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Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

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AUTHOR(S)	Rachel Gugu Mkhasibe, Oluwatoyin Ayodele Ajani
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INVESTIGATING HOW AI CAN SUPPORT SELF-DIRECTED LEARNING FOR STUDENT TEACHERS IN AFRICAN RURAL UNIVERSITIES-PROSPECTS, CHALLENGES AND FUTURE

Rachel Gugu Mkhasibe
Faculty of Education
University of Zululand
South Africa

Oluwatoyin Ayodele Ajani
Faculty of Education
University of Zululand
South Africa

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ABSTRACT

This study investigates how artificial intelligence (AI) can enhance self-directed learning among student teachers in African rural universities. A scoping review methodology was employed, encompassing 214 articles accessed from Scopus and Google Scholar. From these, 78 peer-reviewed English-language articles were selected for thematic analysis. The review highlights both the prospects and challenges of integrating AI into self-directed learning within these specific educational contexts. AI technologies offer significant potential to personalise learning experiences, provide adaptive feedback, and support remote learning in resource-constrained environments. However, the study also uncovers notable challenges, including limited infrastructure, inadequate digital literacy, and resistance to technology adoption. The findings suggest that while AI can significantly benefit self-directed learning, especially in areas where traditional educational resources are scarce, successful implementation requires overcoming these barriers through targeted interventions and support. Future research should focus on developing scalable AI solutions tailored to the unique needs of rural universities and exploring strategies to address the digital divide. This research provides a foundational understanding of AI's role in supporting self-directed learning and offers practical insights for policymakers, educators, and researchers.

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Introduction.

In the rapidly evolving educational landscape, artificial intelligence (AI) has emerged as a transformative force, promising to reshape teaching and learning practices across diverse contexts. This potential is particularly compelling in the context of self-directed learning for student teachers in African rural universities, where educational resources are often limited, and traditional teaching methods may fall short in addressing individual learning needs (Latham, 2019). This introduction explores the role of

AI in enhancing self-directed learning within these unique educational settings, drawing on a comprehensive scoping review of the existing literature.

Self-directed learning, a process where learners take initiative in diagnosing their learning needs, setting goals, finding resources, and evaluating their progress, is increasingly recognised as a crucial educational approach (Knowles, 1975). For student teachers in rural African contexts, self-directed learning can offer a pathway to overcoming barriers imposed by limited access to conventional educational resources (McLaughlin, 2020). However, implementing this approach effectively requires innovative solutions that can cater to diverse learning needs and contexts, making AI an intriguing area of exploration.

AI technologies, including machine learning, natural language processing, and adaptive learning systems, have the potential to personalise learning experiences and provide tailored support that aligns with the principles of self-directed learning (Siemens, 2013). These technologies can offer adaptive feedback, recommend resources, and facilitate remote learning, which is particularly beneficial in rural areas where traditional infrastructure may be lacking (Holmes et al., 2019). For instance, AI-driven platforms can analyse student performance data to customise learning paths, thereby addressing individual strengths and weaknesses more effectively than one-size-fits-all approaches (Weller, 2020).

Despite these advantages, integrating AI into self-directed learning presents several challenges. One significant issue is the limited technological infrastructure in many rural African universities, which can impede the effective deployment and use of AI tools (Van Deursen & Van Dijk, 2019). Additionally, there is often a gap in digital literacy among both educators and students, which can hinder the adoption and effective use of AI technologies (Mann & Stewart, 2000). Resistance to technological change and a lack of support for AI initiatives further complicate the situation, necessitating a nuanced understanding of these barriers and potential solutions.

The digital divide, characterised by disparities in access to and familiarity with technology, is a critical barrier to the successful implementation of AI in rural educational contexts (Hargittai, 2018). For AI to be effectively integrated into self-directed learning, it is essential to address these disparities through targeted interventions that enhance digital literacy and provide necessary infrastructure (Graham & Akyol, 2009). This involves not only technological investments but also capacity-building efforts aimed at improving the skills and confidence of both students and educators in using digital tools.

Moreover, the ethical implications of AI in education must be carefully considered. Issues such as data privacy, algorithmic bias, and the potential for AI systems to reinforce existing inequalities need to be addressed to ensure that AI is used in a manner that supports rather than undermines educational equity (Williamson, 2016). Ensuring transparency in how AI systems operate and making efforts to include diverse perspectives in the design and implementation of these technologies can help mitigate some of these concerns.

