CHAPTER SEVEN

Bridging Artificial Intelligence, Equity, and Innovation in Early Childhood Teacher Education: Strategic Recommendations and Future Directions

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Abstract: This chapter assesses how artificial intelligence (AI) is being integrated into Early Childhood Teacher Education (ECTE), focusing on equity, ethics, and innovation in relation to Work-Integrated Learning (WIL). It draws upon Bronfenbrenner's socio-ecological systems model, Wenger's concept of communities of practice, and critical equity and transformative pedagogies. The chapter conceptualises AI-mediated WIL as a relational ecosystem linking pre-service teachers, mentors, lecturers, and EdTech developers. A qualitative multiple case study methodology was employed to examine the experiences of urban, peri-urban, and rural-based pre-service teachers, mentors, and college lecturers in relation to the use of AI-based WIL. Data were collected through various methods, including semi-structured interviews, focus group discussions, and document analysis. Data collection and analysis involved the application of thematic and cross-case methodologies. Findings from the research indicate a tri-narrative approach whereby AI can provide increased levels of reflection, strengthen mentoring, and enhance opportunities for collaboration and innovation for ECTE students. However, differences in the availability of infrastructure, digital competencies, and ethical governance can limit access to equitable participation. Equitable access to AI-based WIL will require support mechanisms such as mentorship, participatory governance, and support from colleagues and institutions. As such, the RAIIF provides an evidence-based framework for the effective implementation of AI at micro, meso, and macro levels through ethical oversight, co-created innovation, and ongoing professional development. Finally, the chapter will provide recommendations for policymakers and practitioners to promote equitable, culturally responsive, and ethically governed AI-mediated WIL.

Keywords: Artificial intelligence, equity, innovation, early childhood teacher preparation, work-integrated learning.

1. Introduction

The utilisation of Artificial Intelligence (AI) is significantly impacting global education, particularly in the preparation of pre-service teachers and the learning experiences of students (Holmes et al., 2023). In the context of early childhood teacher education, AI has introduced

new opportunities through adaptive assessments, simulation-based teaching practices, and predictive analytics regarding student performance. However, this transformation also presents substantial ethical, social, and pedagogical challenges. Researchers caution that, if left unchecked, AI may exacerbate structural inequities, particularly in low-resource settings (Knox, 2024). Therefore, it is both timely and critical to understand how to bridge the intersections of AI, equity, and innovation within teacher education.

Early Childhood Education (ECE) occupies a unique position in this discourse. ECE is distinctly relational, context-dependent, and value-based. Teacher education programmes, often integrated with Work-Integrated Learning (WIL), highlight the importance of authentic practical experiences and reflective supervision (Darling-Hammond & Hyler, 2023). Consequently, the implementation of AI in human-centred fields, such as ECE, necessitates a careful re-evaluation of ethics, pedagogy, and power dynamics (Schoop & Lam, 2024).

AI technologies, including digital mentorship dashboards, learner observation analytics, and intelligent tutoring systems, possess the potential to enhance learning by providing real-time feedback and customising professional development (Zawacki-Richter et al., 2023). However, countries in the Global South encounter disparities in infrastructure, digital preparedness, and policy alignment, which could reinforce historical inequities (Williamson & Piattoeva, 2023). This chapter perceives AI as both a transformative opportunity and an equity challenge within early childhood teacher education. It critically examines how teacher education institutions can progress from mere technological adoption to intentional innovation ecosystems that prioritise inclusivity, human dignity, and collective education.

Despite these widespread advancements, a significant relative gap remains in Zimbabwe, where empirical and policy-focused research on AI in early childhood teacher education is still limited (Hlongwane, Shava, Mangena, & Muzari, 2024). Challenges such as varying digital infrastructure, limited institutional capacity, the absence of robust national AI guidelines in education, and unequal access to devices and connectivity hinder the meaningful implementation of AI in WIL and teacher education programmes (Tarisayi & Manhibi, 2024). Furthermore, the lack of indigenous, culturally responsive AI tools and insufficient professional development for teachers underscores the urgent need for nation-specific frameworks that align AI integration with Zimbabwe's socio-economic realities and equity objectives (Bulathwela, Pérez-Ortiz, Holloway, Cukurova, & Shawe-Taylor, 2024).

This chapter reviews recent empirical and policy literature on AI in early childhood teacher preparation and WIL, with a focus on equity and inclusion. It scrutinises ethical and governance issues such as data privacy, technology-driven bias, and culturally responsive, developmentally appropriate practices (Berson, Berson, & Luo, 2025). Building on this review, the chapter proposes an operational framework that links AI, equity, and educational innovation, employing participatory, stakeholder-driven approaches. For the integration of AI in Early Childhood

Teacher Education (ECTE) to be effective, the chapter argues for a shift from a technocentric adoption model to an ecosystem approach, which should adopt a relational stance and adhere to ethical governance principles.

1.1 Problem statement

The integration of AI technologies within educational environments is rapidly increasing due to pilot initiatives and vendor-led implementations. Early childhood teacher education, particularly WIL deployments, faces a pressing need to harness AI's potential for apprenticeship and reflection without compromising learner safety, data confidentiality, or equitable access. Berson et al. (2025) noted that current barriers to the effective use of AI in teacher preparation include governance frameworks that inadequately address the learner-specific ethical implications of using AI. This issue is exacerbated by unequal infrastructure at placement sites and a lack of co-design among mentors, students, and lecturers, further limiting the successful use of AI. Additionally, long-term research evidence supporting both the developmental and equity-related effects of using AI remains limited. In Zimbabwe, many barriers to effectively utilising AI to support ECEs are compounded by ongoing urban-rural digital divides, unreliable internet connections, a lack of access to adequate numbers of devices, and the absence of national policies addressing AI in early childhood settings (Reina-Parrado, Roman-Gravan, & Hervas-Gomez, 2025). Low institutional readiness exists, as few colleges of education are prepared to effectively integrate AI into their programmes, resulting in many mentor teachers lacking essential digital pedagogy experience. Moreover, limited institutional awareness and understanding of AI among some lecturers constrains meaningful adoption and training (Holmes et al., 2022). Furthermore, the lack of robust enforcement of child data protection laws (Chen, 2024) heightens concerns about data protection, while parental distrust of AI, fueled by socio-economic vulnerabilities, further complicates the responsible adoption of AI in early childhood contexts.

