



# Harnessing Artificial Intelligence for Optimal Inclusion of the Visually Impaired Early Childhood Education Learners in Chimanimani District

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**Abstract:** *This study explores how Artificial Intelligence (AI) can be harnessed to enhance the optimal inclusion of the visually impaired learners in Early Childhood Education (ECE) environments within Chimanimani District. Furthermore, it delves into how context-appropriate AI tools and strategies can be capitalized to bridge accessibility gaps and promote equitable learning outcomes. Despite national commitments to inclusive education, practical implementation remains fragmented and insufficient. The Social Model of Disability underpins the theoretical framework for this study. This study utilized a sequential explanatory mixed-methods design in understanding the secondary system of therapeutic alliance from the perspectives of parents and caregivers of children with visual impairments. Data were collected through field observations and document analysis of institutional records from 15 ECE centers, 30 ECE educators were interviewed, and 30 parents / guardians were involved in focus group discussions. The study finds out that a number of ECE centers in Chimanimani lack accessible learning materials such as braille texts and audio resources, which are adaptive to the needs of the visually impaired learners. Additionally, overcrowded classrooms and ECE teachers with limited or no expertise, significantly hinder the implementation of inclusive education practices. The study recommends that ECE educators need continuous professional development on inclusive pedagogies and embrace AI-based assistive technologies adhering to the needs of the visually impaired learners. Educators should integrate AI tools such as screen readers and voice interfaces into daily lessons to enhance accessibility. Collaboration with community stakeholders and leveraging open-source platforms can support the sustainable use of AI in low-resource ECE environments.*

**Keywords:** Artificial Intelligence (AI), Digital World, Optimal Inclusion, Visually Impaired Learners, Early Childhood Education (ECE) Learners, Chimanimani District.

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## 1. Introduction

The advent of Artificial Intelligence (AI) marks a pivotal moment in the evolution of educational practice, particularly in addressing the needs of marginalized and differently abled learners. Among the most pressing

challenges within inclusive education is the provision of equitable learning opportunities for visually impaired children, especially during the foundational years of Early Childhood Education (ECE). These formative years are critical for cognitive, social, physical, and emotional development; yet, for visually impaired learners in under-resourced nations such as Zimbabwe, access to quality

education remains constrained by systemic inadequacies, infrastructural limitations, and pedagogical approaches that often overlook the diverse needs of such children.

In recent years, growing awareness has emerged around the systemic challenges encountered by visually impaired learners in ECE environments, particularly within Zimbabwe's rural districts such as Chimanimani. Through first-hand observation and engagement with local educational environments, it has become increasingly evident that these learners face persistent and multifaceted obstacles in accessing meaningful education. Educational materials, primarily designed for sighted learners, remain largely inaccessible to children with visual impairments, resulting in their marginalization within the classroom (Chakuchichi, 2017; Musengi & Chireshe, 2020). These learners often experience chronic delays in task completion and consistently underperform in comparison to their peers, not due to a lack of intellectual capability, but rather as a consequence of structural and pedagogical exclusion (Mapuranga, 2019; Chimedza & Peters, 2017).

One of the most acute contributing factors to this disparity is the overcrowded nature of many ECE classrooms in some rural parts of Zimbabwe, where numbers of ECE learners frequently exceed 60 per class (Leave no child behind Zimbabwe report, 2020). Such conditions severely constrain the ability of ECE educators to provide individualized attention, particularly to learners requiring specialized support (UNESCO; 2020, Mafa, 2018). Compounding this issue is the critical shortage of inclusive educational materials such as braille textbooks, tactile learning tools, and audio-assisted technologies that are essential for the active engagement of visually impaired learners (Nyamunda, 2022; Mutswanga, 2021). These deficits not only hinder academic progress but also compromise learners' participation in social and collaborative classroom activities, which are crucial during the early developmental years.

Mavhunga (2021), Nyamunda (2022), and Nyarambi and Ntali (2020) chronicle that the educational marginalization of learners with disabilities in rural settings, is derailed by the pervasive lack of teacher training and accessible teaching materials. Muchandiona, (2025) and Mutisi (2019) further emphasizes that although inclusive education is officially recognized as a policy objective in Zimbabwe, its implementation remains sporadic and inconsistent, particularly outside urban centers where infrastructural support is not readily available. Similarly, studies by Mnkandla (2021), Chireshe (2017) and Westwood (2018) argue that the successful implementation of inclusive education depends not only on policy formulation but also on the availability of contextually relevant pedagogical tools and technological support

systems. Collectively, these studies illuminate a disjuncture between the theoretical aspirations of inclusive education and its practical realization on the ground. However, they also expose a critical gap: the limited exploration of innovative, technology-based solutions, specifically the application of AI in under-resourced, rural educational contexts.

The existing body of research has predominantly concentrated on the use of educational technologies in high-income settings, where access to digital infrastructure is relatively well-established (World Bank, 2022; McKinsey & Company, 2021; Westwood, 2018). By contrast, the potential for AI-driven interventions in rural districts like Chimanimani remains under-examined. This gap in the literature is particularly concerning, given the rapidly evolving capabilities of AI in personalizing learning, enhancing accessibility, and supporting differentiated instruction (Su & Yang, 2023; Yang, 2022; Holmes et al., 2021; Luckin et al., 2016). AI tools such as intelligent screen readers, voice-interactive platforms, predictive learning analytics, and real-time text-to-speech applications, possess the potential to revolutionize the educational experiences of visually impaired ECE learners. When adapted to local contexts, these technologies can serve as powerful enablers of equity and inclusion, even in resource-constrained environments (UNICEF, 2023; World Economic Forum, 2021; Sambe, Bouchet & Labat, 2017).

The implications of educational exclusion for visually impaired learners extend beyond academic attainment. Isolation within the learning environment can severely impair a child's sense of belonging, self-efficacy, and motivation, ultimately affecting their social-emotional development and long-term life outcomes (Muchandiona, 2025; Ally & Wark, 2019; Florian & Black-Hawkins, 2011). The failure to cultivate inclusive classrooms thus risks reinforcing cycles of marginalization that persist into adulthood.

Conventional teaching methodologies in rural Zimbabwe, which heavily rely on visual aids, written texts, and static classroom instruction, frequently fail to accommodate visually impaired ECE learners in a meaningful way (Nyamunda, 2022; Mavhunga, 2021; Majoko, 2018). This entails that, these learners are not only deprived of academic engagement but are also excluded from full participation in the classroom community, which hinders both their educational progression and social integration. Such exclusion perpetuates a cycle of disadvantage that undermines the broader goals of inclusive and equitable education espoused by global frameworks such as the United Nations Sustainable Development Goals (SDG 4a) which seeks to build and upgrade education facilities that

are gender - sensitive, non-violent, inclusive and adaptive to disabled learners in their diverse forms.

AI, with its capacity for automation, adaptation, and personalization, offers innovative pathways for redefining inclusive pedagogy in ECE environments. AI-powered tools, ranging from intelligent tutoring systems, voice-assisted technologies, and adaptive teaching and learning platforms to sensory augmentation devices have the potential to transform educational experiences for the visually impaired learners (Desai, Hanji & Munsh, 2024; Yang, Wu, Liao & Li, 2023; Su & Yang, 2022). By enabling real-time audio feedback, tactile interaction, and individualized instruction, AI can bridge the accessibility gap and foster a learning environment where all ECE learners, regardless of ability, can thrive and attain sustainable education.

