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SIGNALS OF READINESS FOR AI IMPLEMENTATION AMONG EDUCATORS IN RURAL SCHOOLS OF SOUTH AFRICA

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ABSTRACT
Despite the growing interest in artificial intelligence by learners and educators in South African schools. Limited studies identify rural teacher AI literacy, self efficacy, and sustained professional development as central signals of readiness, and notes that general digital skills rarely substitute for AI specific competencies. Hardware shortages, device sharing, unreliable electricity, and intermittent connectivity constrain feasible architectures and favor offline, local server, and multi user software approaches. Policy and curriculum frameworks recommend embedding AI literacy and Trustworthy AI principles into pre service and in service training, aligning technical methods for clarity, privacy preserving data collection, and bias audits with ethical principles drawn from biomedical ethics and social justice. Vocational uses of generative AI for career guidance are evaluated as offering adaptive pathways and labor market alignment, while also requiring transparent data governance and safeguards for sensitive information. This, qualitative study explores how educators in rural schools of Kwa-Zulu Natal implement technology. 15 educators were purposefully selected. The collection of data was done through zoom semi structured interviews and analyzed thematically. Ethical considerations included informed consent, usage of pseudonyms, and confidentiality. Analyses, highlight workload redistribution: automation of routine tasks can free instructor time for mentorship but initial adoption raises training and governance burdens that, institutions must absorb. Equity themes recur, urging subsidies, inclusive design, diverse datasets, and community partnerships to prevent reinforcement of existing digital divides. Recommendations: prioritize coordinated multi stakeholder planning, invest in connectivity aware architectures and continuous teacher development, mandate privacy and bias monitoring, and evaluate pedagogical outcomes longitudinally. These measures are presented as necessary to enable ethical, context aware deployment of AI in rural schooling so that potential pedagogical benefits can be realized without exacerbating resource and social inequalities.

Keywords: Digital literacy, Educator, Artificial Intelligence, Learning Environment.

1. INTRODUCTION

Artificial intelligence is increasingly positioned within broader movements for educational technology integration, where information and communication technology (ICT) reshapes traditional teaching methods, supports active and flexible learning, and contributes to preparing students for a rapidly evolving, technology driven global economy. Introducing AI in schools offers a potential shift in the educational landscape, promising to enhance learning experiences and improve pedagogical approaches (Strielkowski et al, 2025). Within this transformation, AI is treated alongside approaches such as gamification, Bring Your Own Device, and online collaboration as part of a wider redefinition of classroom dynamics and personalized learning opportunities in secondary and higher education. These developments place new demands on schools, teachers, and policy actors to align curriculum reform with skills based, technology enabled education that emphasizes critical thinking, problem solving, and adaptability (Aprianto et al, 2025). Teacher readiness and professional capacity emerge as central conditions for any meaningful integration of AI and related digital tools. Studies on technology and AI adoption in teacher education underline the significance of self efficacy and attitudes in shaping behavioral intentions, and they call for structured opportunities for pre service teachers to explore teaching with technology in order to build more positive dispositions toward its classroom use (Yiticanlar, Agdas & Degiemenci,2021). In the context of life sciences education, the behavioral intentions of pre service teachers to integrate AI have been described as moderate to low, with concerns about training, resources, and classroom complexities underscoring an urgent need for targeted professional development, curriculum adaptation, and policy support (Mnguni, 2024). These findings highlight that, intentions toward AI integration cannot be separated from perceptions of control, institutional support, and the availability of appropriate tools and infrastructures (Aderibigbe, Ohenhen, Nwaobia, Gidiagba & Ani,2023). Research on AI in medical and higher education further illustrates that technical deployment alone is insufficient without robust ethical and governance frameworks. Commentaries on AI in medical curricula foreground the four principles of biomedical ethics, stressing autonomy, justice, non maleficence, and beneficence when AI applications are used for teaching and learning. Concerns include privacy and confidentiality, lack of informed consent in the reuse of data, risks to learner autonomy when

opaque systems shape decisions, and the danger that overreliance on AI could erode critical judgment and clinical decision making skills. Recommendations therefore include transparent communication about when and how AI is used, mechanisms that surface uncertainty in AI outputs, stakeholder involvement in decision making, and ongoing monitoring of emerging risks such as bias, discriminatory outcomes, and security threats (Busch, Adams & Bressem, 2023). Similar arguments inform work on Trustworthy AI in higher education, which builds on European High Level Expert Group guidelines to specify requirements related to human agency, technical robustness, privacy and data governance, transparency, fairness, societal well being, and accountability, and to translate these into concrete learning outcomes and curriculum structures (AlerTubella, Mora-Cantallops & Nieves, 2023). Within vocational education, generative AI is framed as a driver of a paradigm shift from generalized guidance to highly personalized career planning, supported by natural language processing and machine learning.