1.1.1 Questions

This chapter was guided by the following questions:

- How do empirical and policy literature characterise the applications of AI in early childhood teacher education and WIL, particularly from an equity perspective?
- What are the key ethical, governance, and equity challenges associated with integrating AI into early childhood teacher education and WIL?
- What strategic and operational frameworks can effectively bridge AI, equity, and innovation in early childhood teacher education?

2. Theoretical Frameworks

The incorporation of AI into early childhood teacher education, particularly in WIL, requires a rigorous theoretical grounding that accounts for the multifaceted, relational, and socio-technical

nature of these learning ecosystems. This chapter employs a triangulated theoretical framework that includes Socio-Ecological Systems Theory (Bronfenbrenner, 1979), Communities of Practice (CoP) Theory (Wenger, 1998), and Critical Equity and Transformative Pedagogy Frameworks (Ahmed, 2025). Together, these frameworks provide an integrated understanding of how AI can serve as a teaching/learning tool, a relational mediator, and a socio-ethical intervention.

2.1 Socio-ecological systems theory

Bronfenbrenner's Socio-Ecological Theory views human development through a series of nested layers of social systems, ranging from micro-systems (the immediate environment, i.e., the classroom) to meso-systems (interconnections between various institutions and people, e.g., family and institutions of higher learning), exo-systems (policies, technology, and governance structures that affect WIL experiences indirectly), macro-systems (national education policy, cultural values, and perceptions of AI in pedagogy), and the chronosystem (temporal aspects, including longitudinal adoption of AI, changing policy, and generational changes in digital literacy; Moloi, 2023).

The application of socio-ecological theory to the implementation of AI in education provides insight into how interconnected stakeholders across multiple levels can develop ethical, equitable, and innovative approaches to AI and pedagogy. As Darling-Hammond and Hyler (2023) argue, this also implies that an approach to AI governance will be required at a systems level, rather than as individual technological solutions.

2.2 Communities of practice (CoP) theory

Wenger's (1998) Communities of Practice (CoP) framework conceptualises learning as a form of social participation, wherein knowledge is collaboratively constructed through shared engagement, cooperative endeavour, and mutual accountability. In the context of early childhood teacher education, artificial intelligence (AI) can serve as a mediating technology that enhances the social learning processes inherent to Wenger's CoP model. For instance, emerging AI-enabled dashboards provide mentors and pre-service student teachers with real-time insights into classroom interactions, thereby facilitating learning through more informed and timely reflective practice. AI-generated analytics additionally promote the collective construction of knowledge by creating opportunities for dialogue among student teachers, mentors, and supervisors. Furthermore, AI tools can sustain engagement across placements by archiving reflective logs, lesson plans, and classroom observations, which collectively enable longitudinal learning. Positioning AI within CoPs highlights the relational and participatory dimensions of innovation, emphasising that technology must support rather than substitute the human interactions fundamental to work-integrated learning (WIL) (Jain, 2025; Ngcobo & Mpofu, 2024). CoP theory also underscores the value of distributed expertise, whereby lecturers, in-service mentors, and educational technology developers collaboratively engage in learning and

co-design AI-mediated interventions, thereby cultivating an ecosystem of continuous professional growth.

2.3 Critical equity and transformative pedagogy

Transformative pedagogy emphasises the significance of dialogue, agency, and cultural responsiveness in facilitating change within educational settings. By fostering dialogue, students are afforded the opportunity to examine their roles in the dynamic ways that AI influences their engagement in practice, promotes equity, and shapes child development (Ahmed, 2025; Fleer, 2023). Transformative pedagogy recognises the crucial role of agency and voice in advocating for the inclusion of marginalised communities in both the design and policy-making processes surrounding AI systems. Moreover, transformative pedagogy advocates for cultural responsiveness to ensure that AI tools reflect the local language(s), pedagogical practices, and values of specific communities, thereby addressing potential cultural biases and homogenisation (Fleer, 2023). Furthermore, transformative pedagogy encourages institutions to engage critically with the ethical considerations surrounding AI, including data privacy, consent, and equitable algorithms. In the absence of such accountability, data-driven technologies are likely to exacerbate existing inequities (Crawford, 2021). For instance, adaptive AI-based assessment tools must consider learners' diverse socio-linguistic backgrounds to prevent disadvantages for certain groups and inaccuracies in representing teacher performance.

Consequently, it can be asserted that socio-ecological systems theory, CoP, and critical equity pedagogy provide a framework for analysing the process of implementing AI technology in education. According to socio-ecological systems theory, it is possible to account for the multi-level environmental model within which the technology will be implemented, thereby elucidating the interrelations among various systems, including class, community, and state (Bronfenbrenner, 1979). Concurrently, the central tenet of CoP theory is to focus on social learning during the process of Work Integrated Learning (WIL), wherein AI technology is employed to promote reflective thinking and learning (Wenger, 1998).

3. Review of Related Literature

The inclusion of Artificial Intelligence (AI) in both early childhood educator preparation programmes and work-integrated learning (WIL) will dramatically transform all aspects of educational settings, policies, and perceptions of educational equity. Empirical and policy literature agree that AI's transformative potential is both significant and deeply dependent on how issues of access, ethics, and inclusivity are addressed.

3.1 AI in early childhood teacher education and WIL: An equity-focused synthesis

The emergence of AI has become one of the most transformative forces within global education. The rapid development of research on AI's ability to provide personalised learning, support assessment, and automate educational processes is well documented in the work of Holmes et

al. (2023) and Zawacki-Richter et al. (2023). Through Jain's work (2025), new technologies such as Natural Language Processing (NLP), predictive analytics, and intelligent tutoring systems have altered how teacher preparation is delivered, transforming the way teachers prepare for their roles. This allows for dynamic feedback loops between developmental milestones and technologies for learning, thereby enhancing metacognition and supporting teachers as learning orchestrators instead of content transmitters (Choi, 2025). AI tools, such as generative chatbots and intelligent lesson planners, are being used to assist pre-service teachers with lesson planning, classroom decision-making, and reflective practice during work-integrated learning (WIL) placements. However, despite the potential benefits, the literature highlights that AI innovation can obscure the long-standing inequities present within society (Barbieri and Nguyen, 2025). Fleer (2023) identifies issues related to access, representation, and agency as needing further examination; similarly, Crawford (2021) points out that AI systems frequently reproduce data biases from past iterations. Additionally, Moloi (2023) and Ngcobo and Mpofu (2024) highlight that infrastructure disparities, digital literacy, and policy gaps within the Global South limit equitable adoption of AI within teacher education. Therefore, it is imperative that AI integration into teacher education occurs intentionally and is equity-driven.

