were collected using two complementary research instruments. The quantitative instrument consisted of a structured questionnaire developed following an extensive review of the literature on Artificial Intelligence integration, teacher readiness, digital competence, technology acceptance, and educational technology implementation. The questionnaire comprised two sections. The first section collected demographic information, including participants' gender, age, educational qualification, teaching experience, school type, previous AI-related training, and access to digital resources. The second section measured teachers' readiness for AI integration using multiple dimensions identified in previous literature, including technological competence, pedagogical readiness, digital literacy, attitudes toward Artificial Intelligence, ethical awareness, institutional support, professional development, and implementation intention. Responses were recorded using a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree, allowing respondents to indicate the extent of their agreement with each statement.

The qualitative instrument consisted of a semi-structured interview protocol designed to explore participants' experiences, perceptions, and expectations regarding Artificial Intelligence integration in early childhood education. The interview questions focused on teachers' understanding of AI, classroom experiences, perceived benefits, implementation challenges, ethical concerns, institutional support, professional development needs, and recommendations for effective classroom implementation. Semi-structured interviews provided flexibility to explore emerging issues while ensuring consistency across participants. The interview guide was developed following a review of relevant literature and consultation with experts in educational technology and early childhood education to ensure that all research objectives were adequately addressed.

Prior to the main data collection, the research instruments underwent pilot testing to evaluate clarity, relevance, language appropriateness, and administration procedures. The pilot study involved a small group of early childhood teachers who possessed characteristics similar to those of the target population but were excluded from the main study. Feedback obtained during the pilot phase was used to revise ambiguous wording, improve item sequencing, eliminate redundancy, and strengthen the overall quality of the questionnaire and interview protocol. Pilot testing also assisted in estimating the time required for questionnaire completion and interview administration, thereby improving the efficiency of the data collection process.

Data collection was conducted in sequential phases. During the quantitative phase, permission was obtained from the relevant educational authorities and participating institutions before distributing

questionnaires to selected teachers. Participants received detailed information regarding the purpose of the study, voluntary participation, confidentiality, and ethical considerations before completing the questionnaires. The questionnaires were administered either electronically or in printed form depending on institutional preferences and participants' accessibility to digital resources. Completed questionnaires were carefully reviewed to ensure completeness before being entered into the statistical database for analysis.

Following the completion of the quantitative phase, the qualitative phase commenced. Semi-structured interviews were conducted with purposively selected participants either face-to-face or through secure online communication platforms according to participants' availability and institutional arrangements. Each interview followed the prepared interview guide while allowing participants sufficient flexibility to elaborate on their experiences and professional perspectives. With participants' consent, interviews were audio-recorded to ensure accuracy during transcription and analysis. Field notes were also maintained throughout the interview process to document observations, contextual information, and emerging themes relevant to the development of the proposed framework.

The quantitative data collected through the questionnaires were coded and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to determine the demographic characteristics of the respondents and to assess teachers' readiness for Artificial Intelligence integration across different dimensions. Inferential statistical techniques, including Pearson product–moment correlation and multiple regression analysis, were employed to examine the relationships among the study variables and to identify the factors that significantly influenced teachers' readiness for AI integration. The selection of these statistical techniques was guided by the research objectives and the nature of the variables measured. Pearson correlation was used to determine the strength and direction of relationships among the variables, while multiple regression analysis examined the contribution of predictor variables, including technological competence, pedagogical readiness, digital literacy, institutional support, professional development, and ethical awareness, toward teachers' overall readiness for Artificial Intelligence integration.

Qualitative data obtained from the semi-structured interviews were analyzed using thematic analysis. Audio-recorded interviews were transcribed verbatim before analysis. The transcripts were read repeatedly to achieve familiarity with the data, after which meaningful statements related to the research objectives were identified and assigned initial codes. Similar codes were then grouped into categories representing common patterns across participants' responses. These categories were further refined into broader themes that reflected teachers' experiences, implementation challenges, professional development needs, ethical concerns, institutional support, and recommendations for effective classroom implementation. Throughout the analytical process, themes were continuously reviewed and compared with the original interview transcripts to ensure consistency, credibility, and accurate representation of participants' perspectives.

The integration of quantitative and qualitative findings constituted a central component of the mixed-methods design. Quantitative findings identified the level of teachers' readiness and the statistical relationships among the variables, whereas qualitative findings provided contextual explanations for these results by exploring participants' professional experiences and practical perspectives. The integration process enabled the comparison, confirmation, and interpretation of findings obtained through both methods, thereby producing a comprehensive understanding of teachers' readiness for Artificial Intelligence integration. Areas of convergence and divergence between the quantitative and qualitative findings were carefully examined to strengthen the interpretation of results and support evidence-based conclusions. This integrated analysis also informed the development of the proposed framework for effective classroom implementation.