FRAMEWORK

This study builds on Thongprasit & Wannapiroons (2022) model of AI integration in education, identifying four interrelated components crucial components crucial for understanding AI implementation and adoption, particularly within the South African rural context. The components work synergically to influence the successful adoption and implementation of AI. See Fig 1. The framework encompasses four elements that interact dynamically to shape AI integration outcomes. First end users including educators and learners, represent the human dimension of AI adoption. This component is particularly significant in rural contexts.

FIG 1

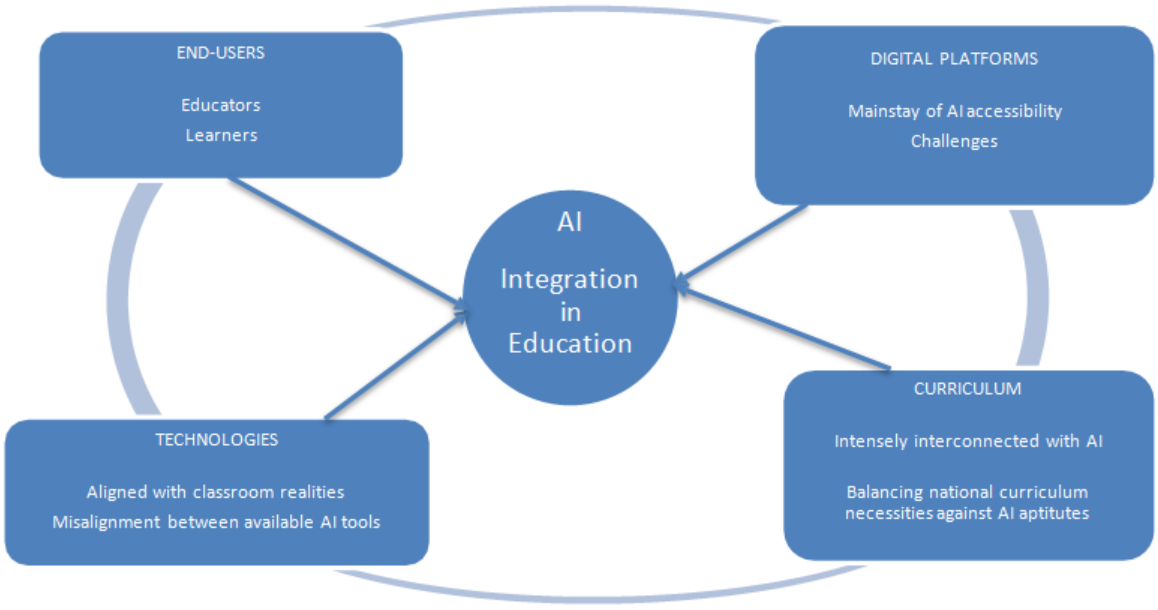

Figure 1. AI Integration in Education: Four Interrelated Components Frameworks

Second, digital platforms create the technological mainstay of AI accessibility, serving as the primary conduits through which AI tools reach educational settings. However, significant challenges emerge in rural areas, where unreliable internet connectivity and a lack of appropriate devices significantly impede meaningful engagement with AI-enhanced learning environments. These infrastructural limitations create barriers that must be addressed for efficient AI adoption.

LITERATURE REVIEW

Across educational levels, AI adoption is frequently embedded within broader movements of ICT integration rather than treated as an isolated innovation. Technological affordances, especially in learning vary as much as technology (Bray et al.,2024). Therefore, learners need to understand the affordances of resources, whether hardware, software or network capabilities. Digital tools such as gamification, Bring Your Own Device initiatives, AI applications, and online collaboration platforms are reported to reshape traditional teaching methods, promote active and flexible learning, and enable more personalized learning opportunities that align with skills demanded in a rapidly evolving global economy. Within this trajectory, AI is positioned as one element in a wider shift toward technology driven, skills-based education that aims to cultivate critical thinking, problem solving, and adaptability (Bester, 2024). Several strands of research document how AI is being trialed in different educational sectors. In higher education, AI powered chatbots have been used in randomized

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controlled trials to support students' university choice, illustrating the potential of scalable, standardized, interview like survey architectures for decision making support and data collection across geographically dispersed cohorts. These chatbots are viewed as particularly suitable for disseminating standardized information, handling routine queries, and streamlining preliminary screening processes, while human advisors focus on more complex or emotionally demanding support needs (Cingillioglu, Gal & Prokhorov, 2024). Commentaries stress that AI supported teaching and learning must be governed by the principles of autonomy, justice, non maleficence, and beneficence, with medical institutions urged to define clear learning purposes and objectives, ensure transparency regarding when and how different AI applications are used, and obtain informed consent from users. Recommendations include treating AI tools as add ons rather than replacements for traditional materials, providing appropriate training on AI applications to maximize benefits, and continuously monitoring for emerging risks such as privacy breaches, discriminatory outcomes, and embedded biases (Busch, Adams & Bressem, 2023). These developments illustrate how AI adoption in education is increasingly coupled with ethical oversight and stakeholder collaboration. At the policy and curriculum design level, European initiatives around Trustworthy AI have begun to shape expectations for higher education programs. Building on High Level Expert Group guidelines, Trustworthy AI is defined through components of lawfulness, ethics, and robustness, and is further operationalized into seven requirements including human agency and oversight, technical robustness and safety, privacy and data governance, transparency, diversity and non discrimination, societal and environmental well being, and accountability. Efforts are underway to translate these domain independent requirements into concrete learning outcomes, teaching frameworks, and sector specific interpretations so that higher education can contribute to ethical, safe, and cutting-edge AI development (Aler Tubella, Mora-Cantallops & Nieves, 2023).