3.1.1 AI in early childhood teacher education

Early childhood teacher education aims to empower teachers with the knowledge and skills to facilitate children's development using play-based, inclusive, and culturally responsive teaching strategies (Darling-Hammond & Hyler, 2023). The emergence of AI in early childhood teacher education has brought both benefits and drawbacks. AI can support the development of pre-service student teachers' reflective practices by providing feedback from an AI system after they use AI-supported observation tools that analyse video recordings of classrooms to identify teacher-learner interactions (Knox, 2024), thereby improving their professional judgments.

On the contrary, AI-supported observation tools reduce complex human interactions to calculable elements, potentially diminishing the relational, emotional, and ethical aspects of ECE practice (Schoop & Lam, 2024). AI-supported tools that automate observation and assessment may lead to a diminished recognition of the importance of contextualised knowledge and lived experiences (Karataş & Yüce, 2024). This is especially relevant to the area of sociocultural variation in child-rearing practices, language use, and learning expectations that exist among families of young children (Fleer, 2023).

3.1.2 Work-integrated learning in the age of AI

Work-Integrated Learning (WIL) in the Age of AI in early childhood teacher education provides students with both theoretical knowledge and practical application through WIL, creating a pedagogical link between the two (Cooper et al., 2024). By emphasising experiential learning opportunities, reflection, and mentoring, WIL enables students to engage in real learning settings.

The use of AI is changing how student teachers experience WIL, including virtual or hybrid practicum experiences such as AI-driven simulations, digital portfolios, and adaptive learning dashboards (Ngcobo & Mpofu, 2024). With these technologies, students can participate in practice-based activities and receive pedagogically relevant feedback based on their decisions from real-world classroom examples (Jain, 2025).

However, the success of AI-enhanced WIL relies on institutional capability, ethical oversight, and technological fluency among mentors and student teachers (Moloi, 2023). Without sufficient training, AI can become a mechanistic substitute for human apprenticeship rather than an additional support system. This necessitates strategic innovation ecosystems and partnerships among colleges, early learning centres, technology developers, and policymakers to co-create equitable AI tools grounded in pedagogical theory and local context.

3.1.3 Equity and digital inclusion in AI-enabled teacher education

The commitment to equity is fundamental to both teacher education and ethical artificial intelligence (Varsik & Vosberg, 2024). However, digital divides continue to persist, with research indicating that disparities exist along socio-economic and geographic lines (Moloi, 2023). Access to reliable infrastructure, digital literacy, and culturally appropriate content remains uneven, particularly in low-resource settings (Moloi, 2023).

The design and governance of artificial intelligence can either exacerbate existing inequities or mitigate them. For instance, automated systems developed primarily using Western data may reinforce linguistic and cultural biases, thereby limiting their applicability in ECE settings in Africa (Knox, 2024). Moreover, equity encompasses issues of representation and agency concerning who develops artificial intelligence systems, provides the data utilised to train those systems, and the educational values they embody (Crawford, 2021).

Consequently, the integration of equitable artificial intelligence will necessitate not only technological inclusion but also epistemological inclusion, recognising diverse ways of knowing and teaching (Fleer, 2023). This necessitates a call to develop 'decolonial' artificial intelligence in education (Williamson & Piattoeva, 2023), which emphasises the importance of creating technology that affirms the localisation of technological tools, indigenous knowledge systems, languages, and frameworks for child development.

3.1.4 Ethical and governance considerations

AI in education raises several ethical issues related to data privacy, surveillance, transparency, and accountability. As AI systems assemble and process vast amounts of learners' data, concerns arise regarding informed consent, learner data protection, and the opacity of technology (Holmes et al., 2022). These issues are exacerbated in ECTE due to the vulnerabilities of learners and student teachers, who are subject to observation and assessment.

Frameworks for governance, such as UNESCO's recommendation on the ethics of AI (2023) and the European Commission's ethics guidelines for trustworthy AI (2024), emphasise values of beneficence, non-maleficence, justice, and autonomy (Schoop & Lam, 2024). However, these global frameworks need to be adapted to fit local educational realities. Research conducted by Ngcobo and Mpofu (2024) indicates that many teacher education colleges in Sub-Saharan Africa lack clear procedures for governance concerning AI, resulting in ad hoc and uneven implementation. For example, in Kenya, the integration of AI in education remains inconsistent, with institutions adopting technologies independently and often without clear policy direction or standardised guidelines.

An emerging consensus advocates for participatory AI governance, where mentors and student teachers have a voice in decision-making (Schoop & Lam, 2024). Such participatory strategies can alleviate ethical risks while fostering transparency, trust, and shared ownership of digital innovation. While no Zimbabwe-specific research was found, these international challenges are likely exacerbated in Zimbabwe due to infrastructural and policy constraints, highlighting the urgent need for context-sensitive frameworks and investment to ensure unbiased, ethical AI integration in early childhood education (Aliyu, 2025).

3.1.5 Innovation ecosystems in early childhood education

Innovation in early childhood education has a greater chance of success when it is viewed as an ecosystem—a dynamic set of interactions and relationships among different entities, such as people, institutions, and technologies (Bronfenbrenner, 1979; Wenger, 1998). In the context of AI in early childhood education, innovation ecosystems will comprise the relationships between institutions of higher education, early childhood centres, ed-tech companies, and government agencies working collaboratively as co-creative partners (Darling-Hammond & Hyler, 2023).