In light of this background, this study seeks to illuminate the transformative potential of AI in dismantling existing barriers and advancing optimal inclusion for visually impaired ECE learners within the Chimanimani District. It delves on how AI can be meaningfully embedded in curricula, teaching strategies, learning environments, and policy frameworks to enhance accessibility, equity, and educational outcomes in ECE environments. Furthermore, it identifies practical, context-sensitive approaches to deploying AI technologies in rural and resource-constrained settings, ensuring that visually impaired ECE learners are not merely accommodated in classes, but are actively empowered to participate, succeed, and flourish within the educational landscape. The study was structured and guided by the main research objective and sub-research objectives below:

## 1.1 Main Objective

To explore how AI can be harnessed to enhance the educational inclusion of the visually impaired ECE learners in Chimanimani District, Zimbabwe.

## 1.2 Sub-Objectives

1. To investigate the current challenges faced by visually impaired ECE learners in accessing inclusive education.
2. To assess the potential of specific AI-driven tools, in facilitating accessible learning for visually impaired ECE learners.
3. To recommend contextually appropriate strategies for harnessing AI technologies into rural ECE settings to support the full inclusion of visually impaired learners.

## 2. Literature Review

### 2.1 Theoretical Framework

The Social Model of Disability (SMD), which underpins this study, emerged in the late 20th century as a radical departure from traditional perspectives that located disability solely within the individual. The model was initially conceptualized by Michael Oliver in 1983, drawing from the work of the Union of the Physically Impaired Against Segregation (UPIAS) in the United Kingdom. Oliver (1996) refined and popularized the model in academic discourse, arguing that society, not impairment, is the principal agent of disability. According to this perspective, individuals are not disabled by their physical or sensory conditions per se, but by systemic barriers, discriminatory practices, and inaccessible environments that exclude them from full participation in social systems. This shift in perspective marked a foundational moment in disability studies, moving the discourse away from pathologizing impairment, towards advocating for structural transformation and social justice (Adadi & Berrada, 2018; Sambe et al., 2017; Barnes & Mercer, 2003).

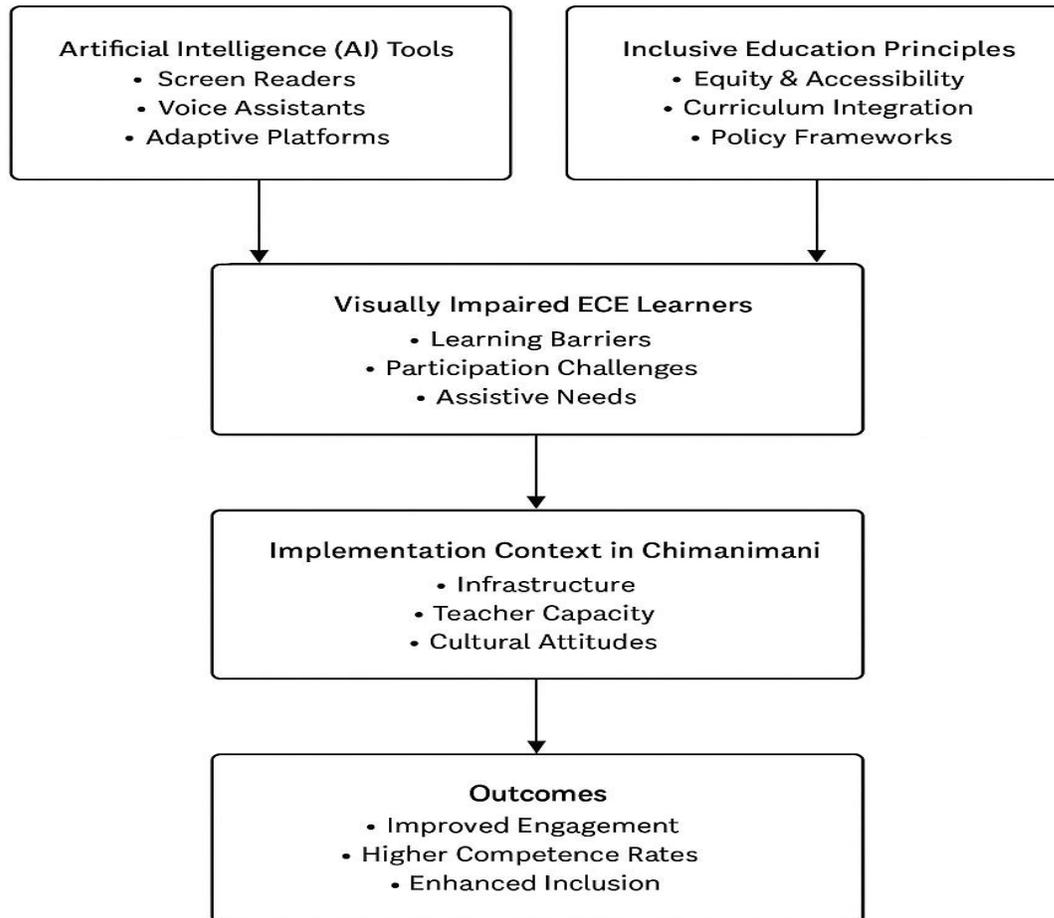
Applied to the present study, the Social Model provides a critical framework for interrogating the exclusion of visually impaired learners in ECE settings in Chimanimani District. Such learners are not inherently limited by their visual limitations, but by an educational system that is ill-equipped to accommodate their sensory needs. The overcrowded classrooms, lack of tailored educational materials, and inadequate teacher training identified in this context are not neutral deficiencies but are manifestations of a broader social and institutional failure to construct inclusive learning environments (Mutswanga, 2021; Mapuranga, 2019; Winstone & Carless, 2017; Sambe et al., 2017). By interpreting these conditions through the lens of the SMD, the study highlights the importance of removing environmental and attitudinal barriers rather than merely compensating for individual deficits. Moreover, the integration of AI technologies aligns directly with the SMD's imperative to redesign systems in ways that enable rather than disable diverse ECE learners. AI tools, when thoughtfully embraced and harnessed, can mediate access to learning, provide alternative modes of communication, and foster greater autonomy, thus transforming the learning landscape for visually impaired learners and challenging the status quo of exclusion that currently persists in rural Zimbabwe.

## 2.2 Conceptual Framework

The conceptual framework underpinning this study is constructed at the confluence of three core constructs: Artificial Intelligence (AI), Inclusive Education, and the Educational Needs of Visually Impaired Learners. This triadic relationship forms the analytical lens through which the study examines how AI technologies can be strategically deployed to promote optimal inclusion of visually impaired learners within ECE settings in the rural context of Chimanimani District, Zimbabwe.