SOUTH AFRICAN EDUCATIONAL LANDSCAPE

Rural schooling experiences in southern Africa illustrate how broader ICT and AI ambitions are constrained by infrastructural and socio-economic realities. In Namibia, many schools, particularly in rural areas, continue to struggle to provide quality education because of limited infrastructure decades after independence, reflecting wider African patterns where inadequate physio economic conditions hinder effective ICT integration in teaching and learning. Government efforts to expand connectivity through partnerships with national telecommunications providers and low cost internet offerings for schools have not fully resolved these gaps, as became clear when COVID 19 related directives for online learning could not be implemented in under resourced schools lacking both ICT infrastructure and, in some cases, reliable electricity. These constraints frame any discussion of advanced digital tools, including AI, since access to devices, connectivity, and power remains uneven. At the same time, curriculum reforms that introduce ICT related subjects from primary through upper secondary grades, and strategic initiatives such as the Education and Training Sector Improvement Plan, signal a policy level commitment to embedding digital competencies in schooling and to leveraging ICT tools and resources to improve outcomes (Mathinya, 2024). Together, these developments depict an education system that is formally oriented toward digital transformation yet still grappling with deep structural inequities in infrastructure and access. Experiences from other low resource rural contexts underscore the potential role of partnerships in mitigating state capacity limitations that affect technology enabled education. When governments cannot shoulder the full cost of ICT infrastructure, arrangements in which external agencies, including non governmental organizations and actors from developed countries, help implement technology in schools are presented as both necessary and useful. Comparative accounts from the United States and Nepal describe small districts and rural communities that lack budgets for expensive school technologies and governments unable to provide infrastructure, prompting special funding schemes and strategic partnerships that align with multilateral recommendations for technology in education in the developing world. An ecology-based view of policy implementation is proposed to analyze how such external actors, relationships, and shifting global conditions shape the sustainability of ICT initiatives (Rana,2023). Although these analyses are not specific to South Africa, they foreground issues that are salient for rural educational systems across the region, including decisions about which external agencies to involve, what roles they might assume, and how evolving political and funding landscapes may affect long term support for ICT and, by extension, AI implementation.

AI IN PEDAGOGICAL THEORY

Conceptualizations of AI in education frequently distinguish between different pedagogical functions of AI based tools and environments. One account identifies AI based instructional tools, AI enabled learning environments, and AI supported assessment and feedback systems as distinct but complementary categories within science education. AI enabled learning environments extend traditional classrooms into virtual and augmented reality spaces that afford simulated hands-on experiences and collaborative problem solving. AI literacy is defined in this work as encompassing understanding and application of AI concepts, ethical issues,

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and practical tools, implying that pedagogical theory for AI integration must incorporate both technical and ethical dimensions of teacher knowledge. Philosophical concerns include fears that AI may foster over dependence on technology, undermine critical thinking, and erode the human relational dimensions of teaching, captured in references to the importance of teacher authority and cultural values such as Ubuntu in the classroom. These views lead to a conclusion that behavioral intention to integrate AI is moderate to low, and that pedagogical models for AI must remain sensitive to contextual constraints, teacher beliefs, and local educational values (Mnguni, 2024). Within vocational education, generative AI for career planning is explicitly aligned with constructivist learning theory and established career development models. Constructivist theory is invoked to argue that learners actively construct knowledge through interactions with their environment, and that tailored learning experiences are therefore critical. Career development theories such as Super's life span, life space theory and Holland's vocational choice theory are used to frame how AI facilitated insights can support individuals to steer their trajectories in line with interests, competencies, and values. Generative AI applications built on natural language processing and machine learning enable systems that provide bespoke advice, formulate adaptive learning pathways, and deliver real time labor market insights. These capabilities are described as pedagogically sound because they nurture dynamic, individualized learning experiences, support mentorship like guidance roles for educators, and enhance students' readiness and decision making regarding future careers (Mnguni, 2024). These recommendations collectively imply that pedagogical designs involving AI should treat AI tools as add ons rather than replacements for traditional materials, preserve fundamental dimensions of the human being in educational encounters, and incorporate regular assessment and optimization of AI tools to maximize educational benefits while minimizing harms (Busch, Adams & Bressem, 2023). Across these strands, research conceptualizes AI not as a monolithic instructional agent but as a heterogeneous set of tools and environments whose pedagogical value depends on teacher competencies, ethical framing, and alignment with disciplinary theories of learning and development (Busch, Adams and Bressem, 2023; Mnguni, 2024; Author, 2024).