In light of these considerations, it is evident that while AI holds considerable promise for enhancing self-directed learning, its application in rural African universities requires a thoughtful and context-sensitive approach. The integration of AI should be pursued with a clear understanding of the local challenges and opportunities, aiming to create solutions that are both practical and impactful (Selwyn, 2016).

The potential for AI to transform self-directed learning in these settings is significant, but it also demands a comprehensive approach that addresses both technological and contextual factors. Future research should focus on developing AI solutions that are adaptable to the specific needs of rural universities and on exploring strategies to overcome barriers related to infrastructure, digital literacy, and resistance to change.

In summary, this study seeks to address the following research objectives:

1. To evaluate the potential benefits and challenges of implementing AI to support self-directed learning in rural African universities.
2. To identify the key barriers to the adoption of AI technologies in these educational settings and propose strategies to address them.
3. To explore the ethical considerations and implications of using AI in the context of self-directed learning and provide recommendations for ensuring equitable and effective use.

Literature Review.

Artificial Intelligence (AI) has been increasingly recognised for its potential to enhance self-directed learning by providing personalised educational experiences. Self-directed learning, as defined by Knowles (1975), involves learners taking initiative in diagnosing their learning needs, setting goals, finding resources, and evaluating their progress. AI technologies can support these processes by offering adaptive learning platforms that tailor educational content to individual needs (Siemens, 2013). For instance, AI-driven systems can analyse learners' interactions and performance data to provide customised feedback and recommendations, thereby facilitating a more personalised learning experience (Weller, 2020).

AI's capacity to personalise learning is particularly relevant in contexts where traditional educational resources are limited, such as rural African universities. AI technologies can adapt learning materials to the varying levels of proficiency and learning styles of students, which is crucial for fostering effective self-directed learning (Holmes, Bialik, & Fadel, 2019). For example, intelligent tutoring systems use machine learning algorithms to assess students' understanding in real-time and adjust the difficulty of tasks accordingly, thereby providing a tailored learning experience that can enhance student engagement and performance (VanLehn, 2011).

Despite its potential benefits, implementing AI in rural African universities presents several challenges. One significant barrier is the **digital divide**, which refers to disparities in access to and use of technology (Hargittai, 2018). Rural areas often face infrastructure challenges, such as unreliable internet connections and limited access to modern computing devices, which can hinder the deployment and effectiveness of AI technologies (Van Deursen & Van Dijk, 2019). Furthermore, a lack of technological infrastructure can also impact the ability of institutions to support and maintain AI systems effectively (McLaughlin, 2020).

Another critical challenge is the **digital literacy** gap among both students and educators in rural areas. Digital literacy encompasses the skills required to effectively use digital tools and technologies, and its absence can limit the successful integration of AI into educational practices (Mann & Stewart, 2000). Research indicates that both educators and students in rural settings often lack the necessary skills to utilise AI tools fully, which can impede their ability to benefit from these technologies (Graham & Akyol, 2009). Addressing this gap requires comprehensive training programs and support structures to build digital competencies.

Resistance to technological change is another barrier that can affect the adoption of AI in educational contexts. Cultural and institutional resistance can arise due to scepticism about the effectiveness of new technologies or concerns about their impact on traditional teaching methods (Blin & Munro, 2008). In rural African universities, where traditional pedagogies are deeply entrenched, introducing AI may face resistance from both faculty and students (Kezar, 2014). Overcoming this resistance requires change management strategies that involve engaging stakeholders in the decision-making process and demonstrating the value of AI technologies in enhancing educational outcomes (Selwyn, 2016).

The use of AI in education also raises important **ethical considerations**. Issues such as data privacy, algorithmic bias, and the potential reinforcement of existing inequalities must be carefully managed (Williamson, 2016). AI systems rely on vast amounts of data, which raises concerns about how this data is collected, stored, and used. Ensuring that AI technologies are implemented in ways that protect students' privacy and promote fairness is essential (Selwyn, 2021). Transparency in AI systems and inclusive design practices can help address some of these ethical concerns.