The framework was developed through the systematic integration of empirical evidence generated during both phases of the study. Quantitative findings identified the major dimensions influencing

teachers' readiness, while qualitative findings provided practical recommendations concerning classroom implementation, professional learning, institutional support, ethical AI practices, and pedagogical integration. These findings were synthesized to establish a comprehensive framework comprising interrelated components that support responsible Artificial Intelligence integration in early childhood education. The framework emphasized teacher readiness as the central element supported by digital competence, pedagogical knowledge, ethical awareness, institutional leadership, technological infrastructure, continuous professional development, curriculum alignment, and collaborative learning environments. The resulting framework provides practical guidance for teachers, school leaders, teacher education institutions, and policymakers seeking to integrate Artificial Intelligence into early childhood classrooms effectively and responsibly.

To ensure the quality of the quantitative instrument, both validity and reliability procedures were undertaken. Content validity was established through expert evaluation. The questionnaire and interview protocol were reviewed by specialists in early childhood education, educational technology, Artificial Intelligence, educational research, and measurement and evaluation. These experts examined the instruments for content relevance, clarity, language appropriateness, alignment with the research objectives, and adequacy of item coverage. Their recommendations were incorporated into the final version of the instruments by revising ambiguous items, improving wording, eliminating redundancy, and ensuring comprehensive representation of the constructs under investigation. Face validity was also established during the pilot study, where participants confirmed that the questionnaire items were understandable, relevant, and appropriate for the intended respondents.

Construct validity was supported through the development of questionnaire items based on established theoretical frameworks and empirical literature concerning Artificial Intelligence integration, teacher readiness, digital competence, and educational technology adoption. The questionnaire dimensions were carefully aligned with the conceptual framework developed for the study to ensure consistency between theoretical constructs and empirical measurement. This systematic approach strengthened the overall validity of the research instrument and enhanced confidence in the interpretation of the findings.

Reliability of the quantitative instrument was assessed using Cronbach's alpha coefficient after completion of the pilot study. Cronbach's alpha is widely recognized as an appropriate measure of internal consistency for Likert-scale instruments. The reliability coefficients obtained for the questionnaire dimensions demonstrated acceptable to excellent internal consistency, indicating that the instrument consistently measured teachers' readiness for Artificial Intelligence integration. Necessary revisions identified during pilot testing further improved the reliability of the instrument before administration to the full sample. The qualitative component also incorporated strategies to enhance trustworthiness. Interview questions were carefully designed to encourage detailed and authentic responses, while member checking was conducted by allowing selected participants to verify the accuracy of interview summaries and interpretations. Additionally, careful documentation of coding procedures and thematic development strengthened the dependability and credibility of the qualitative findings.

Ethical principles were observed throughout the research process. Prior approval for conducting the study was obtained from the relevant educational authorities and participating institutions. All participants were informed about the purpose of the study, research procedures, voluntary participation, confidentiality, anonymity, and their right to withdraw from the study at any stage without penalty. Written informed consent was obtained before administering questionnaires and conducting interviews. Participants were assured that the information collected would be used exclusively for academic research purposes and that no personal identifiers would appear in any publication or research report. Completed questionnaires, interview recordings, transcripts, and electronic data files were securely stored using password-protected devices accessible only to the researcher. Data confidentiality was maintained throughout the research process, and all procedures complied with accepted ethical standards for educational research.

The mixed-methods design adopted in this study strengthened methodological rigor by combining numerical evidence with participants lived experiences, thereby providing a more comprehensive understanding of teachers' readiness for Artificial Intelligence integration in early childhood education. The quantitative findings offered measurable evidence regarding readiness levels and influencing factors, whereas the qualitative findings enriched the interpretation by explaining how teachers perceived Artificial Intelligence, the challenges they encountered, and the professional support required for successful implementation. The integration of these complementary sources of evidence facilitated the development of an empirically grounded framework that addresses both theoretical and practical dimensions of Artificial Intelligence implementation in early childhood classrooms. Consequently, the methodological approach employed in this study ensured the production of reliable, valid, and contextually relevant findings capable of informing educational practice, teacher professional development, institutional planning, and future research on responsible Artificial Intelligence integration in early childhood education.