SIGNALS AND INDICATORS FOR AI READINESS AMONG EDUCATORS

Technological Competence

Technological competence for AI integration among educators is closely tied to both their existing digital skills and their specific preparedness to work with AI based tools. Analyses of South African life sciences education describe a clear deficit in teacher readiness to harness AI innovations, with science teachers often exhibiting low awareness and understanding of AI applications despite growing technological advancements in schools. This readiness gap persists even where general digital literacy is improving, indicating that conventional ICT skills do not automatically translate into AI specific capabilities. Within this context, the type of AI deployed, such as AI based instructional tools, AI enabled learning environments, and AI supported assessment systems, is argued to have distinct pedagogical implications that teachers must understand in order to select and use tools effectively. A core component of technological competence in this domain is AI literacy. AI literacy is defined as the understanding and application of AI concepts, ethical considerations, and practical tools, and is treated as a foundational skill that teachers should possess. Evidence associates higher AI literacy with increased user confidence and preparedness for using AI in practice, suggesting that competence is not only a matter of technical operation but also of conceptual grasp and ethical grounding. Attitudes and self perceptions interact with competence in important ways. Studies on pre service teacher attitudes report that perceived ease of use, technology readiness, and self efficacy in exploring new tools influence their competencies for educational practice and shape their willingness to integrate AI into teaching. Where preparedness is low, rapid technological shifts can be experienced as intimidating, reducing both confidence and actual use of tools. Findings also indicate that behavioral intention to integrate AI among pre service life sciences teachers is moderate to low, with concerns about inadequate training, resource availability, and the need for ongoing mentoring and technical support featuring prominently (Mnguni, 2024). These concerns highlight that competence is experienced not only as an individual skill set but also as a function of institutional support and access to sustained guidance. From a systems perspective, technological competence is embedded within broader ICT integration agendas. Work from Namibian secondary education underscores that empowering teachers and school leaders with skills and knowledge for effective ICT use strengthens the foundation for sustainable technology adoption, and explicitly connects capacity building to digital literacy, equitable access to resources, and ongoing technical support (Wu et al, 2024). Although this analysis focuses on ICT generally rather than AI specifically, it identifies collaborative strategies among teachers, administrators, and government stakeholders as prerequisites for meaningful technology use, particularly in rural and disadvantaged areas. In combination with South African findings on AI literacy and teacher preparedness, this suggests that signals of educator readiness for AI involve not only individual knowledge and skills, but also the presence of structured

professional development, supportive leadership, and infrastructural conditions that allow those competencies to be enacted in practice (Mnguni, 2024; - & Ghandour et al -, 2024).

Attitudinal Factors

Attitudinal dispositions toward AI among educators constitute a key signal of readiness, shaping both intentions to adopt AI and responses to enabling conditions such as infrastructure and professional development. In South African life sciences education, pre service teachers' behavioral intention to integrate AI is characterized as moderate to low, with mixed attitudes that balance optimism about AI's potential against reservations regarding efficacy and learner engagement. Subjective norms position integration as contingent on multiple stakeholders, including School Governing Bodies, senior teachers, and parents, whose expectations and concerns add further barriers. Perceived behavioral control is described as highly variable, with inadequate training, limited resources, and uneven access to mentoring and technical support constraining confidence in using AI for teaching. Within this context, AI literacy is not only a competence issue but also an attitudinal one. Evidence associates AI literacy with increased user confidence and preparedness for using AI in practice, and it is argued that teacher AI literacy could facilitate effective incorporation of AI tools into teaching practice and thereby enhance educational outcomes. To do so, teachers are expected to understand general characteristics of AI and its pedagogical applications, and to possess ethical grounding, technological aptitude, and the ability to engage learners meaningfully through AI. Professional development and training programs targeting these competencies are described as imperative, yet current efforts are noted to be limited in resources and structure, leaving many teachers underprepared. Incorporating AI competencies into pre service teacher training is proposed as one strategy to shape attitudes early in teachers' careers. Attitudes are further influenced by prior exposure and training experiences. Pre service teacher programs that emphasize pedagogical knowledge and ICT related courses are reported to affect the ability to integrate technology into teaching, including AI. Perceived competence in exploring emerging technologies contributes to willingness to experiment with new tools, indicating that attitudinal factors are tightly coupled to self efficacy and technology readiness (Mnguni, 2024). Professional development that enhances technological and pedagogical knowledge about AI educational technologies and addresses misconceptions is recommended to support effective adoption and to calibrate perceived benefits and concerns (Viberg *et al.*, 2025). These findings collectively show that readiness for AI integration cannot be inferred from infrastructure or policy alone. Attitudinal factors encompass optimism and skepticism about AI's pedagogical value, perceived social expectations from institutional authorities and parents, self efficacy and technology readiness, AI literacy, and trust in AI applications.