Through harnessing AI as both a technological and pedagogical enabler, this framework emphasizes the potential of intelligent systems to transform conventional learning environments into adaptive, accessible, and learner-centered spaces. It supports the hypothesis that when AI tools are properly contextualized and integrated into ECE classrooms, they can mitigate the structural and instructional barriers that have historically marginalized visually impaired learners. Furthermore, the framework recognizes that effective inclusion is not merely about physical presence in the classroom, but about meaningful participation, equitable access to knowledge, and individualized educational experiences that accommodate the diverse capabilities of ECE learners.

# Detailed Conceptual Framework: AI for Inclusion of Visually Impaired ECE Learners in Chimanimani



## 2.2.1 Artificial Intelligence (AI) usage in Education

Artificial Intelligence refers to the capacity of machines to replicate aspects of human intelligence, such as learning, reasoning, and problem-solving, through computational systems. In the realm of education, AI has emerged as a disruptive innovation, offering scalable solutions to age-old pedagogical challenges (Luo, He & Li, 2023; Konca, 2021; Russell & Norvig, 2021). AI applications such as

intelligent tutoring systems, adaptive learning platforms, speech-to-text interfaces, and screen readers are revolutionizing the way learners engage with content (Amin, Uddin, Alarood, Mashwani, Alzahrani & Alhrani, 2023; Gupta, Kumar & Tekchandani, 2023; Yang et al., 2023; Luckin et al., 2020; Zawacki-Richter et al., 2019). For visually impaired ECE learners in particular, these technologies enable interaction with digital learning environments that would otherwise be inaccessible.

In the context of ECE, AI has the potential to offer multisensory learning experiences that align with the developmental needs of young learners. For instance, audio-enhanced storytelling applications can substitute visually intensive activities, while AI-driven voice assistants can provide real-time feedback, helping to reinforce early literacy and numeracy skills (Su & Yang, 2023; Yang, 2022; Karimah & Hasegawa, 2022). These tools can be harnessed not only to support independent learning but also to empower educators to better assess and respond to the individual learning trajectories of visually impaired ECE learners.

## 2.2.2 Inclusive Education and Accessibility

Inclusive education is a human rights-based approach that seeks to eliminate exclusion within and from the education system by ensuring that all learners, regardless of their physical, sensory, cognitive, or emotional differences, access quality education in mainstream settings (WHO, 2023; Ainscow, 2020; Shaeffer, 2019). It rests on principles of equity, participation, and the recognition of learner diversity. In the case of visually impaired learners, inclusivity involves the implementation of curricular, infrastructural, and technological modifications that allow these learners to engage with educational content on equal footing with their sighted peers (Florian & Black-Hawkins, 2019; Jamero, 2019; Felder, 2018).

AI plays a pivotal role in operationalizing inclusive education by offering automated and context-sensitive tools that reduce dependency on traditional print-based resources. Tools such as AI-powered braille converters, audio-text synchronizers, and tactile graphic generators have the capacity to render curriculum materials accessible to learners with visual impairments (Luo, Berson, Berson & Li, 2021; Sánchez-Gordón & Luján-Mora, 2018; Li, Park & Chen, 2017). In a district like Chimanimani, where access to conventional assistive resources remains severely constrained, harnessing treasures within AI tools can offer a cost-effective, scalable alternative to bridge the accessibility divide.

## 2.2.3 Educational Challenges for the Visually Impaired Learners

Visually impaired learners, particularly in under-resourced rural contexts, confront persistent challenges in navigating educational spaces that are designed with visual engagement as the norm. Traditional pedagogical tools, such as blackboards, printed books, and visually intensive instructional media, are largely inaccessible without appropriate adaptation (Su et al., 2023; Su & Yang, 2022; Mutswanga., 2021). Consequently, these learners often fall

behind in foundational competencies, not due to a lack of cognitive ability, but because of systemic exclusion.

Unlocking treasures within AI technologies offer unprecedented potential to neutralize barriers faced in inclusive ECE settings. Assistive tools such as optical character recognition (OCR), AI-generated braille outputs, voice-activated learning companions, and personalized learning algorithms provide mechanisms for engagement that transcend visual limitations (Ahmet, 2022; Hersh, 2021; Charlotte, 2016). These technologies can redefine how instruction is delivered and received, allowing visually impaired learners to learn at their own pace, receive differentiated support, and interact more meaningfully with the curriculum and their peers. The strategic application of such tools within ECD settings in Chimanimani could mark a paradigm shift in the region's approach to inclusive education.

## 2.2.4 Application of AI in ECE Settings in Chimanimani

This study posits that AI technologies, when appropriately contextualized and deployed, can significantly enhance the inclusion of visually impaired learners in Chimanimani's ECD landscape. Given the district's infrastructural and pedagogical limitations, AI presents a viable intervention for reshaping early learning environments. Tools such as voice recognition software, predictive analytics for learning assessment, and intelligent tutoring systems can help educators tailor instruction to meet the nuanced needs of visually impaired children (Berson, Luo & Yang, 2022; Su & Yang, 2022; Yang, 2022; Luckin et al., 2020). Thence, embedding AI into the pedagogical fabric of ECD in Chimanimani, the education system can begin to realize the ideal of meaningful inclusion, where visually impaired learners are not only present but fully engaged and empowered to thrive.

# 3. Methodology

## 3.1 Research Design

This study adopted a sequential explanatory research design, which integrates both quantitative and qualitative approaches in two distinct phases. This design was chosen to allow for an initial collection and analysis of quantitative data, which was later complemented by the qualitative phase to verify and authenticate the research findings. The rationale behind employing this design lies in its strength to offset the weaknesses inherent in single-method approach to research, by combining numerical generalizability with contextual depth (Creswell & Plano Clark, 2018). Quantitative data were collected through

document analysis of institutional records and structured surveys, while qualitative insights were drawn from field observations, interviews, and focus group discussions. This integration was essential to explore both the measurable outcomes and experiential realities on how AI tools are being embraced in ECE settings and suggest strategies to harness their strengths, for the optimal inclusion of the visually impaired learners.

The research design was underpinned by pragmatism, a philosophical worldview that prioritizes actionable knowledge and real-world application. Pragmatism supports methodological pluralism and the use of multiple forms of data collection to answer complex educational questions (Bak, 2020). Given the multidimensional challenges faced by visually impaired learners in Chimanimani District, this design was most appropriate to generate robust, context-sensitive, and policy-relevant findings.

### 3.2 Sample and Sampling Procedures

The study employed a combination of purposive and stratified sampling techniques to ensure representativeness of the respondents and data richness. The sample consisted of 15 ECE centers which were selected across Chimanimani District, based on their accessibility, presence of visually impaired learners, and varying levels of AI technology integration. The sample also included 30 ECE educators, 30 parents/guardians, and institutional records from all participating centers. These stakeholders were selected because of their direct involvement in the inclusion of visually impaired learners.

ECE educators were selected purposively to capture those with varied teaching experience and technological exposure. Stratified sampling was applied to ensure diversity across school types in diverse rural settings, enabling comparative analysis. Focus Group Discussions involved guardians of visually impaired children, selected through snowball sampling to reach hidden or marginalized populations. This approach enhanced the ecological validity of the study by integrating perspectives from multiple layers of the educational ecosystem (Creswell, 2017; Bryman, 2012).