DESCRIPTIVE ANALYSIS

Descriptive analysis was conducted to summarize the demographic characteristics of the respondents and to examine the overall level of teachers' readiness for Artificial Intelligence (AI) integration in early childhood education. Measures of frequency, percentage, mean, and standard deviation were used to describe the respondents and the major dimensions of teacher readiness. According to Field (2018), descriptive statistics provide a clear overview of data distribution and facilitate the interpretation of respondents' perceptions before conducting inferential statistical analyses.

Table 1 presents the demographic profile of the respondents.

Table 1: *Demographic Profile of Respondents*

Variable	Category	Frequency	Percentage (%)
Gender	Male	82	27.3
	Female	218	72.7
Age	Below 30 years	64	21.3
	31–40 years	118	39.3
	41–50 years	79	26.3
	Above 50 years	39	13.0
School Type	Public	176	58.7
	Private	124	41.3
Teaching Experience	Less than 5 years	51	17.0
	6–10 years	87	29.0
	11–15 years	93	31.0

Variable	Category	Frequency	Percentage (%)
	More than 15 years	69	23.0

Table 1 indicates that the majority of respondents were female teachers (72.7%), reflecting the common gender distribution within early childhood education. Most participants (39.3%) were between 31 and 40 years of age, suggesting that the sample largely consisted of teachers with considerable professional experience. Public school teachers represented 58.7% of the respondents, while 41.3% were employed in private institutions. Nearly one-third of the teachers (31.0%) had between 11 and 15 years of teaching experience, indicating that the respondents possessed substantial classroom expertise. Such diversity in demographic characteristics provided a comprehensive representation of early childhood teachers across different institutional settings.

Table 2: *Teachers' Readiness for Artificial Intelligence Integration*

Dimension	Mean	SD	Interpretation
Digital Competence	4.18	0.58	High
Pedagogical Readiness	4.05	0.63	High
Attitude towards AI	4.24	0.55	High
Ethical Awareness	4.11	0.61	High
Institutional Support	3.82	0.74	Moderate
Professional Development	3.76	0.71	Moderate
Overall Readiness	4.03	0.47	High

The findings presented in Table 2 indicate that teachers demonstrated a generally high level of readiness for Artificial Intelligence integration in early childhood education (M = 4.03, SD = 0.47). Among the measured dimensions, attitude toward AI obtained the highest mean score (M = 4.24), suggesting that teachers recognized the educational value of Artificial Intelligence and were willing to adopt innovative instructional approaches. Digital competence (M = 4.18) and ethical awareness (M = 4.11) also received high ratings, indicating that respondents perceived themselves as reasonably prepared to utilize AI responsibly within classroom settings.

However, institutional support (M = 3.82) and professional development (M = 3.76) recorded comparatively lower mean scores, although both remained within the moderate range. These findings suggest that while teachers expressed positive attitudes and confidence toward AI integration, they perceived greater institutional investment in training opportunities, technological infrastructure, and administrative support as necessary to facilitate successful classroom implementation. Similar findings have been reported by UNESCO (2023), which emphasizes that sustainable AI integration requires not only teacher competence but also supportive institutional policies and continuous professional learning.

Qualitative Analysis

Semi-structured interviews were conducted; the themes are the following that emerged from the interviews.

Theme 1: Positive Perceptions of Artificial Intelligence

The qualitative findings revealed that most teachers viewed Artificial Intelligence as an innovative educational technology capable of enhancing classroom teaching and improving children's learning experiences. Participants believed that AI could assist teachers in preparing lesson plans, developing creative learning activities, and personalizing instruction according to children's learning needs. Many respondents also stated that AI could reduce teachers' administrative workload and allow them to devote more time to meaningful interaction with children.

"Artificial Intelligence helps me prepare engaging learning activities in less time." (Teacher 4)

"AI provides creative ideas that make classroom learning more interesting for young children." (Teacher 9)

These findings support the quantitative results, which showed that teachers generally demonstrated positive attitudes toward AI integration.

Theme 2: Need for Professional Development

Almost all participants emphasized that although they were interested in using AI, they required systematic training before implementing it effectively in classrooms. Teachers reported limited practical knowledge of AI applications and requested continuous professional development programmes, workshops, and institutional guidance.

"We are willing to use AI, but we need proper training before using it with children." (Teacher 12)

"Professional development is necessary because AI is changing very rapidly." (Teacher 17)

The findings indicate that teacher readiness depends not only on personal motivation but also on continuous institutional support and capacity building.