Infrastructure and Resource Requirements

Evidence from work on intelligent tutoring systems (ITS) and ICT in low resource settings identifies concrete constraints around hardware stocks, device form factors, and supporting infrastructure that are directly relevant for AI deployment. A review of ITS projects in the developing world isolates ICT hardware availability as the primary barrier to adoption, noting that many systems implicitly assume a 1: 1 student to computer ratio that is rarely achievable in such contexts. In rural classrooms, mobile phones often constitute the main computing platform, yet a lack of software explicitly targeting these devices remains a related problem for technology enhanced learning (Nye, 2015). Analyses of ICT initiatives in Namibian secondary schools similarly emphasize that equitable access to ICT resources is essential, particularly in rural and disadvantaged areas, and that any framework for digital tools must therefore account for uneven device availability and access conditions (- and -, 2024). Different forms of hardware sharing emerge as a pervasive adaptation to scarcity. Classroom studies of ITS deployments show that computer sharing accounts for over 60 % of use in developing areas, with students leaving their own machines to share a device instead. Multi user approaches such as MultiLearn+, which splits a laptop screen into quadrants with separate keypads, and Single Display Groupware, which provides a shared projection with individual input devices, illustrate how a single machine can be configured for multiple concurrent users. These designs reduce cost per student substantially because inexpensive inputs like keypads, wireless mice, or clickers replace additional processors and displays. Time and location sharing also extend limited hardware, through practices such as scheduled computer lab access or mobile "Learning Van" laboratories that visit rural schools on a rotating basis (Nye, 2015). Such strategies indicate that in environments where AI is to be integrated, software must tolerate and ideally support multi user, time shared access patterns rather than presupposing individual, continuously available devices (Nye, 2015; Mbambo & Du Plessis, 2024). Power and connectivity shape both hardware usability and software choices. Studies of ITS projects in Zambia and braille literacy interventions report that inconsistent electricity and power costs can prevent schools from reliably operating computer labs, prompting design of specialized low power devices and reliance on laptops or mobile devices with battery backup to bridge short outages. Parallel research on rural schools in the United States also notes slower internet speeds, student home access constraints, and the need to consider smartphone

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friendly technologies and offline capable tablets when connectivity is intermittent or expensive (Kormos & Wisdom, 2021). Basic ICT skills and technical support further mediate the practical availability of hardware and software.

Professional Development Programs

Targeted professional development emerges as a central mechanism for building the AI related competencies that teachers require to engage meaningfully with AI tools. Work on life sciences education in South Africa defines AI literacy as understanding and applying AI concepts, ethical considerations, and practical tools, and notes that higher levels of AI literacy are associated with increased confidence and preparedness to use AI in practice. On this basis, AI literacy among teachers is expected to facilitate more effective incorporation of AI applications into teaching and to support improved educational outcomes. To reach this point, teachers are expected to understand general characteristics of AI and its pedagogical applications, and to possess ethical grounding, technological aptitude, and the ability to engage learners through AI supported activities. Current provision of training is described as fragmented. Existing initiatives that explore teacher preparation through professional development are reported, yet a persistent gap in both resources and structured training remains (Ramraj & Marimuthu, 2020). Authors therefore argue that ongoing professional development, rather than one off workshops, is essential for equipping teachers with the AI specific skills demanded by emerging classroom practices (Mbambo & Plessis, 2024). Embedding AI competencies into pre service teacher education is proposed as a complementary strategy, since programs that emphasize pedagogical knowledge and ICT related courses have been shown to affect graduates' ability to integrate technology into their teaching. Training that explicitly develops technological pedagogical content knowledge can increase readiness to use digital tools in classrooms, while positive attitudes toward technology and perceived ease of use are linked to stronger competencies for educational practice. Conversely, low levels of preparedness can make rapid technological change feel intimidating, with negative effects on both attitudes and adoption (Mnguni, 2024).