Despite these challenges, AI holds promise for **enhancing self-directed learning** by providing tools that support learner autonomy. Adaptive learning platforms, powered by AI, can offer personalised resources and feedback that align with students' individual learning goals (Breslow, 2018). These tools can facilitate self-directed learning by helping students identify their strengths and weaknesses and guiding them in setting and achieving their learning objectives (Siemens, 2013). AI's role in supporting self-directed learning is particularly valuable in settings where access to traditional educational resources is limited.

AI also presents **opportunities for innovation** in rural education. By leveraging AI technologies, rural universities can offer innovative educational solutions that address some of the limitations of traditional teaching methods (Holmes et al., 2019). For example, AI can support remote and asynchronous learning, making it possible for students in isolated areas to access high-quality

educational resources and support (Weller, 2020). Additionally, AI-driven educational tools can help bridge gaps in knowledge and provide additional resources that might not be available locally (Ng, 2012).

Several case studies demonstrate the successful integration of AI in educational contexts similar to those in rural Africa. For instance, AI-powered platforms have been used in low-resource settings to improve literacy and numeracy skills among students (Higgins & Moseley, 2001). These case studies offer valuable insights into how AI technologies can be adapted to meet the needs of students in resource-constrained environments and provide practical examples of how these tools can be effectively implemented (Selwyn, 2016).

Future research should focus on **developing AI solutions** that are specifically tailored to the needs of rural universities. This includes designing AI tools that are compatible with limited technological infrastructure and addressing the digital literacy gaps identified in the literature (Graham & Akyol, 2009). Research should also explore strategies for overcoming resistance to technological change and ensuring that AI implementations are ethically sound (Williamson, 2016). By focusing on these areas, researchers can contribute to the development of AI solutions that are both effective and equitable.

The findings of this review have important **policy implications** for educational stakeholders. Policymakers should consider investing in technological infrastructure and digital literacy programs to support the effective use of AI in rural universities (McLaughlin, 2020). Additionally, policies should address ethical concerns related to data privacy and algorithmic bias, ensuring that AI technologies are used responsibly and transparently (Selwyn, 2021). Collaborative efforts between governments, educational institutions, and technology providers can help create a supportive environment for the integration of AI in education.

AI has significant potential to enhance self-directed learning in rural African universities, but its implementation is accompanied by several challenges. Addressing these challenges requires a multifaceted approach that includes improving technological infrastructure, enhancing digital literacy, managing resistance to change, and addressing ethical considerations. By focusing on these areas, educational institutions can harness the benefits of AI while overcoming the barriers to its effective use.

Methodology.

This study employed a scoping review methodology to investigate how artificial intelligence (AI) can support self-directed learning for student teachers in rural African universities. Scoping reviews are particularly useful for exploring the breadth of literature on a topic, identifying key themes, and understanding the current state of research (Arksey & O'Malley, 2005). This approach allows for a comprehensive mapping of the available evidence, providing insights into both the opportunities and challenges associated with AI integration in this context.

A total of 214 articles were accessed from two major academic databases: Scopus and Google Scholar. These databases were selected due to their extensive coverage of peer-reviewed literature and their relevance to educational technology and AI (Falagas et al., 2008). The initial search was designed to capture a broad range of studies related to AI, self-directed learning, and educational settings, ensuring a wide scope of relevant literature.

To ensure the relevance and quality of the studies included, specific inclusion criteria were applied. Only articles published in English and in peer-reviewed journals were considered, resulting in a final selection of 78 articles. This focus on English-language, peer-reviewed sources ensured that the review drew from high-quality, scholarly research (Garfield, 2006). The selection process involved screening abstracts and full texts to identify studies directly related to AI's role in self-directed learning and its application in educational contexts similar to rural African universities.

The selected articles were subjected to thematic analysis to identify common themes and trends related to the integration of AI in self-directed learning. Thematic analysis is a qualitative research method that involves coding and categorising data to uncover patterns and insights (Braun & Clarke, 2006). This approach enabled the identification of key themes such as the benefits of AI, implementation challenges, and ethical considerations. The analysis was conducted iteratively, with themes being refined and expanded based on the data.