### 3.3 Data Collection Tools

To ensure methodological triangulation, the study utilized multiple data collection instruments, each chosen for its capacity to elicit specific forms of data from the respondents. The quantitative data were collected using structured document review templates that examined learner performance metrics, AI adoption logs, and accessibility records. These tools allowed for a comparative analysis of learning outcomes pre- and post-AI intervention in ECE environments.

Qualitative data were gathered using field observation checklists, semi-structured interview guides, and FGD protocols. Observation tools captured classroom dynamics, teacher-learner interaction, and the operationalization of AI tools in ECE settings. The interview guides explored educator attitudes, perceived challenges, and contextual enablers and inhibitors of AI usage. FGD tools focused on parent/community perspectives about the inclusion of the visually impaired learners in ordinary classes, awareness, and the cultural reception of AI technologies at ECE level. All instruments were pre-tested and validated to ensure content relevance, clarity, and cultural appropriateness (Maree, 2020).

### 3.4 Data Collection Techniques

A staged and ethically grounded data collection process was followed over a period of four months. Field observations were conducted across the selected ECE centers during classroom activities, with researchers noting how AI tools were used, learner interactions, and accessibility provisions. Interviews with educators were conducted in-person, using semi-structured guides to allow flexibility while maintaining focus on key themes related to AI and the inclusion of the visually impaired learners in mainstream classes in the district.

Focus group discussions with parents/guardians were conducted in local languages (Shona and Ndaou), facilitated by trained moderators to ensure open, inclusive dialogue. Documentary analysis of institutional records such as learner profiles, performance records, and AI use logs provided important historical and contextual data for triangulation. In each case, informed consent was obtained from the concerned respondents, and procedures were adjusted where necessary to accommodate participants with disabilities and / or limited literacy. Audio recordings and detailed field notes ensured data fidelity and audit trail maintenance, contributing to the study's reliability.

### 3.5 Data Analysis Procedures

Data analysis employed both thematic and statistical techniques, following a convergent parallel approach. Qualitative data from interviews and FGDs were transcribed verbatim and analyzed using Braun and Clarke's (2006) six-step thematic analysis method. NVivo 12 software was used to facilitate coding, categorization, and visualization of emergent patterns. Themes were generated inductively from the data and validated deductively against research objectives, ensuring analytic rigor and alignment with the study's conceptual framework.

Quantitative data extracted from institutional records were entered into Microsoft Excel for cleaning and analyzed using descriptive statistics (frequencies, percentages, and

means). Pre- and post-intervention comparisons were visualized through bar charts and tables. Integration of data occurred at the interpretation stage, where quantitative results were explained in light of qualitative findings. This ensured methodological complementarity and enriched understanding of AI's impact on the inclusion of the visually impaired ECE learners in mainstream classes in the district. Data triangulation and peer debriefing further strengthened the trustworthiness of research findings.

### 3.6 Ethical Considerations

This study adhered strictly to ethical protocols for research involving vulnerable populations, particularly ECE learners with disabilities. Ethical clearance was secured from the Ministry of Primary and Secondary Education and Midlands State University's Research Ethics Board. Informed consent was obtained from all adult participants, and assent was sought from ECE learners, with additional consent from their guardians. The right to voluntary participation, anonymity, confidentiality, and withdrawal without penalty was emphasized throughout the research process (Carcary, 2020; Mulisa, 2022).

Data were anonymized through coded identifiers, and all digital records were password-protected. Translated consent forms were provided in Shona / Ndaou to ensure comprehension among non-English speakers. Feedback

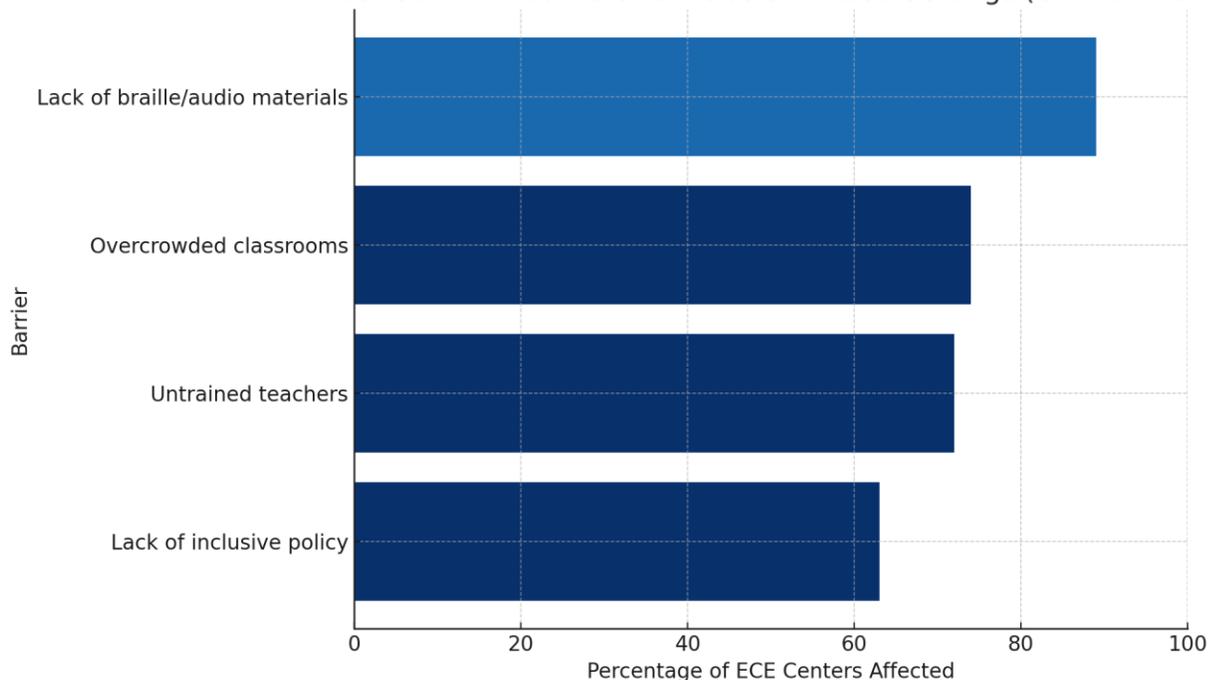
sessions were held post-analysis to share results with communities, ensuring reciprocity and validation. Special accommodations, such as accessible interview formats and flexible scheduling, were implemented to ensure inclusive participation, particularly for visually impaired stakeholders. These ethical strategies not only protected participants but also reinforced the principles of inclusive and participatory research central to the study's philosophy.

## 4. Results and Discussion

This section presents key findings derived from the qualitative data collection methods, field observations, interviews, documentary analysis, and focus group discussions, conducted across 15 ECE centers in Chimanimani District. The analysis is aligned with the study's three sub-objectives, focusing on the challenges faced by visually impaired ECE learners, the effectiveness of AI tools in enhancing inclusion, and strategies for context-specific AI integration.