Curriculum Integration

Embedding AI related competences into curriculum structures requires alignment between subject content, ethical frameworks, and broader ICT agendas. Analyses of Namibian secondary schooling argue that curriculum reform must track the interdisciplinary nature of 21st century learning and shift toward technology driven, skills based education that prioritizes critical thinking, problem solving, and adaptability. Within this framing, ICT tools, including AI, are not peripheral add ons but are expected to be woven into subject curricula in ways that cultivate creative thinkers for a rapidly evolving job market. A context specific framework developed for Namibia emphasizes aligning curriculum with digital tools, supported by comprehensive teacher training and a supportive environment, in order to bridge digital divides and prepare learners for the modern workforce (Mbambo & Du Plessis, 2024). For AI specifically, AI literacy is proposed as a foundational curricular construct in life sciences teacher education. Pre service teachers in South Africa are reported to have had no prior formal training on AI and its educational uses, yet they are positioned as potential first generation AI adopters whose pedagogical content knowledge is being formed. Recommendations include in depth studies on specialized AI literacy training requirements for life sciences and the development of policies that ensure equitable access to AI technologies across diverse educational settings. Future work is urged to investigate the efficacy of different AI enabled pedagogical approaches and to conduct longitudinal studies on the long term effects of AI integration on learner outcomes and teacher practice, implying that curricula should incorporate both conceptual and practical AI components that can be systematically evaluated over time (Mnguni, 2024). Ethical and societal dimensions of AI also require explicit curricular treatment. At policy level, coordinated strategies are advocated to ensure uniform introduction of Trustworthy AI, provide time and expertise for curriculum development, and incentivize interdisciplinary collaboration in AI ethics education (Aler Tubella, Mora-Cantallops & Nieves, 2023). Regular assessment and optimization of AI applications within curricula are viewed as crucial to maximize educational benefits and minimize harms, with ongoing monitoring of privacy, security, and bias related risks that may emerge as AI tools evolve (Busch, Adams & Bressem, 2023). Vocational education contributes another curricular perspective focused on generative AI for career planning. Here, generative AI based on natural language processing and machine learning underpins systems that deliver bespoke advice, construct adaptive learning pathways, and provide real time labor market insights. These applications are explicitly connected to constructivist learning theories and career development models, and their integration is framed as pedagogically sound when curricula are reoriented toward dynamic, individualized learning experiences. Institutional responsibilities include strategic planning, judicious technology selection and customization, and sustained stakeholder engagement and training. Ethical and privacy considerations are treated as integral curriculum level concerns, with institutions expected to formulate transparent data usage policies, ensure unbiased system functionality, and safeguard sensitive student information. Such measures are

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described as critical for cultivating and maintaining trust in AI driven guidance and for aligning AI enriched curricula with institutional goals and student needs (Mbambo & Du Plessis, 2024). Strategic, ethically grounded curriculum design, supported by coordinated policies and continuous evaluation, is therefore central to any sustainable expansion of AI use in education (Aler Tubella, Mora-Cantallops & Nieves, 2023; Busch, Adams and Bressem, 2023; Mbambo & Du Plessis, 2024; Mnguni, 2024).

Ethical and Cultural Considerations of using AI in education

Privacy and security concerns around AI mediated learning are particularly salient where systems process sensitive personal or educational data. In medical education, use of AI applications with real patient information requires that privacy and confidentiality of sensitive data be guaranteed, and in many jurisdictions informed consent from patients whose data are used is required (Wu et al, 2024). Institutions must ensure adherence to strict privacy regulations and policies such as the General Data Protection Regulation and the Health Insurance Portability and Accountability Act, alongside approvals from relevant regulatory authorities and institutional review boards. AI supported learning activities also generate new sensitive data, including assessments and analyses of individual performance, which may create competitive pressures or negative emotions if results are visible to peers (Hua et al, 2024). For this reason, handling individual results with confidentiality is explicitly recommended, coupled with technical and organizational safeguards that constrain access to such records. Autonomy oriented analysis of AI in medical curricula further connects privacy and security to informed decision making (Mbambo & Du Plessis,2024). Students and educators are expected to know when and how AI applications are used, and to give informed consent before engaging with them. Large language models are described as prone to hallucination and conceptual opacity, which complicates users' ability to judge the appropriateness of AI generated recommendations. Institutions are therefore urged to make AI use transparent and comprehensible, to promote professional responsibility and accountability in decisions that rely on AI outputs, and to offer AI models as add ons rather than replacements for traditional materials so that users can decide whether to use them. These measures are framed as protecting both autonomy and non maleficence by ensuring that users retain control over their data and over the extent to which AI shapes their learning.

AIM OF THE STUDY

This study aims to explore the signals of readiness for AI implementation by educators in rural areas of Kwa-Zulu Natal in South Africa where according to several studies several obstacles persist, including a dearth of AI training, inadequate infrastructure, and ethical concerns regarding privacy and equitable access to technology. The study seeks to understand the lived experiences of these educators. The research question emerged: What signals of readiness for AI implementation among educators in rural areas exist, and what implications do their experiences have for developing equitable, context sensitive AI education strategies?

RESEARCH METHOD

This study employed a qualitative research design to determine signal of readiness to adopt and implement technology in rural schools of Kwa Zulu Natal. An exploratory approach was utilized to unearth detailed context rich understandings of complex phenomenon that are often obscured by quantitative methods (Lim, 2025). It assists researchers to explore the intersections of technology and pedagogy within the authentic realities of the rural education context.

Sampling

To ensure relevance and depth, the purposive sampling technique was utilized to identify 3 educators in each of the 5 regions of Kwa Zulu Natal with experience in implementing AI tools to facilitate learning (Kayaalp et al, 2025). In addition, extreme variation sampling was utilized to capture wide spectrum of perspectives, drawing from educators with diverse teaching contexts, technological exposure, and institutional support levels (Rubach & Lazarides, 2025). In disclaiming, the sample size of n=15 educators may seem inadequate but Kwa-Zulu Natal is a country on its own.

Data Collection

All participants were affiliated with schools that had implemented AI-related strategies. Data collection was conducted through a combination of written online zoom semi- structured interview, guided by a flexible interview protocol that ensured consistency across cases while permitting exploration of emergent themes. Participants were invited to share their experiences and challenges encountered in implementing AI, the coping mechanisms adopted, and their reflections on their role in shaping effective teaching and learning.