The synthesis of the data involved organising the findings into six key themes: (1) Personalisation of Learning, (2) Technological and Infrastructure Challenges, (3) Digital Literacy and Skill Gaps, (4) Resistance to Technological Change, (5) Ethical Considerations, and (6) Opportunities

for Innovation. Each theme was examined in detail to understand how AI can support self-directed learning and to identify the barriers that need to be addressed. This thematic organisation provided a structured overview of the current state of research and highlighted areas for further investigation.

To ensure the reliability and validity of the findings, multiple researchers independently reviewed and coded the articles. This process helped to minimise bias and ensured a consistent approach to data analysis (Lincoln & Guba, 1985). Discrepancies in coding were resolved through discussion and consensus, enhancing the robustness of the thematic analysis. Additionally, the use of well-established criteria for article selection and thematic analysis contributed to the credibility of the review.

Several limitations of the study should be acknowledged. The focus on English-language articles may have excluded relevant research published in other languages, potentially limiting the comprehensiveness of the review (Mackenzie et al., 2007). Furthermore, the reliance on Scopus and Google Scholar may have overlooked some relevant studies available in other databases or grey literature. These limitations should be considered when interpreting the findings and making recommendations.

Based on the findings of this scoping review, future research should focus on developing AI solutions that are specifically tailored to the needs of rural universities. This includes addressing technological and infrastructure challenges, enhancing digital literacy, and exploring strategies to overcome resistance to change (Graham & Akyol, 2009). Additionally, further research should investigate the ethical implications of AI in education and propose guidelines for ensuring equitable and responsible use of AI technologies (Williamson, 2016). By addressing these areas, future studies can contribute to the effective integration of AI in supporting self-directed learning in diverse educational contexts.

Results.

Theme 1. Personalisation of Learning.

One of the most prominent findings from the scoping review is the potential of AI to personalise learning experiences for student teachers in rural African universities. AI technologies, such as adaptive learning systems and intelligent tutoring systems, are designed to tailor educational content based on individual learner needs (Siemens, 2013). These systems use data analytics to assess students' progress and adjust learning materials in real-time, offering a more customised educational experience than traditional methods (VanLehn, 2011). For instance, AI can analyse students' responses to quizzes and assignments, providing targeted feedback that addresses specific areas of weakness (Weller, 2020). This level of personalisation is particularly beneficial in settings where resources are limited, as it helps ensure that each student receives the support they need to succeed.

Furthermore, AI-driven platforms can facilitate self-directed learning by recommending resources and activities aligned with students' individual learning goals. This capability supports the principles of self-directed learning by allowing students to set and pursue their own learning objectives, while AI provides guidance and support (Holmes et al., 2019). Personalisation through AI also promotes engagement by adapting content to match students' interests and learning preferences, which can enhance motivation and reduce dropout rates (Breslow, 2018). Thus, AI has the potential to significantly improve learning outcomes by offering a more tailored and responsive educational experience.

However, the effectiveness of AI in personalising learning is contingent upon the quality and quantity of data available. AI systems rely on accurate and comprehensive data to make informed decisions about personalised learning paths (Siemens, 2013). In rural settings, where data collection and management practices may be less developed, ensuring the reliability of AI recommendations can be challenging (Graham & Akyol, 2009). This limitation highlights the need for robust data management systems and training to optimise the benefits of AI in personalising learning.

Overall, the ability of AI to personalise learning represents a significant advancement in educational technology, offering the potential to address individual learning needs more effectively than traditional methods. However, realising this potential requires careful consideration of data management practices and the development of supportive infrastructure in rural contexts.

Theme 2. Technological and Infrastructure Challenges.

The review identified several technological and infrastructure challenges associated with implementing AI in rural African universities. One of the primary issues is the lack of reliable internet

connectivity, which is crucial for the effective functioning of AI technologies (Van Deursen & Van Dijk, 2019). In many rural areas, internet access is sporadic or non-existent, which can severely limit the deployment and usability of AI systems (McLaughlin, 2020). This challenge underscores the need for investments in technological infrastructure to support the integration of AI into educational practices.

Additionally, the availability of modern computing devices is another significant barrier. Many rural universities may have outdated or insufficient hardware that is incompatible with the requirements of advanced AI applications (Hargittai, 2018). This disparity in technological resources can hinder the ability of institutions to implement and maintain AI systems effectively (Selwyn, 2016). Addressing this challenge requires targeted funding and support to upgrade technological infrastructure and provide the necessary equipment for AI applications.