More recent studies have emphasised relational agency, or the ability of parties to combine their differing areas of expertise and interests into a cohesive unit aimed at common goals (Schoop & Lam, 2024). Innovation ecosystems involving AI will require all parties to be mutually engaged in learning processes, ensuring that technology developers have some understanding of pedagogical realities, and that teachers become aware of the affordances of AI, using them critically and reflectively (Jain, 2025).

Across the continent of Africa, several initiatives, such as the African Union's AI for Development in Africa Framework (African Union, 2024), advocate for regional coordination to promote ethically and inclusively developed technologies. Nonetheless, the gap between policy aspirations and the readiness of institutions to implement these policies remains substantial (Moloi, 2023). Closing this gap will entail not only building capacity but also necessitate forward-looking thinking to anticipate how the rapid evolution of AI may redefine professional learning, ethics, and identity in early childhood education.

The use of Artificial Intelligence (AI) in early childhood teacher education and work-integrated learning is a double-edged sword when it comes to equity in the education sector of Africa, particularly in Zimbabwe, as represented in empirical and policy literature. There are two sides to this issue; on the one hand, AI-enabled adaptive learning platforms and intelligent content delivery systems, as noted by Chisom, Unachukwu, and Osawaru (2024), can personalise learning, increase access to underserved areas, and provide students with immediate, relevant feedback. The ability to enhance teacher professional development and improve teachers' digital skills for the next generation of education systems are among the benefits that these new technologies can bring, as mentioned by Tarisayi and Manhibi (2024).

However, the same body of literature also highlights many challenges related to equity that remain unaddressed. Numerous barriers to equity still exist, such as a lack of physical infrastructure, insufficient preparedness on the part of educators, and growing gaps in technology access, as stated by Qayyum et al. (2025). Therefore, if these issues are not appropriately addressed through focused funding and policy mechanisms, they will only serve to widen the gaps between those who have the resources and capabilities to take advantage of these new technologies and those who do not.

Furthermore, ethical considerations surrounding AI have also emerged, including data privacy, cultural relevance, and algorithmic bias; thus, the implementation of policies and regulations that promote equity and social justice is required (Chisom et al., 2024). Additionally, it has been identified that collaborative and long-term investment from all stakeholders is necessary to ensure that AI becomes a transformative tool for education rather than an exclusionary device.

4. Methodology

The qualitative, multi-case study design is appropriate for the chapter's objective of gaining an understanding of how AI, equity, and innovation are integrated into early childhood teacher education. It provides contextually rich information, captures participant perspectives, and offers strategic recommendations for policy and practice.

4.1 Research paradigm

This chapter employs a constructivist-interpretivist paradigm as the conceptual foundation for this research project. It is based on the premise that all knowledge is co-created through the interaction between the author and participants within social and cultural contexts (Creswell & Poth, 2023). Furthermore, the adoption of AI in early childhood teacher education has a relational component that is significantly influenced by the values, practices, and expectations of various stakeholders, including pre-service student teachers, mentors, college lecturers, and technology providers. Utilising an interpretivist paradigm allows for an exploration of ethical, equitable, and innovative dynamics (Denzin & Lincoln, 2023) while enabling a more detailed analysis of the ethical implications, power imbalances, and structural inequalities associated with

the adoption of AI (Mnguni, 2024). The integration of these two paradigms in this chapter will provide the researcher with a robust empirical foundation and a normative perspective on the necessity of considering justice and inclusion when incorporating AI in early childhood teacher education.

4.2 Research approach

A qualitative research approach was employed to explore how stakeholders in early childhood teacher education construct their understanding of AI integration across different socio-cultural and infrastructural environments. This was achieved through methods such as document analysis, focus groups, and semi-structured interviews, which examined the lived experiences and ethical considerations of pre-service students, mentors, and lecturers. These methods provide insights into complex issues that cannot be identified through quantitative data (Mohammed, 2023). Additionally, through collaborative and ongoing dialogue, qualitative research offers a rich source of contextualised information on how issues related to equity, innovation, and relational pedagogy are developing in Zimbabwe's emerging AI environment (Mnguni, 2024).

4.3 Research design

The use of a multiple-case study design was based on several reasons. AI adoption in work-integrated learning (WIL) is characterised by various interrelated factors, including the technological infrastructure available, policies at the institutional level, mentorship practices, and the cultural context in which they are situated. These factors are most effectively explored using in-depth case-based research approaches (Mnguni, 2024). Examining numerous institutions and learning contexts allows for cross-case contrast, revealing patterns, deviations, and contextual nuances in AI integration, equity outcomes, and innovation practices. Case studies facilitate the development of practical and conceptual frameworks, linking socio-ecological theories, CoPs, and critical equity theories to real-world applications in teacher education (Creswell & Poth, 2023). The chapter focuses on one purposefully selected teacher education college, one highly resourced urban primary school, one fairly resourced peri-urban primary school in Bulawayo, and one poorly resourced rural primary school in Matabeleland North, Zimbabwe. This selection enables the exploration of both resource-rich and resource-constrained environments, highlighting equity and access challenges across different settings.

4.4 Participants and sampling

A purposeful sample was drawn to achieve diversity among participants' roles, institutions, and settings (Mnguni, 2024). The sample included nine student teachers on attachment as part of an AI-based WIL placement, representing different socio-economic backgrounds; six mentors who supervise student teachers in Early Childhood Development (ECD 'A' and 'B') classrooms; and

four college lecturers who equip student teachers with the relevant knowledge, skills, and strategies to integrate technology.

Participant selection was based on achieving diversity in relation to geographical context (urban, peri-urban, and rural) and technological access (high and low infrastructure environments), as well as professional experience (mentors with varying experience in using AI). This sampling method ensured a deeper understanding of the multi-tiered dynamics influencing AI adoption, equity, and innovation.

4.5 Data collection methods

To establish reliability and legitimacy, the chapter employed a triangulated method for data collection. Semi-structured interviews were conducted with mentors and college lecturers to explore their perceptions on AI adoption, ethical considerations regarding AI, mentorship, and innovation (the interviews lasted 30-45 minutes, and all were fully transcribed). Three focus groups were held with pre-service student teachers to examine commonalities in their shared experiences, the challenges they encountered, and how they collaborated in the AI-mediated WIL setting. Document analyses were conducted on institutional AI policy documents to understand governance structures, working protocols, and equity-focused strategies. By employing a combination of qualitative methods, the author was able to enhance their understanding of this phenomenon and cross-validate the findings from each of the different methodologies used.