Data Analysis

Data were analyzed utilizing Thematic Content Analysis (TCA) from the response on ZOOM recorded online meetings, a well-crafted method for identifying patterns and constructing meanings from a qualitative data

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(Ebrahim & Rajab, 2025). This analytical approach facilitated the development of core themes that encapsulate the findings of the study.

Results

The findings of this study are organized thematically. From the analysis four core themes emerged viz: Inadequate Digital Infrastructure and limited connectivity, Language and cultural Relevance Challenges, Insufficient institutional and Government Support and substandard teacher development on digital literacy.

Inadequate Digital Infrastructure

The first challenge was lack of electricity and supporting infrastructure for technology one educator described the main challenge as she had this to share: Respondents Region1

"Most of us around the area prefer the traditional method of teaching as not all educators are able to use technology, worse off learners are not exposed to all these, gadget, they come from poor families and their parents are not educated".

At the same school another educator added

"It also becomes very difficult to come up with innovative ideas, families who live around here are very rural, they are traditionalists who do not even watch news on TV, introducing technology in schools should actually start with educating the community".

And one respondent from region 3 had this to share

"We thought after voting we will be better off, whether you are a teacher or nurse it's the same, we feel sidelined there is no development taking place here, even the officials from the department hardly visit the school, it is just us and the principal"

From the above assertions one can deduce that there are no signs of readiness to implement technology as one educator alluded that she is comfortable with the traditional method of teaching. They were of the view that if technology should be adopted and implemented the community should be involved. Training of educators in technology implementation was not done.

Limited Connectivity

Across all regions respondents highlighted poor internet connection and insufficient digital infrastructure as barriers towards technology use. Responded Region 4 had this to share

"Mam, we don't even have electricity or wi-fi, how do they expect us to implement blended learning, they only focus on developing schools in urban areas, our kids are left behind. We do want to teach them remotely but unfortunately resources are not for rural areas"

DISCUSSION

Respondents highlighted lack of resources and internet connection which severely affect the adoption of technology. Attention is not given to rural schools as officials seldomly visit the schools. It emerged from the data that even educators have limited or no knowledge of employing technology in their lessons. Reading the responses left the wondering about the quality of teaching and learning happening in rural schools. Furthermore, limited access to technological resources emerged as a pervasive issue. Educators and learners do not utilize technology because of lack of training and resources. The narratives concerning substandard or no professional development as far as the adoption of technology is concerned in rural schools expose a disconnect in the digital transformation of education that is without continuous context sensitive professional development, change is unlikely to take place in rural schools. This concern was echoed across recent literature highlighting that short term interventions and once off workshops are insufficient to promote meaningful adoption and instructional innovation. Dominguez-Gonzalez et al, (2025) infers that digital competence remains generally low among educators particularly in secondary schools and that training programs often fail to address educator's real-world classroom needs. Respondents consistently highlighted a gap in both educators and learner's digital competence that erodes confidence and constraints the pedagogical use of available technological resources. Disparities in financial allocation were also raised wherein one educator inferred that the focus is on schools in the urban areas.

CONCLUSION

The evidence synthesized here indicates that effective introduction of AI in low resource school settings requires coordinated attention to technology, people, policy, and ethics. AI and related ICT function best when integrated with curriculum goals, supported by sustained professional development, and matched to realistic hardware and connectivity profiles. Where device access, power stability, and network bandwidth are limited,

solutions such as multi user interfaces, time or location sharing, local servers, and offline module delivery can make AI supported activities feasible without assuming a 1:1 device ratio or always online services. Teacher capacity and confidence are central determinants of classroom uptake, in the case of rural educators no training was done and resources were not provided. AI literacy that combines conceptual familiarity with ethical awareness and practical classroom strategies should be cultivated through both pre service programs and ongoing in service training. Professional learning that emphasizes pedagogical uses, corrects common misconceptions about what AI does, and provides hands on practice tends to increase trust and willingness to experiment. Mentoring, peer support, and institutional technical assistance reduce the burden on individual instructors and help sustain use over time. Implementation strategies should be iterative, evidence informed, and context sensitive. Pilot deployments that test hardware arrangements, offline modes, ethical safeguards, and curriculum fit can generate the local data needed for scalable decisions. Research agendas that include longitudinal studies of learning outcomes, comparative evaluations of delivery architectures, and monitoring of equity impacts will help refine practices over time. Combining practical adaptations for infrastructural constraints with explicit ethical governance and sustained capacity building offers a viable pathway for bringing AI supported pedagogies into under resourced educational settings in a manner that is responsible, inclusive, and pedagogically meaningful.