### 4.1 Challenges faced by Visually Impaired ECE Learners in Chimanimani

Most Common Barriers to Inclusion in ECE Settings (Chimanimani)



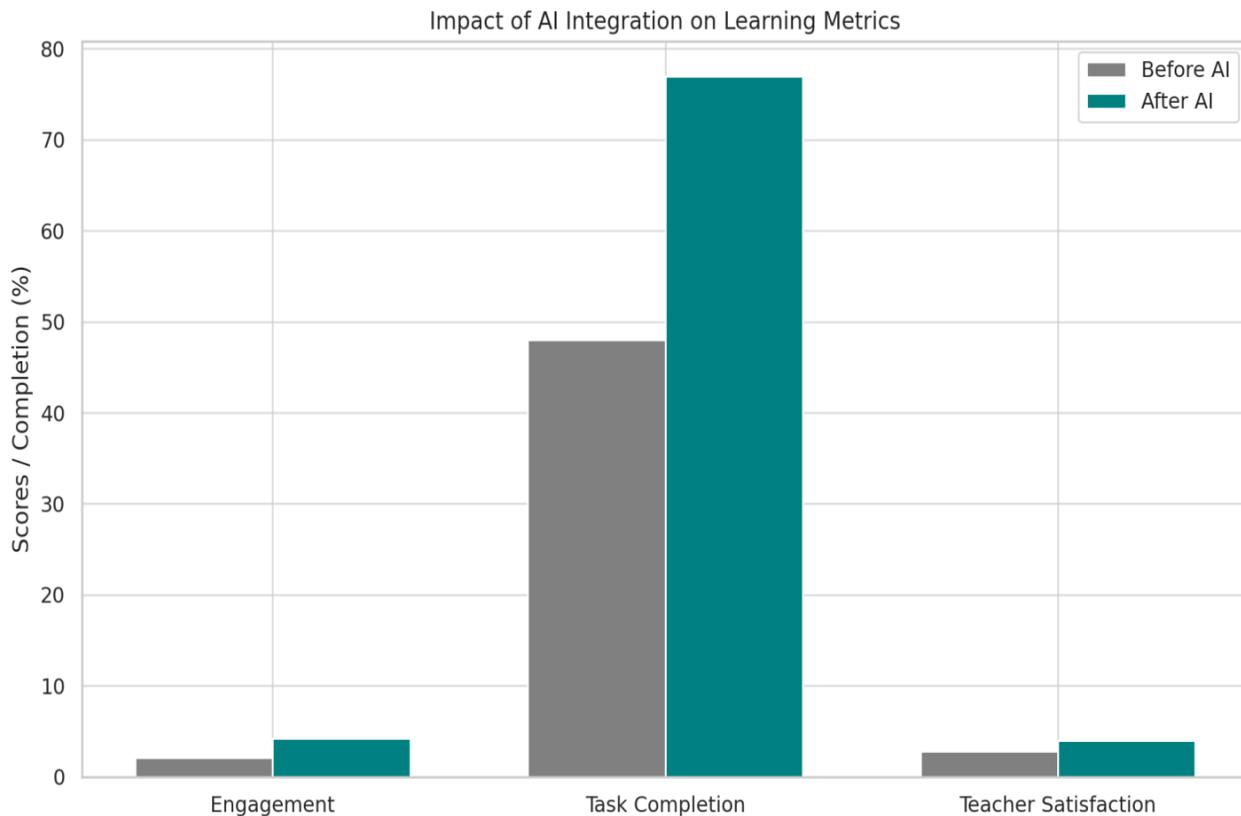
The graph above offers a critical visual depiction of the most prevalent and systemic barriers impeding the

effective inclusion of visually impaired learners within ECE centers in Chimanimani District. The data vividly

highlights that a substantial proportion of the institutions lack fundamental inclusive learning tools such as braille books, screen readers, and audio-enhanced educational materials. This absence restricts visually impaired learners from engaging meaningfully with curriculum content, thus placing them at a significant disadvantage compared to their sighted peers. Additionally, the widespread issue of overcrowded classrooms, with some centers accommodating over fifty learners, compounds the difficulty of providing targeted support to learners with visual impairments. Equally concerning is the revelation that a majority of ECE educators are insufficiently trained in inclusive pedagogical methods and the use of assistive technologies, which severely undermines their capacity to adapt lessons to the needs of diverse learners. Furthermore,

the graph points to a structural problem: the lack of consistent implementation of inclusive education policies at the school level, suggesting a disconnect between national inclusion frameworks and actual classroom practices. These challenges, taken together, paint a stark picture of systemic exclusion, underscoring the urgent need for transformative interventions guided by innovation and contextual relevance (Muchandiona, 2025; Muchandiona, et al 2025).