4.6 Data analysis

Data in this chapter will be presented and analysed in alignment with the primary guiding questions. This approach ensures coherence between the chapter objectives, data generation, and analytical procedures (Creswell & Poth, 2023). The data will be systematically organised according to each research question, enabling a focused interpretation of participants' perspectives. The analysis will incorporate the identification of themes, supported by relevant verbatim quotations, to enhance credibility and depth (Mnguni, 2024). Consequently, this method facilitates a structured and rigorous examination of the data while maintaining fidelity to the research aims.

4.7 Ethical considerations

Ethical integrity was vital to the chapter, particularly given the involvement of pre-service student teachers, mentors, and college lecturers (ECD) in WIL environments. The author applied for ethical clearance from the Provincial Education Director and from the principal of the participating teacher education college in Bulawayo Province. Furthermore, written consent was obtained from all participants who took part in semi-structured interviews and focus group discussions. Data were anonymised, and identifying information was removed. Pseudonyms were used in all reporting. Digital data were securely stored in password-protected systems, while

hardcopy data were kept in lockable cabinets. The author engaged in reflexive practices to minimise bias and ensured a culturally sensitive interpretation of the findings.

4.8 Trustworthiness

To ensure that the credibility of this study is sufficiently high for it to be deemed transferable, dependable, and confirmable, the author employed a variety of strategies (Denzin and Lincoln, 2023; Creswell and Poth, 2023). The utilisation of multiple data collection methods and sources, all yielding similar results, contributed to the credibility of this research. Participants were also given the opportunity to review the initial findings, enabling them to validate the accuracy of the preliminary results and their relevance to their experiences. This study additionally includes detailed descriptions of the research context and the procedures followed, thereby enhancing its transferability. Furthermore, the author documented the decision-making process involved in developing the coding schemes and themes, as well as in interpreting the data, to provide insight into the transparent methodology that underpinned the development of the findings. The coding frameworks and thematic interpretations were also independently reviewed by other scholars, minimising author bias, which aligns with the peer debriefing strategy.

5. Presentation of Results

5.1 Empirical and policy literature of the applications of AI in early childhood teacher education and WIL

The views of lecturers (A, B, and mentor B) were similar. Lecturer A said that *"AI has the potential to enhance both ECD teacher preparation and work integrated learning (WIL), but barriers such as unequal access, cultural misfit and a lack of adequate infrastructure could limit its equitable use"* and lecturer B stated that "*unless implemented carefully, AI will have the potential to create even greater inequalities than exist at present between students undertaking the same qualification and the children they teach"*. Mentor B from an urban school stated that *"AI can be an opportunity to further develop student teacher learning opportunities; however, the disparity in terms of infrastructure, means that many placement locations do not provide an opportunity for meaningful use of AI."* Furthermore, she states that "*the disparity in this regard creates inequitable WIL experiences and inequitable preparation for early childhood teaching."* Student teacher 1 (from a focus group discussion across different contexts) acknowledged that AI had the potential to improve their learning but also stated that *"access and experience was largely determined by the quality of the infrastructure available within the placement schools that they attended."* She further explained that *"disparities in the access to technology in their schools' created disparities in the preparedness, confidence and assessment performance of their peers during teaching practice."* The analysis of institutional documentation indicated a recognition of the importance of developing teacher capacity; however, no concrete AI competencies were included in the pre-service curriculum for ECD. Furthermore, while there was acknowledgment of equity in the context of policy rhetoric (i.e. the urban/rural divide), the operationalisation of this concept in curricula was found to be weak. Finally, it was noted that there is currently no inclusion of AI-enabled practicum models in the

existing WIL guidance. Overall, a closer examination of the findings from all data sources reveals that AI is perceived as having the potential to enhance early childhood teacher education and WIL. However, similar to other studies (Qayyum et al., 2025 & Zhou, 2025), it appears that the benefits of AI are being unequally realised and are constrained by issues related to infrastructure, curriculum, and contextual factors.

5.2 Key ethical, governance, and equity challenges associated with integrating AI into early childhood teacher education and WIL

The application of AI in ECTE and WIL has led to numerous ethical and governance issues. For instance, one of the most critical governance problems identified from the data analysis process is the governance gap associated with AI technology. This problem arises due to inadequate policy formulation and a lack of ethical guidelines regarding the appropriate use of AI technology in education, particularly in areas where vulnerable groups, such as children, participate in WIL. As stated by Student Teacher 2, *"Without explicit AI policies, ethical guidelines, and data-protection frameworks, we cannot be certain of how to responsibly implement AI tools with young children in our WIL settings."* From document analysis, it came out that there is no clear policy on AI integration in teacher education programs. Ngcobo & Mpofu, (2024) argue that lack of such clear definitions makes it easy for learning organisations to adopt AI technologies that might infringe on their clients' privacy or create room for bias (Crawford, 2021).

Moreover, another critical barrier to implementing AI in ECTE and WIL is access to adequate technology. Educational institutions from urban, peri-urban, and rural locations differ greatly in their physical setup, hence unequal access for learners to AI in their learning process. The digital divide is also a serious challenge since some schools lack the infrastructure and capacity to implement AI, as pointed out by Tarisayi and Manhibi (2024). The technological gap creates a problem where students from well-endowed institutions are better placed to utilise AI tools compared to those in poorly endowed locations.

Lastly, cultural and pedagogical issues emerged as other critical challenges when considering the effective implementation of AI in ECTE and WIL. Notably, the lack of context-specific AI tools that consider Zimbabwe's indigenous language and culture was a significant problem. Peri-Urban Mentor A stated, *"Poor capacity building for lecturers, mentors, and student teachers results in inconsistent or ad-hoc use of AI and raises serious ethical questions surrounding learner data, bias, and reliance on AI"* (Fleer, 2023). The lack of culturally sensitive AI resources could also make it hard for student teachers to use AI in their lessons. This is especially true for early childhood educators who have to meet specific pedagogical requirements to accommodate children's developmental needs. It is essential to develop AI tools that work effectively but also adhere to cultural and pedagogical values (Barbieri & Nguyen, 2025).