REFERENCES

Adeleye, O., Eden, C. A. & Adeniyi, I. S. (2024). Innovative teaching methodologies in the era of artificial intelligence: A review of inclusive educational practices. World Journal of Advanced Engineering Technology and Sciences, 11(2), 069-079.

https://doi.org/10.30574/wjaets.2024.1.1.2.0091

Algahtani, S.S. (2024) 'A strategic framework for ICT integration in namibian secondary schools: Insights from windhoek', *International Journal for Multidisciplinary Research*, 6(6). Available at: https://doi.org/10.36948/ijfmr.2024.v06i06.29993.

Aler-Tubella, A., Mora-Cantallops, M. and Nieves, J.C. (2023) 'How to teach responsible AI in higher education: Challenges and opportunities', *Ethics and Information Technology*, 26(1). Available at: https://doi.org/10.1007/s10676-023-09733-7.

Busch, F., Adams, L.C. and Bressem, K.K. (2023) 'Biomedical ethical aspects towards the implementation of artificial intelligence in medical education', *Medical Science Educator*,

33(4). Available at: https://doi.org/10.1007/s40670-023-01815-x.

Bush, F. Adams, L.C & Bressem, K.K. (2023) Ethical Integration of Artificial Intelligence (AI) in Medical Education. Medical Science Education 33 (1) DOI:10.1007/540670-023-01815

Cingillioglu, I., Gal, U. and Prokhorov, A. (2024) 'AI-experiments in education: An AI-driven randomized controlled trial for higher education research', *Education and Information Technologies*, 29(15). Available at: https://doi.org/10.1007/s10639-024-12633-y.

Dominguez-Gonzalez, M, La Rosa Antonio, Gomez, C.H & Graven (2025) Teacher digital competence: Keys for an educational future through a systematic review. Volume 17, Issue

2. Article no: Ep577

Duan, J & Wu, S. (2024) 'Beyond traditional pathways: Leveraging generative AI for dynamic career planning in vocational education', *International Journal of New Developments in Education*, 6(2). Available at: https://doi.org/10.25236/ijnde.2024.060205.

Ghandour, A., Woodford, B. J. & Abusaimeh, H. (2024). Ethical considerations in the use of Chatgpt: An Exploration Through the Lens of Five Moral Dimensions. IEEE Acess, 12, 60682-60693. https://doi.org./10.1109/ACCESS.2024.3394243\

Hua, Y.C., Denny, P., Wicker, J & Taskova K (2024). A systemic review of aspect-based sentiment analysis: domains, methods and trends. Artificial Intelligence Review 57 (11). DOI.10.1007\5. 10462-024-10906-2

Kayaalp, M.E (2025) Artificial Intelligence in medical and biological research: Promise and perils of chat GPT and Deepseek in advance healthcare

Kormos, E. and Wisdom, K. (2021) 'Rural schools and the digital divide', *Theory & Practice in Rural Education*, 11(1). Available at: https://doi.org/10.3776/tpre.2021.v11n1p25-39.

Lim, W.M (2025) What is qualitative research? An overview and guidelines. Australasian Marketing Journal, 33, 199-229.

Mathiya, E. L. (2024). What future for small-scale farming in South Africa? (Publication No. 3070005824) Wageningen University and Research.

Mbambo, G. P & Du Plessis, E. C. D (2024). Impact of Artificial Intelligence on Teacher Training in Open Distance and Electronic Learning. International Journal of Learning, Teaching and Educational Research, 23 (5), 370-

386.https://doi.org/10.26803/ijlter.23.5.19

Mnguni, L. (2024) 'A qualitative analysis of south african pre-service life sciences teachers' behavioral intentions for integrating AI in teaching', *Journal for STEM Education Research*,

8(2). Available at: https://doi.org/10.1007/s41979-024-00128-x.

Nye, B.D. (2015) 'Intelligent tutoring systems by and for the developing world: A review of trends and approaches for educational technology in a global context', *International Journal of Artificial Intelligence in Education*, 25(2). Available at: https://doi.org/10.1007/s40593-014-0028-6.

OECD. The future of education and skills: education 2030. OECD learning compass 2030. Paris: Organisation for Economic Co-Operation and Development.,2019 (Accessed on 25 Jan 2020)

Rana, K. 'Implementation of nepal's education policy in ICT: Examining current practice through an ecological model'.

Rubach, C & Lazarides, R (2025) Editorial: Empowering Teacher Professionalization with Digital Competencies 15(7):867. DOI:10.3390/educsc115070867

Thongprasit, J & Wannapiron, P. (2022). Framework of artificial intelligence learning platform for education. International education studies, 15(1), 76-86 https://doi.org/10.5539/ies.v15nlp76

UNESCO. Education 2030: Incheon declaration and framework for action for implementation of sustainable development goal 4. Paris: Organization for Economic Co-operation and Development.,2019 (Accessed on 2025 Jan 20). Available from

:https://www.oecd.org/content/dam/oecd/en/publication/reports/2018/06/the-future-of-education-and-skills-5424dd26/54ac7020-en.pdf

Viberg, O. *et al.* (2025) 'What explains teachers' trust in AI in education across six countries?', *International Journal of Artificial Intelligence in Education*, 35(3). Available at: https://doi.org/10.1007/s40593-024-00433-x.