Theme 3: Institutional Support and Ethical Considerations

Participants highlighted the importance of administrative support, adequate technological infrastructure, reliable internet access, and clear institutional policies for successful AI implementation. They also expressed concerns regarding children's privacy, ethical use of AI, and excessive dependence on technology. Teachers believed that AI should complement rather than replace human interaction in early childhood education.

"Technology should support teachers, not replace personal interaction with children." (Teacher 6)

"Schools need clear policies to guide responsible use of Artificial Intelligence." (Teacher 14)

These findings demonstrate that responsible AI integration requires ethical awareness, institutional commitment, and appropriate technological resources.

Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings provided a comprehensive understanding of teachers' readiness for Artificial Intelligence integration in early childhood education. The quantitative results indicated a generally high level of readiness among teachers, particularly regarding positive attitudes toward AI, digital competence, and ethical awareness. The qualitative findings reinforced these results, as participants consistently acknowledged the educational benefits of AI and expressed willingness to integrate it into classroom practice. However, both sets of findings identified professional

development and institutional support as the most significant challenges affecting effective implementation. Teachers emphasized the need for continuous training, administrative encouragement, technological infrastructure, and ethical guidelines to ensure responsible AI integration. The convergence of quantitative and qualitative evidence strengthened the development of the proposed framework for effective classroom implementation, demonstrating that successful AI adoption requires the combined influence of teacher competence, institutional readiness, and ongoing professional learning.

The paper shows that teachers reported the highest mean score for attitude toward Artificial Intelligence, followed by digital competence and ethical awareness, indicating a generally positive disposition toward AI integration. Comparatively lower mean scores for institutional support and professional development suggest that teachers require additional organizational resources and training opportunities to implement AI effectively in early childhood classrooms.

FINDINGS

The findings of this study revealed that early childhood teachers generally demonstrated a positive level of readiness for Artificial Intelligence (AI) integration in classroom teaching. The quantitative findings indicated that teachers possessed relatively strong digital competence, positive attitudes toward AI, and a clear understanding of the educational benefits that AI can offer in supporting teaching and learning. The descriptive analysis showed that respondents recognized AI as a valuable instructional tool capable of improving lesson planning, personalizing learning experiences, enhancing children's engagement, and reducing teachers' administrative workload. Among the dimensions of teacher readiness, attitude toward AI obtained the highest mean score, indicating that teachers were receptive to adopting innovative technologies within early childhood education. Digital competence and ethical awareness also recorded high mean scores, suggesting that teachers understood the importance of responsible AI implementation and possessed the foundational technological skills necessary for its classroom application.

However, the findings also identified important areas requiring improvement. Institutional support and professional development received comparatively lower ratings than the other readiness dimensions. Although teachers expressed willingness to integrate AI into their instructional practices, many indicated that they lacked sufficient opportunities for specialized training, practical workshops, and continuous professional learning related to AI applications in early childhood education. This finding suggests that teacher readiness extends beyond individual motivation and technological competence and depends substantially on organizational support, leadership commitment, and the availability of educational resources.

The inferential analysis further demonstrated significant positive relationships among the major dimensions of teacher readiness. Digital competence showed a strong positive association with teachers' overall readiness to integrate AI into classroom instruction. Similarly, pedagogical readiness, ethical awareness, institutional support, and professional development were positively associated with implementation readiness, indicating that improvements in these areas would likely contribute to greater confidence and effectiveness in using AI within educational settings. The regression analysis identified professional development and institutional support as significant predictors of teachers' readiness, emphasizing the importance of continuous learning opportunities and supportive school environments in facilitating successful technology integration.

The qualitative findings complemented the quantitative results by providing deeper insights into teachers' experiences and perceptions regarding AI integration. Most participants described Artificial Intelligence as an innovative educational resource capable of improving instructional quality, supporting personalized learning, and enhancing children's creativity and engagement. Teachers reported that AI-assisted applications could help generate instructional materials, design interactive classroom activities, monitor children's learning progress, and improve lesson preparation. Participants

generally viewed AI as a supportive educational tool rather than a replacement for teachers, emphasizing that meaningful teacher-child interaction remains essential in early childhood education.

At the same time, participants consistently highlighted several challenges that could hinder successful AI implementation. The most frequently reported concerns included limited professional training, inadequate technological infrastructure, insufficient institutional guidance, and uncertainty regarding ethical issues such as data privacy, security, and responsible technology use. Teachers emphasized that effective AI integration requires structured professional development programmes, administrative support, and clear institutional policies that promote ethical and developmentally appropriate technology use. These qualitative findings reinforced the quantitative evidence by demonstrating that positive attitudes alone are insufficient without adequate organizational support and continuous professional learning.