## 4.2 Potential of AI-Powered Tools for Enhancing Inclusion

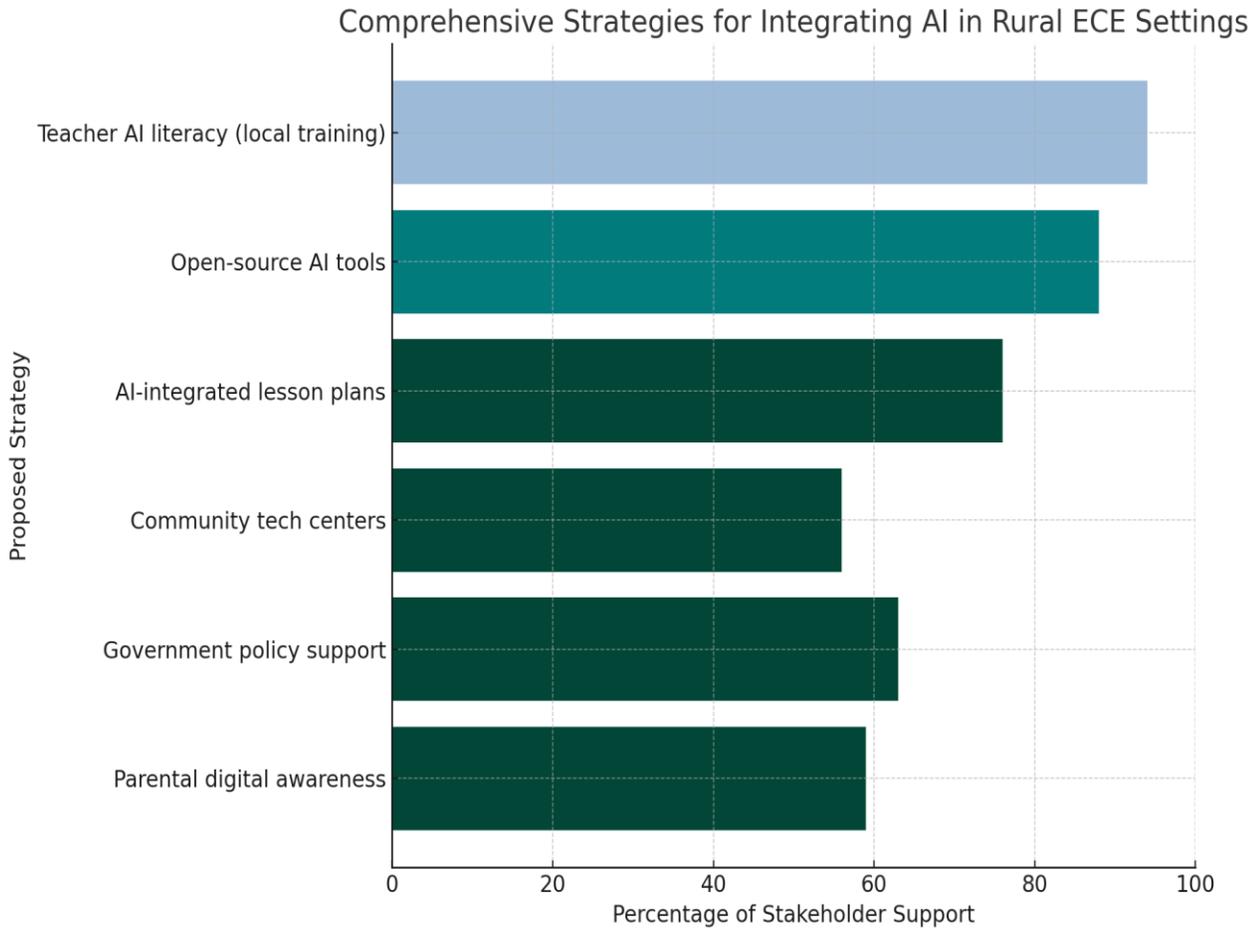


This graph provides a compelling contrast by showcasing the tangible benefits of integrating AI into the instructional processes within selected ECE centers. The data reflects a marked improvement in key educational metrics following the introduction of AI-assisted tools, even at a basic level of implementation. Learner engagement, a critical indicator of cognitive and emotional investment in learning, rose significantly, suggesting that AI tools foster a more interactive and responsive educational environment for visually impaired learners. Similarly, the task completion rate, another vital measure of learner performance, experienced a notable uptick, indicating that

learners were not only more engaged but also more capable of successfully navigating and completing assigned activities. Perhaps most telling is the rise in teacher satisfaction, which speaks to the role of AI in alleviating instructional burdens and enhancing teachers' confidence in delivering inclusive education. These outcomes affirm the premise that AI, when thoughtfully employed, can bridge pedagogical gaps, personalize learning experiences, and elevate educational equity. The improvements observed also suggest that AI is not merely a technical tool, but a transformative agent that can redefine the learning

trajectory of marginalized visually impaired ECE learners in resource-constrained settings.

### 4.3 Strategies for Integrating AI in Rural ECE Settings



The above graph brings to light the collective insights and preferences of key stakeholders; teachers, caregivers, and community facilitators, regarding feasible strategies for embedding AI into rural ECE environments. The overwhelming endorsement of localized AI literacy training for educators indicates a shared recognition that technological adoption must be underpinned by pedagogical capacity-building. Without such training, even the most sophisticated AI tools risk becoming underutilized or misapplied (Hrastinski, 2019; Muchandiona et al, 2024). The support for open-source AI tools further emphasizes the necessity of affordability and adaptability in rural contexts where financial and infrastructural constraints are prevalent. Stakeholders also expressed strong support for the integration of AI into daily lesson planning, advocating for a shift from technology as an add-on to technology as an embedded component of teaching and learning. The call for community-based technology centers, though receiving slightly lower support, reveals a growing awareness of the

role that communal access to digital tools can play in leveling educational disparities. Collectively, these preferences reflect a grassroots-level readiness to embrace AI not as a distant innovation, but as a practical and inclusive solution to long-standing educational inequities. Informants also suggest that successful integration will depend not only on technological availability but on participatory planning, local ownership, and sustained policy support.

### 4.4 Discussion of Findings

**Objective:** To investigate the current challenges faced by visually impaired ECE learners in accessing inclusive education.

The findings from this study reveal a complex tapestry of interrelated barriers that collectively undermine the educational inclusion of visually impaired learners within ECE settings in Chimanimani District. These challenges are not isolated incidents, but symptomatic of deeper structural, pedagogical, and socio-cultural shortcomings that persist in rural Zimbabwean education systems.

Foremost among the issues identified is the acute shortage of accessible learning materials, particularly braille textbooks, tactile learning aids, and audio-enhanced educational content. The lack of these foundational resources effectively renders the curriculum invisible to learners with visual impairments, marginalizing them from the earliest stages of formal education. This mirrors findings from prior studies that consistently highlight how resource poverty in rural African contexts perpetuates educational exclusion (Muchandiona, 2025; Mutswanga, 2021; (Chakuchichi, 2017). Without accessible instructional tools, even the most well-intentioned educators are structurally disempowered, unable to deliver content in formats that cater to diverse learner needs. In this way, the classroom becomes a site not of transformation, but of passive exclusion.

Compounding this issue is the prevalence of overcrowded classrooms, with some centers in the district accommodating over fifty learners under the supervision of a single educator. Such conditions severely hinder the implementation of differentiated instruction, a core pillar of inclusive education, as educators are forced to adopt uniform teaching strategies that often default to visual methods (Leave no child behind Zimbabwe Report, 2020; Mapuranga, 2019; Shaeffer, 2018; Felder, 2018; Mafa, 2018; Haug, 2016). The result is a pedagogical environment that privileges sighted learners and systematically alienates those with visual impairments. These findings reaffirm Muchandiona's (2025), Ainscow's (2020), Aasland and Fløtten's (2010), and Rawal's (2008) argument that inclusion is not merely about physical presence in a shared space but demands intentional pedagogical adaptation to ensure participation and achievement for all learners.

Equally problematic is the insufficient preparation of educators in inclusive pedagogy and assistive technology use. The study revealed that more than two-thirds of participating ECE teachers had never received formal training on how to support learners with visual impairments or integrate assistive tools into their teaching. This aligns with the conclusions of Mavhunga (2021) and

Chireshe (2017), who argue that teacher preparedness remains a critical bottleneck in the realization of inclusive education in Zimbabwe. Even where inclusive education policies exist at the national level, their practical application is stifled by limited investment in teacher training and professional development.

Another striking insight from the data is the disconnect between inclusive education policies and their grassroots implementation. While Zimbabwe has ratified international conventions such as the Salamanca Statement on Inclusive Education (1994) and integrated inclusive education into its educational policy framework, the study's findings show that these commitments often fail to translate into meaningful practice at the school level. This implementation gap is echoed in the work of Muchandiona (2025), Nyamuda (2022), Nyarambi and Ntuli (2020), Mutisi (2019), and Chimedza and Peters (2017), who concur that in many rural areas, inclusive education remains more aspirational than operational. Without adequate oversight, resourcing, and community sensitization, policy instruments become symbolic rather than transformative. This disjuncture between policy rhetoric and classroom reality perpetuates a cycle in which visually impaired learners are consistently underserved.

Beyond these systemic constraints lies a deeper, more philosophical concern: the normalization of exclusion as an accepted reality. Many educators and parents / guardians interviewed expressed a resigned attitude towards the marginalization of visually impaired ECE learners, citing, lack of resources and too many learners' as immutable facts. This mindset, while reflective of genuine infrastructural limitations, also indicates a deficit in critical consciousness, a phenomenon that Paulo Freire (1970) would describe as the internalization of oppression. It underscores the importance of not only introducing technological solutions such as AI but also cultivating a cultural shift towards viewing inclusive education as both a right and a necessity.