In conclusion, while AI has the capability of revolutionising teacher education at early childhood stages, it must be adopted responsibly to address the above ethical, governance, and equity

issues. Without adequate frameworks, the adoption of AI could end up exacerbating inequities, especially in peripheral areas. According to the statistics provided above, the adoption of AI technology should go beyond technology but also involve ethical governance and cultural sensitivity, among others.

5.3 Strategic and operational frameworks to bridge AI, equity, and innovation in early childhood teacher education

The data reveal an evident void in coherent and contextualised AI frameworks used in Zimbabwean early childhood teacher education. This has resulted in an unevenly distributed, fragmented, and ethically risky use of AI. As a result of this lack of coherent and contextualised AI frameworks, lecturers and student teachers have called for both national and institutional policies that are explicit and contextualised to the Zimbabwean linguistic, cultural, and infrastructural realities. Lecturer D *emphasised, "we need comprehensive and contextually grounded frameworks to direct the ethical and equitable integration of AI in early childhood education and work-integrated learning."* Therefore, Lecturer D argued that there needs to be national and institutional policies that clearly articulate how to utilise AI in ways that are consistent with Zimbabwean cultural, linguistic, and infrastructural realities while providing equitable resource allocation. This is consistent with Socio-Ecological Systems Theory, which asserts that educational innovation is formed by the continuous interaction among individual, institutional, and societal factors (Ozturk, 2025).

Mentors at varying school locations reiterated their desire for a structured, equitable, and ethically sound framework to direct the incorporation of AI into ECD teaching practice. Mentor A at a peri-urban school stated that "we need specific guidelines on what tools are suitable, what the pedagogical uses of the tools are, and how to safeguard children using the tools, along with methods to localise AI content so it reflects Zimbabwean language and culture." Mentor C, at a rural school, emphasised that *"the most important step is to prioritise foundational accessibility like having enough power, devices, and offline-capable tools to enable meaningful AI utilisation."* This is consistent with Vesna et al. (2025) and Cabral & Palavras (2025), who noted that until there are operationalised equity commitments such as a minimum digital standard, mobile AI toolkits, or offline solutions, low-resource and rural schools will be systemically disadvantaged, similar to global concerns regarding the digital divide in AI-based education.

Student teachers similarly emphasised the need for a comprehensive and equitable AI integration framework that would provide them with clear pedagogical direction, practical skills development, and robust ethical protections. Student Teacher 3 at a peri-urban location expressed, *"there should be a structured, hands-on training programme that connects coursework with practical AI projects to build confidence and reduce uncertainty when conducting teaching practice."* Community of Practice (CoP) Theory is consistent with student teachers' desires for structured, hands-on training and well-prepared mentors, which are necessary for building confidence and reducing

uncertainty, because a fragmented or inconsistent capacity-building process can lead to variable levels of support and inhibit the establishment of a community of expertise (Fleer, 2023). Student teachers' concern for fairness was prominent, with requests for a minimum amount of AI experience to occur in college labs, mobile digital kits, or offline-capable tools to allow for equitable assessment regardless of where students are placed for field experiences.

The policy review has revealed several critical knowledge gaps regarding the integration of Artificial Intelligence (AI) into Early Childhood Teacher Education (ECTE), particularly in Work-Integrated Learning (WIL). While many policies reference equity, rural inclusion, and digital access, operational strategies, minimum digital requirements, and provisions for low-tech environments are very rarely provided. This limits the alignment of these policies with the reality of educational systems. As indicated by Ahmed (2025) and Henriksen et al. (2025), the perspectives of Critical Equity and Transformative Pedagogy emphasise that without sufficient standards and ethical frameworks, digital divides will widen, inclusion will be undermined, and child-centred practices will be compromised. Furthermore, weak governance, limited capacity building, and a lack of adequate safeguards have exacerbated the fragmented nature of AI implementation in ECTE. Therefore, there is an urgent need for strategic, operational, and contextual AI frameworks.

6. Discussion of Findings

The primary objective of this chapter was to assess how both empirical and policy literatures have conceptualised the use of AI in ECTE and WIL) concerning issues of equity. From a socio-ecological perspective, the findings clearly demonstrate that disparities in the integration of AI within ECTE and WIL are multi-layered, occurring across micro, meso, and macro systems. At the micro level, inequalities manifest in classrooms where student teachers' access to AI-enabled tools, digital literacy, and opportunities for reflective practice vary significantly. The evidence indicating uneven access to devices, unreliable internet connectivity, and limited pedagogical preparedness highlights the need for interventions that directly support individual competencies and classroom practices (Ozturk, 2025; Qian et al., 2025). At the meso level, institutional disparities are evident in the uneven availability of infrastructure, professional development opportunities, and the absence of coherent institutional strategies for AI integration. The lack of alignment between policy intentions and institutional practices further exacerbates inequities. At the macro level, fragmented governance frameworks, policy gaps, and inconsistent national strategies constrain equitable AI adoption. These interconnected challenges justify the need for the RAIIF to adopt a multi-level structure that simultaneously addresses individual capacity building, institutional readiness, and policy coherence. The findings therefore support a framework that is layered, context-responsive, and capable of intervening across all levels of the educational ecosystem (Zhou, 2025).

From the perspective of Communities of Practice (CoP), the findings reveal a significant gap in collaborative and sustained professional learning environments necessary for effective AI integration. The variability in AI use and the reported lack of structured support systems indicate that many educators operate in isolation, without access to shared knowledge, mentorship, or collective problem-solving mechanisms. This absence of collaborative spaces limits innovation, particularly in resource-constrained contexts where peer learning and knowledge exchange are critical (Aliyu, 2025). The evidence highlighting the potential of communities of practice to provide mentorship, shared learning experiences, and contextually relevant solutions underscores the importance of embedding relational learning ecosystems within the RAIIF. Berson et al. (2025) and Ding (2025) suggest that such ecosystems would facilitate continuous professional development, enable the co-construction of knowledge, and support the adaptation of AI tools to local realities. Consequently, the framework must prioritise the establishment and sustenance of collaborative networks that bridge the gap between theory and practice, thereby enhancing both innovation and equity in AI integration.