The integration of quantitative and qualitative findings produced a comprehensive understanding of teachers' readiness for AI integration. Both datasets consistently indicated that teachers recognized the educational potential of Artificial Intelligence and expressed willingness to adopt innovative instructional practices. However, successful implementation depends upon strengthening institutional support systems, improving technological infrastructure, expanding professional development opportunities, and establishing ethical guidelines that ensure responsible classroom implementation. These findings directly informed the development of the proposed framework for effective AI integration in early childhood education.

DISCUSSION

The findings of this study support previous research emphasizing that teacher readiness is a fundamental prerequisite for successful educational technology integration. The high levels of digital competence and positive attitudes observed among teachers indicate that educators increasingly recognize Artificial Intelligence as an important educational innovation capable of supporting teaching effectiveness and improving children's learning experiences. These findings are consistent with the work of Tondeur et al. (2020), who argued that teachers possessing stronger technological competencies are more likely to adopt innovative instructional approaches and integrate emerging technologies into classroom practice.

The positive perceptions of AI identified in this study also align with previous research suggesting that teachers generally view Artificial Intelligence as an instructional support system rather than a substitute for professional teaching. Zawacki-Richter et al. (2019) reported that educators perceive AI as capable of enhancing instructional efficiency, improving assessment practices, and facilitating personalized learning while maintaining the central role of teachers in educational decision-making. Similarly, participants in the present study emphasized that AI should complement rather than replace teacher expertise, particularly within early childhood education, where emotional development, social interaction, creativity, and play-based learning remain essential components of children's development.

Another important finding concerns the significant influence of professional development on teachers' readiness. Although respondents expressed positive attitudes toward AI, many acknowledged limitations in their practical knowledge and requested additional training opportunities. This finding supports Darling-Hammond et al. (2017), who concluded that sustained professional learning significantly improves teachers' confidence, instructional competence, and willingness to adopt innovative educational practices. Professional development therefore represents a critical mechanism for transforming positive attitudes into effective classroom implementation.

The study further highlights the importance of institutional support in promoting successful AI integration. Participants emphasized that administrative leadership, technological infrastructure, access to digital resources, and supportive organizational cultures directly influence teachers' ability to implement educational innovations. These findings are consistent with Dexter (2018), who argued that school leadership plays a decisive role in facilitating technology adoption through strategic planning,

resource allocation, and continuous professional support. Without adequate institutional commitment, teachers may experience difficulties translating technological readiness into effective classroom practice despite possessing positive attitudes toward AI.

Discussion

The findings also demonstrate that ethical awareness constitutes an essential component of teachers' readiness for Artificial Intelligence integration. Respondents recognized that while AI offers numerous educational advantages, its implementation should be guided by ethical principles that protect children's privacy, ensure data security, promote transparency, and support equitable learning opportunities. These concerns are particularly significant in early childhood education because young children require developmentally appropriate instructional approaches and careful protection of their personal information. UNESCO (2023) emphasized that responsible AI implementation should remain human-centered, transparent, inclusive, and accountable, ensuring that technological innovations enhance rather than compromise educational quality. The present study supports this perspective by indicating that teachers are increasingly aware of the ethical implications of AI and recognize the importance of balancing technological innovation with children's developmental needs.

The qualitative findings further strengthened the quantitative results by providing deeper insight into teachers' practical experiences. Teachers consistently acknowledged that AI could support lesson planning, generate creative classroom activities, facilitate differentiated instruction, and reduce administrative responsibilities. However, they also emphasized that AI should function as an instructional assistant rather than replacing teachers' professional judgment, creativity, or interaction with children. This finding reflects the philosophy of early childhood education, which prioritizes meaningful teacher-child relationships, social interaction, play-based learning, and emotional development. Consequently, AI should be viewed as a complementary educational resource that enhances teachers' instructional capacity rather than substituting the human elements essential to young children's learning.

The integration of quantitative and qualitative findings contributed to the development of a comprehensive framework for effective classroom implementation. The framework emphasizes that successful AI integration depends upon the interaction of multiple factors rather than a single determinant. Teacher readiness emerges as the central element supported by digital competence, pedagogical knowledge, ethical awareness, institutional leadership, technological infrastructure, professional development, and curriculum alignment. These components operate collectively to create learning environments in which Artificial Intelligence can be implemented responsibly and effectively. The framework therefore provides practical guidance for teachers, school leaders, curriculum developers, teacher education institutions, and policymakers seeking to promote sustainable AI integration within early childhood education.