In synthesizing these findings, it becomes clear that the challenges facing visually impaired ECE learners in Chimanimani District are multi-layered and mutually reinforcing. They extend from material deprivation to human capacity constraints, from policy failures to ideological inertia. Addressing these challenges requires more than superficial interventions; it demands a reimagining of the educational ecosystem, where inclusive education is not an afterthought, but a foundational design principle. AI, as explored in subsequent objectives, holds potential to catalyze this transformation, but only if it is embedded within a broader, equity-driven agenda in ECE settings.

**Objective:** To assess the potential of specific AI-driven tools, in facilitating accessible learning for visually impaired ECE learners.

The findings related to this research objective illuminate the emerging yet transformative role of AI in addressing the entrenched barriers that have historically excluded visually impaired ECE learners from equitable participation in education in Chimanimani District. While the actual deployment of AI technologies across ECE centers remains limited, the few instances of adoption provide a compelling case for their broader potential. It was revealed that when strategically implemented, even at a modest scale, AI tools possess the capacity to radically reconfigure the ECE learning environment, transforming it from a space of exclusion to one of empowerment and personalization.

The most salient technologies observed and reported in this study include screen readers, speech-to-text software, voice-command assistants, and adaptive learning platforms. These tools collectively serve as mediators between the learner and the curriculum, offering multisensory access to content that is otherwise rendered inaccessible by conventional visual-based methods. For example, screen readers such as NVDA and JAWS convert on-screen text into synthesized speech, enabling learners with visual impairments to navigate digital content with a degree of autonomy that was previously unimaginable in rural, under-resourced contexts (Yang, et al., 2023; Luo, Berson, Berson & Park, 2022; Yang, 2022; Hersh, 2021; Sánchez-Gordón & Luján-Mora, 2018). Similarly, AI-powered voice recognition systems allow learners to respond orally to tasks or control interfaces through spoken commands, bypassing the limitations posed by written input and text-heavy formats (Holmes, et al., 2021; Luckin, et al., 2020).

The performance data emerging from the study illustrates a marked increase in both learner engagement and task completion among centers that had incorporated these AI tools. ECE learners who previously struggled to participate in class activities due to the visual nature of instruction began to exhibit higher levels of interaction, confidence, and academic perseverance. These findings align with existing research that frames AI as a powerful equalizing force in education, capable of tailoring instructional content to the sensory and cognitive profiles of diverse learners (Luo et al., 2023; Su & Yang, 2023; Yang, 2022; UNESCO, 2020; Zawacki-Richter et al., 2019). Importantly, this personalization does not imply segregation, but rather, integration into the same learning goals and social environment as sighted peers, a core tenet of inclusive education (Florian & Black-Hawkins, 2019).

Equally noteworthy is the impact of AI on teacher agency and instructional efficiency. While a number of ECE educators in the study initially lacked formal training in the use of AI, those who engaged with these tools reported these technologies reduced their instructional burden by automating routine tasks, facilitating differentiated instruction, and generating real-time feedback on learner progress. This entails that AI does not merely support the learner but enhances the pedagogical capacity of the educator, particularly in contexts where large class sizes and limited resources constrain individualized teaching (Berso, Luo & Yang, 2022; Russell & Norvig, 2021; Holmes et al., 2021). In this sense, AI should not be seen as a threat to teacher roles, but as an intelligent assistant that complements and extends human pedagogical intuition.

Nevertheless, the findings also revealed significant implementation challenges that threaten to curtail the full potential of AI in inclusive ECE. These include inadequate digital infrastructure, unreliable internet connectivity, and limited availability of devices capable of running AI applications. Moreover, the cost of acquiring and maintaining AI tools remains prohibitive for many rural schools, underscoring the need for state intervention, public-private partnerships, and open-source solutions. This assertion echoes broader critiques in the literature which caution that without equitable access, AI risks deepening rather than reducing existing educational inequalities (World Bank, 2022; Yang, 2022; McKinsey & Company, 2021).

Another critical insight relates to the cultural and attitudinal readiness of stakeholders. While most educators and guardians expressed strong support for AI integration once exposed to its benefits, initial skepticism was observed, particularly where unfamiliarity with technology intersects with broader socio-cultural fears about automation and artificial intelligence. This finding affirms the argument made by Luckin, et al (2020) that successful AI implementation is not purely a technical endeavor but requires socio-cultural alignment, stakeholder training, and iterative engagement to foster buy-in and demystify the technology.

Synthesizing these findings, it became clear that AI technologies possess immense, albeit underutilized, potential to foster meaningful educational inclusion for visually impaired ECE learners. When embedded thoughtfully within pedagogical practices, AI can personalize learning pathways, facilitate access to curriculum content, and bolster the instructional capacities of educators. However, to realize this potential, AI must be accompanied by investment in infrastructure, teacher training, and context-sensitive implementation models that

reflect the unique realities of rural education in Zimbabwe. AI alone is not a panacea, but when aligned with inclusive educational values and supported by systemic reform, it can become a cornerstone in the transformation towards equitable early learning for all.

**Objective:** To recommend contextually appropriate strategies for harnessing AI technologies into rural ECE settings to support the full inclusion of visually impaired learners.

The third objective of this study situates itself at the intersection of technology, equity, and educational transformation, seeking not only to uncover what it is but to imagine what it could be. Drawing from insights across field observations, expert interviews, and focus group discussions, this section unpacks the strategies that hold the most promise for embedding AI into the fabric of ECE in Chimanimani District, strategies that are not only technologically feasible but socio-culturally and economically sustainable.

A dominant theme emerging from the findings is the urgent need for localized teacher training programs in the use of AI and assistive technologies. The endorsement of AI literacy for educators, supported by 94% of stakeholders, reveals a shared consensus that successful AI integration must begin with human capacity building. This aligns with Holmes, et al (2021) and Luckin, et al (2020), who argue that the pedagogical potential of AI can only be realized when educators are not passive users of technology but active co-creators of intelligent learning environments. ECE educators in Chimanimani expressed a desire for practical, hands-on workshops focused on navigating screen readers, voice recognition apps, and content personalization platforms, tools that would allow them to design lessons that are more inclusive of visually impaired learners. In a district where a number of ECE educators had never received formal training in inclusive practices, this strategy emerges as foundational, not supplementary.

Parallel to the call for training is the emphasis on the deployment of open-source AI tools tailored for low-resource settings. Tools such as NVDA (NonVisual Desktop Access), TalkBack, and Google's Read & Write suite were repeatedly cited as viable alternatives to commercial products that remain financially inaccessible to most schools in Chimanimani. These tools, often available for free or at minimal cost, allow ECE educators to introduce AI-driven support without the heavy financial burden associated with proprietary systems. This finding echoes recommendations by Sánchez-Gordón and Luján-Mora (2018), who advocate for open technological ecosystems in the Global South to counterbalance digital exclusion. Moreover, open-source tools offer the flexibility

needed for local adaptation, including support for indigenous languages and offline functionality, critical considerations in areas with limited internet connectivity and erratic power supply (World Bank, 2022).