Through a critical equity perspective, the findings underscore the risk that AI, if uncritically adopted, may reproduce or even exacerbate existing structural inequalities. Issues of cultural irrelevance, algorithmic bias, and unequal access to digital resources highlight the importance of foregrounding equity and inclusion in any framework for AI integration (Cabral & Palavras, 2025). The evidence suggests that current implementations often fail to account for diverse socio-cultural contexts, thereby marginalising already disadvantaged groups. Furthermore, Ahmed (2025) and Henriksen et al. (2025) argue that the persistence of policy rhetoric without concrete operationalisation points to a lack of accountability in ensuring equitable outcomes. These insights justify the inclusion of an explicit equity and inclusion lens within the Responsible AI Integration Framework (RAIIF), grounded in principles of social justice and transformative pedagogy. Such a lens necessitates the development of culturally responsive AI tools, the prioritisation of low-resource and offline-compatible technologies, and the implementation of ethical safeguards to protect vulnerable learners. It also requires mechanisms to translate policy commitments into actionable strategies that directly address inequities in access, participation, and outcomes (Aliyu, 2025; Zhou, 2025).

Taken together, the integration of these three perspectives provides a coherent and evidence-based justification for the RAIIF. The socio-ecological lens necessitates a multi-level and systemic approach; the CoP lens emphasises the importance of collaborative and relational learning structures; and the critical equity lens ensures that all interventions are guided by principles of inclusion, justice, and contextual relevance (Aliyu, 2025; Ozturk, 2025). The convergence of these findings highlights that effective AI integration in ECTE and WIL cannot be achieved through isolated or technocentric approaches but rather requires a comprehensive framework that is simultaneously structural, relational, and transformative (Wenger, 1998; Cabral & Palavras, 2025).

7. Conceptual Framework

The "Relational AI-Education Innovation Framework" (RAIIF) proposed in this chapter provides a guiding structure for integrating AI into early childhood teacher education. The RAIIF is a synthesis of the chapter's empirical and theoretical data, with an emphasis on equity-centred relational dynamics and multiple levels of focus.

7.1 Core components of RAIIF: Relational learning ecosystems

The WIL experience incorporates an AI-based mediation system to support interaction among a multitude of actors, including pre-service teachers, mentors, learners, lecturers, and other stakeholders (Darling-Hammond & Hyler, 2023). The WIL experience is framed using Socio-Ecological Theory and Community of Practice (CoP) models, which demonstrate that this is a collaborative and problem-solving process in a mentor-led environment where both professional development and contextualised learning of educators occur collaboratively.

7.2 Equity and inclusion lenses

Adopting AI in education is approached from a critical equity perspective, prioritising access for marginalised learners and the development of culturally responsive tools. Implementation approaches encompass multiple languages, infrastructure support, and mentorship structures, collectively aimed at removing educational discrepancies and creating equitable learning opportunities (Aliyu, 2025).

7.2 Ethical governance

Governance of AI in education includes strict policy compliance, stakeholder involvement in decision-making, data privacy safeguards, and technology-driven accountability, ensuring responsible enactment (Ngcobo & Mpofu, 2024). Such governance mechanisms operate across both institutional (mesosystem) and community (macrosystem) levels, facilitating harmonised oversight and alignment with broader ethical and regulatory standards.

7.3 Innovation and continuous adaptation

This method provides an iterative process of co-creative development and reflective practice with AI, allowing it to evolve to meet changing pedagogical and contextual needs. The method encourages experimentation, continuous feedback processes, and the development of a mechanism for adapting to challenges, ensuring that AI can be appropriately integrated into educational environments that are responsive and effective.

7.4 Operationalising RAIIF

The framework views AI integration in WIL across three levels. At the micro-level, it emphasises AI-mediated mentoring, reflective analytics, and adaptive lesson simulations; at the meso-level, it focuses on collaboration between institutions, curriculum development, and the formation of

communities of practice; and at the macro-level, it addresses policy orientation, equity-oriented governance, and sustainable AI adoption techniques. The chronosystem dimension ensures ongoing monitoring and modification over time, including stakeholder responses and technological advancements. By integrating technology, pedagogy, equity, and ethics, the framework offers a practical and theoretically grounded approach for the implementation of AI in WIL programmes.

8. Conclusions and Recommendations

Taken together, these integrative perceptions depict AI as a relational and ethical ecosystem rather than a discrete technological solution. Effective integration relies on fostering insightful teachers, equitable access, collective mentorship networks, and governance systems that resonate with local contexts. These interdependencies create the conceptual foundation for a strategic framework of AI in ECD teacher education—one that recognises that technological innovation must be accountable for the human and cultural dimensions of learning.

8.1 Implications

The findings of this study have a variety of multi-layered implications for policy, practice, pedagogy, and research, particularly in relation to the intersections of AI, equity, and innovation in early childhood teacher education. These implications pertain to the socio-ecological dynamics, ethical governance, and relational learning ecosystems identified in this study.

8.1.1 Policy implications

AI must be integrated into classrooms with a focus on fairness for all, emphasising access, the use of tools that are both culturally and linguistically appropriate, and a strong technology infrastructure (Fleer, 2023). Policymakers at both national and local levels have the responsibility to create frameworks governing the ethics of using AI, specifically regarding the protection of student and teacher data privacy, establishing accountability, and obtaining informed consent (Ngcobo & Mpofu, 2024). Participatory forms of governance should involve preservice teachers, their mentors, and their communities to provide a greater level of transparency and representational voice. The sustainability of funding and investment will be critical to supporting the development of digital infrastructure, mentorship, and continuous professional development for teachers to achieve equitable long-term AI implementation (Fleer, 2023).

8.1.2 Pedagogical implications

Effective use of AI in teacher training requires mentorship-coached communities of practice (CoPs), wherein mentors possess expertise in using AI-based methods, reflect on their practices, and provide ethical supervisory support for students. The technology-based instruction delivered through AI must be culturally and contextually relevant to each student's environment, including their language, culture, and pedagogy; this is particularly important given the variety of educational settings (e.g. urban schools, rural schools, schools serving diverse populations,

etc.) (Holmes et al., 2022). Furthermore, pre-service teachers should engage in structured cycles of reflection and utilise AI analysis to develop critical thinking, problem-solving, and professionally responsible judgments when making decisions regarding students' needs and instruction.