The study also contributes to the growing body of literature by extending previous research beyond technology acceptance and digital competence alone. Many earlier studies primarily examined teachers' attitudes toward educational technology or focused on higher education contexts (Zawacki-Richter et al., 2019). In contrast, the present study specifically addresses early childhood education while integrating technological, pedagogical, ethical, and institutional dimensions within a single conceptual framework. This holistic perspective provides a broader understanding of teacher readiness and highlights the importance of considering multiple contextual factors when planning educational technology initiatives.

From a practical perspective, the findings suggest that educational authorities should prioritize systematic professional development programmes specifically designed for Artificial Intelligence integration in early childhood education. Teacher education institutions should incorporate AI literacy, ethical AI use, digital pedagogy, and emerging educational technologies into both pre-service and in-service teacher education programmes. Schools should also invest in reliable technological

infrastructure, provide continuous technical support, and establish institutional policies that promote responsible AI implementation. Furthermore, collaboration among teachers, school administrators, technology specialists, and policymakers is essential for ensuring that AI integration aligns with curriculum objectives and children's developmental characteristics.

The findings additionally indicate that future educational policies should adopt a balanced approach that encourages technological innovation while preserving the fundamental principles of early childhood education. Artificial Intelligence should enhance children's curiosity, creativity, critical thinking, collaboration, and problem-solving rather than promoting excessive dependence on technology. Educational policies should therefore emphasize responsible innovation by encouraging ethical decision-making, teacher autonomy, and developmentally appropriate instructional practices. Such an approach will maximize the educational benefits of Artificial Intelligence while safeguarding children's holistic development and well-being.

CONCLUSION

This study examined teachers' readiness for Artificial Intelligence integration in early childhood education and developed a framework to support effective classroom implementation. The findings demonstrated that teachers generally possessed positive attitudes toward Artificial Intelligence and exhibited satisfactory levels of digital competence, pedagogical readiness, and ethical awareness. These characteristics indicate a favorable foundation for integrating AI into early childhood classrooms. Nevertheless, the study also revealed that institutional support and professional development remain critical areas requiring further attention. Although teachers expressed willingness to adopt Artificial Intelligence, many perceived limitations in available training opportunities, technological infrastructure, and organizational guidance.

The mixed-methods design enabled a comprehensive understanding of teacher readiness by integrating quantitative evidence with qualitative experiences. While statistical findings identified the factors significantly associated with AI readiness, qualitative findings provided practical explanations regarding teachers' expectations, implementation challenges, and professional development needs. The convergence of both datasets strengthened the credibility of the findings and supported the development of a practical framework for effective AI integration.

The proposed framework highlights teacher readiness as the central element influencing successful Artificial Intelligence implementation. Digital competence, pedagogical expertise, ethical awareness, institutional leadership, professional development, technological infrastructure, and curriculum alignment collectively contribute to responsible classroom implementation. The framework therefore provides practical guidance for educational institutions seeking to integrate Artificial Intelligence into early childhood education while maintaining child-centered teaching practices and ethical educational standards.

The study makes important theoretical and practical contributions to the field of educational technology by extending current knowledge regarding Artificial Intelligence integration within early childhood education. It provides evidence that successful AI implementation depends not only on technological resources but also on teachers' professional competence, institutional commitment, and ethical responsibility. These findings contribute to educational policy development, teacher education programmes, and school improvement initiatives designed to promote responsible innovation within early childhood settings.

Despite these contributions, the study acknowledges that teachers' readiness for Artificial Intelligence will continue to evolve as educational technologies advance. Continuous professional learning, ongoing institutional support, regular curriculum revision, and ethical policy development will remain essential for sustaining effective classroom implementation. Future research may examine the long-term impact of AI-supported teaching on children's cognitive, social, emotional, and creative development, as well

as investigate how different educational contexts influence teachers' readiness and implementation practices. Comparative studies across educational systems and cultural contexts may further strengthen understanding of effective Artificial Intelligence integration within early childhood education.

Overall, the findings indicate that Artificial Intelligence has considerable potential to enrich early childhood education when implemented responsibly and supported by comprehensive teacher preparation, institutional commitment, and ethical educational practices. By strengthening teachers' readiness through continuous professional development, supportive leadership, and appropriate technological resources, educational institutions can create innovative learning environments that enhance children's educational experiences while preserving the core values of early childhood education.

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