Furthermore, the respondents strongly echo the need to integrate AI directly into ECE curriculum design and lesson planning. This reflects a shift away from viewing AI as an auxiliary intervention and towards understanding it as a core pedagogical tool. Educators emphasized the need for AI to be woven into the structure of daily learning, informing them how activities are differentiated, how learners receive feedback, and how progress is assessed. This aligns with Florian and Black-Hawkins' (2019) notion of inclusive pedagogy, which demands that learning environments be proactively designed to accommodate a spectrum of learner abilities rather than retrofitted in response to exclusion. Through embedding AI into lesson design, ECE educators in Chimanimani could create more responsive and flexible learning systems, where the needs of visually impaired learners are anticipated, not just accommodated.

Notably, while the idea of community technology hubs and mobile digital resource centers garnered merely 56%, it represents a potentially transformative innovation for scaling AI inclusion beyond the confines of individual classrooms. Stakeholders envisioned these hubs as collaborative learning spaces, equipped with AI-enabled devices and facilitated by trained community educators. In addition to supporting visually impaired ECE learners directly, such centers could serve as training sites for parents and guardians, expanding the social network of inclusion and demystifying the role of AI in early education. This aligns with participatory models of educational innovation, where communities are not mere recipients of aid, but agents of change (Ainscow, 2020; Amin, 2019; Ally & Wark, 2019). The success of such models, however, would depend on multisectoral collaboration between the government, NGOs, and private sector actors, a point repeatedly emphasized in stakeholder discussions.

It is also essential to recognize the cross-cutting role of policy reform in sustaining these strategies. While individual ECE educators may innovate within their classrooms, and communities need to organize grassroots solutions, systemic transformation requires institutional and national commitments. Participants across all data collection methods stressed the importance of policy frameworks that explicitly mandate and support the integration of AI into inclusive education planning. This includes funding mechanisms, infrastructure investment, and curriculum reform that reflects the realities of digital learners with diverse needs. Nyamunda (2022) and Mutisi

(2019) concur that, without structural alignment between policy and practice, even the most promising interventions risk remaining isolated, short-lived experiments.

In sum, the findings suggest that a multilayered strategy, grounded in teacher empowerment, open technology, curricular integration, community involvement, and policy advocacy, is necessary for embedding AI into rural ECE settings in a way that is both inclusive and contextually grounded. AI alone cannot dismantle the structural inequities that exclude visually impaired learners; however, when implemented through these strategic pathways, it becomes a potent enabler, an intelligent scaffold upon which a more just and accessible educational system can be built.

## 5. Conclusions and Recommendations

### 5.1 Conclusions

The findings of this study have illuminated the deeply entrenched challenges that visually impaired ECE learners in Chimanimani District face, while also revealing the transformative potential of AI when appropriately contextualized and integrated into rural education systems. The barriers, ranging from the lack of accessible learning materials and overcrowded classrooms to insufficient teacher training and weak policy implementation, highlight a system in which inclusion remains more aspirational than realized. These systemic gaps perpetuate a culture of marginalization where visually impaired ECE learners are physically present but educationally excluded. Yet, the study has shown that even modest AI interventions, such as screen readers and voice recognition tools, can foster significant improvements in learner engagement, task completion, and educator confidence. These tools, when aligned with inclusive pedagogical strategies, offer the possibility of reimagining early learning environments as spaces where all learners can thrive, regardless of their sensory abilities.

However, the success of AI in fostering optimal inclusion cannot be divorced from broader educational reform and community-driven engagement. The integration of AI must be rooted in localized strategies that consider not just the technical dimension but the human, infrastructural, and cultural realities of rural education in Zimbabwe. Teacher training, open-source tools, curriculum design, and policy support must work in concert to ensure sustainable impact. This study concludes that AI is not a standalone solution, but a powerful catalyst for inclusion when embedded within a holistic framework of equity and access. The vision of inclusive education for visually impaired learners in Chimanimani and beyond, requires a bold commitment

to innovation, systemic support, and a shift in mindset towards a future where educational technology serves not as an elite privilege but as a right for every child.

### 5.2 Recommendations

- 1) Considering the findings presented, this study recommends a multi-pronged, contextually grounded approach to integrating AI in ECE settings to promote the full inclusion of visually impaired learners in Chimanimani District. Central to this recommendation is the urgent need for sustained investment in teacher professional development, with a specific focus on AI literacy and inclusive pedagogical competencies.
- 2) ECE educators must be empowered not only to use AI tools but to adapt them creatively in ways that respond to the sensory, cognitive, and emotional needs of their learners.
- 3) The establishment of infrastructure that supports the deployment of AI technologies, including access to reliable electricity, internet connectivity, and affordable digital devices is also central for full inclusion to be achievable.
- 4) Open-source AI solutions should be prioritized to ensure sustainability and accessibility, particularly in low-resource environments.
- 5) Inclusive education policies must be operationalized through enforceable frameworks that support the integration of AI into curriculum planning, teacher training institutions, and classroom assessment systems.
- 6) Community engagement and stakeholder participation, including parents, local leaders, and technology partners, must be harnessed to foster shared ownership of AI-driven inclusion. Ultimately, these recommendations call for a shift in the educational paradigm, one that views AI not as an external addition but as an embedded ally in dismantling systemic exclusion and advancing the rights of all learners, regardless of visual ability.

### 5.3 Limitations of the Study

While this study provides valuable insights into the integration of artificial intelligence (AI) for the inclusion of visually impaired Early Childhood Education (ECE) learners in Chimanimani District, certain limitations should be acknowledged. First, the study is context-specific, focusing on a single district, which may limit the generalizability of the findings to broader educational settings. Additionally, while the mixed-methods approach strengthened the study by combining qualitative depth with quantitative rigor, certain methodological constraints remain. The sample size for quantitative data may not be

large enough to allow for extensive statistical generalization, while qualitative data interpretation, though rich, may introduce some level of subjectivity. Moreover, the rapid advancement of AI technologies presents a challenge, as findings may require periodic updates to remain relevant. Constraints such as resource availability, infrastructural readiness, and teacher training were considered, but their long-term implications warrant further exploration. Despite these limitations, the study's findings remain robust and provide a strong foundation for further research and practical implementation, contributing to the discourse on AI-driven inclusive education for visually impaired ECE learners.

## 5.4 Future Research Directions

Future research should build on the findings of this study by expanding its scope to include multiple districts or national-level analyses to enhance the generalizability of results. A longitudinal approach could provide deeper insights into the long-term impact of artificial intelligence (AI) on the inclusion of visually impaired ECE learners, tracking their progress over time. Additionally, future studies could explore the scalability and adaptability of AI-driven interventions in diverse socio-economic and infrastructural contexts, particularly in rural and under-resourced areas. Comparative research examining different AI technologies and their effectiveness in enhancing inclusive education for visually impaired learners could also provide valuable insights for policymakers and educators. Furthermore, integrating perspectives from parents, caregivers, and AI developers could offer a more holistic understanding of the challenges and opportunities associated with AI adoption in ECE. Given the rapid evolution of AI, continuous research into emerging innovations, ethical considerations, and their pedagogical implications will be crucial for sustaining inclusive and equitable education. By focusing on these areas, future research can contribute to the refinement of AI applications in special needs education, ensuring sustainable and meaningful inclusion for visually impaired learners.

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