8.1.3 Institutional and partnership implications

Developing collaborative innovation ecologies necessitates the co-design of AI interventions by teacher education colleges, early learning centres, and EdTech developers, ensuring alignment with pedagogical goals, equity imperatives, and local contextual needs (Darling-Hammond & Hyler, 2023). Colleges must facilitate ongoing professional learning through sustained training in AI literacy and ethics, thereby empowering educators to engage responsibly with rapidly evolving technologies. Moreover, the active involvement of the community—encompassing the participation of families and local stakeholders in the co-design process—is vital for fostering transparency, confidence, and cultural relevance in AI-mediated educational practices.

8.1.4 Chapter implications

Forthcoming chapters on AI in education must prioritise longitudinal studies to evaluate the long-term effects of AI integration on teacher preparation, student outcomes, and systemic equity. Cross-cultural comparative studies are essential to identify best practices for culturally responsive AI adoption across varied educational and technological contexts (Ngcobo & Mpofu, 2024). Moreover, academic attention should emphasise technology-driven transparency, ethical oversight, and participatory governance models to alleviate bias and ensure the responsible application of AI interventions in early childhood education.

8.2 Strategic recommendations

This chapter highlights AI's ability to assist in transforming early childhood teacher education but emphasises that this will depend on the quality of equitable access, ethical governance, and relational practices. The findings indicate that AI has the potential to support mentoring, reflection, and professional development as a complement to human scaffolding. Realising AI's potential for the transformation of early childhood teacher education requires policy approaches to address issues such as equity in access to technology, digital literacy among teachers, the contextual relevance of AI applications, protecting data privacy, ensuring that AI is treated fairly, and promoting participatory, community-driven innovations.

8.2.1 For policymakers

National AI in education techniques should prioritise equity, ethical governance, and robust infrastructure support to foster inclusive and responsible technology integration (Darling-Hammond & Hyler, 2023). Policies must be formulated through participatory processes that encompass teachers, students, and community delegates, ensuring transparency and contextual relevance. Additionally, accountability frameworks must be created to govern the actions of both

AI vendors and educational institutions, ensuring adherence to ethical standards and protecting educational outcomes.

8.2.2 For teacher education institutions

Educational curricula should deliver comprehensive AI literacy and ethics training for both pre-service teachers and mentors, empowering them to engage responsibly with emerging technologies. Collaborative communities of practice (CoPs) must be fostered to integrate AI tools into WIL while preserving the centrality of human relational dynamics. Furthermore, AI tools must be developed and applied to be culturally responsive, inclusive, and accessible, ensuring relevance and equity across diverse educational contexts (Bulathwela et al., 2024).

8.2.3 For EdTech developers

The use of AI systems in education must incorporate a design for adaptability, transparency, and an equitable focus on learners from different linguistic backgrounds, as well as contextual customisation to accommodate the varied needs of students. Close working relationships are needed between educators and developers of AI so that the development of AI technologies is aligned with educational goals, thereby enhancing instructional quality (Darling-Hammond & Hyler, 2023). Developers of AI systems must create ethical safeguards, including minimising the collection of student data, employing strong protocols to protect student privacy, and auditing for systemic biases, all to provide a framework to assure the appropriate use of AI in the classroom.

8.2.4 Equity and access

To create a more equitable environment for the use of AI in education, institutions need to begin by eliminating the "digital divide" through the creation of reliable infrastructure that includes the availability of the internet and devices, ensuring all teachers and students can access AI resources (Qayyum et al., 2025). Next, institutions will need to establish mechanisms for ongoing assessment of equity; these assessments would measure the equity of AI tool implementation across different learner populations to help identify and mitigate inequity in access to educational opportunities.

8.2.5 Innovation and continuous improvement

To provide an environment that is both supportive and ethically equitable regarding innovative early childhood educational practices through collaborative research and partnerships, institutions must foster relationships with other educational entities, technology developers, and researchers to design and evaluate rigorous and effective uses of AI as a tool for educators (Darling-Hammond & Hyler, 2023). Additionally, institutions can create an environment of reflective practice by encouraging educators to examine how they use AI in the classroom, share their reflections, and develop collective approaches to best utilise these new forms of technology. Ultimately, institutions must be aware of emerging trends in AI and its relationship

to education and adapt their policies and practices to incorporate and responsibly develop new technologies and knowledge in the most efficient and productive way possible.

8.2.6 For researchers

To responsibly implement AI into early childhood education, we need to develop a longitudinal research agenda that evaluates how AI-mediated work integrated learning affects both teacher development and equity outcomes over time. We must also explore the potential for cross-cultural and multiple contextual uses of AI to ensure its applicability is as wide as possible across all educational contexts. Additionally, to address technology-driven bias in AI use and to allow for participatory oversight while ensuring fairness, accountability, and inclusion in AI deployment, we must establish robust ethics frameworks and governance structures (Berson et al., 2025).

8.3 Concluding Remarks

Integrating AI into early childhood teacher education presents both challenges and opportunities. When approached strategically, with equity, ethics, and relationality at the forefront, AI can enhance reflective practice, mentoring, and innovative practices through WIL. However, in the absence of thoughtful strategies, AI risks exacerbating existing discrepancies and ethical blind spots (Ngcobo & Mpofu, 2024). This chapter provides a theoretical and empirical foundation for AI integration, a conceptual framework (RAIIF) for operationalisation, and strategic recommendations for diverse stakeholders. Overall, the chapter underscores the importance of bridging AI, equity, and innovation to cultivate responsible, inclusive, and transformative ecosystems in teacher education.

This chapter is limited by its small sample size and its focus on a single province in Zimbabwe. The findings are not intended to be statistically generalisable but rather to offer contextualised insights and a transferable conceptual framework. Furthermore, the rapid advancement of AI technologies means that the specific tools discussed may become obsolete; nonetheless, the principles of the RAIIF are expected to remain relevant in the future and promote the implementation of innovations.

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