Another related issue is the **maintenance and technical support** for AI systems. Even when technological infrastructure is available, maintaining and troubleshooting AI systems can be challenging without adequate technical expertise (Graham & Akyol, 2009). Rural universities often face shortages of IT professionals with the skills required to manage and support AI technologies, which can impact the sustainability of AI initiatives (McLaughlin, 2020). Investing in training and capacity-building for technical staff is essential to ensure the long-term success of AI integration.

Conversely, while AI has the potential to transform education in rural African universities, its implementation is constrained by significant technological and infrastructure challenges. Addressing these barriers requires comprehensive strategies to improve internet connectivity, upgrade computing devices, and provide technical support.

Theme 3. Digital Literacy and Skill Gaps.

Digital literacy and skill gaps were identified as critical barriers to the effective use of AI in rural educational settings. Digital literacy encompasses the ability to use digital tools and technologies effectively, and its absence can limit the successful adoption of AI (Mann & Stewart, 2000). In rural areas, both educators and students may lack the necessary skills to utilise AI systems fully, which can impede the benefits of these technologies (Selwyn, 2016).

The review highlighted that many educators in rural universities have limited experience with digital technologies and may struggle to integrate AI into their teaching practices (Graham & Akyol, 2009). This skill gap can result in ineffective use of AI tools, reducing their potential impact on self-directed learning. Providing professional development opportunities and training programs for educators is crucial to build digital competencies and ensure that AI technologies are used effectively (Holmes et al., 2019).

Students in rural areas also face challenges related to digital literacy. Limited exposure to digital technologies and insufficient training can hinder their ability to engage with AI-driven learning platforms (Van Deursen & Van Dijk, 2019). Enhancing students' digital skills through targeted educational programs and support can improve their ability to use AI tools for self-directed learning and maximise the benefits of personalised educational experiences (Weller, 2020).

Overall, addressing digital literacy and skill gaps is essential for the successful integration of AI in rural educational settings. This involves investing in training and support for both educators and students to build the necessary skills for effective use of AI technologies.

Theme 4. Resistance to Technological Change.

Resistance to technological change emerged as a significant challenge in the integration of AI into rural African universities. Cultural and institutional resistance can arise due to scepticism about the effectiveness of new technologies or concerns about their impact on traditional teaching methods (Blin & Munro, 2008). In rural contexts, where traditional pedagogies are deeply entrenched, introducing AI may face resistance from both faculty and students (Kezar, 2014).

One aspect of this resistance is the **perceived threat to traditional teaching methods**. Educators who are accustomed to conventional teaching practices may be hesitant to adopt AI technologies, fearing that they may undermine their authority or disrupt established methods (Selwyn, 2016). Overcoming this resistance requires a clear demonstration of how AI can complement and enhance existing teaching practices rather than replace them.

Additionally, there may be concerns about the **reliability and validity** of AI systems. Faculty and students may question the accuracy of AI-driven recommendations and feedback, particularly if

they lack familiarity with the technology (Graham & Akyol, 2009). Building trust in AI systems involves ensuring transparency in how these technologies operate and providing evidence of their effectiveness through pilot projects and case studies (Williamson, 2016).

To address resistance to technological change, it is crucial to engage stakeholders in the planning and implementation of AI initiatives. Involving educators, students, and other key stakeholders in decision-making processes can help build support for AI technologies and foster a positive attitude towards their integration (Kezar, 2014). Providing ongoing support and addressing concerns through communication and education can further facilitate the adoption of AI in rural educational settings.

Theme 5. Ethical Considerations.

The ethical implications of using AI in education were a prominent theme in the review. AI technologies raise several ethical concerns, including issues related to **data privacy**, **algorithmic bias**, and the **reinforcement of existing inequalities** (Williamson, 2016). These concerns need to be carefully addressed to ensure that AI is used in a manner that promotes fairness and equity in education.

Data privacy is a critical issue, as AI systems often rely on large amounts of personal data to function effectively. Ensuring that students' data is collected, stored, and used in compliance with privacy regulations is essential to protect their rights and build trust in AI technologies (Selwyn, 2021). Implementing robust data protection measures and maintaining transparency about data practices can help address privacy concerns.

Algorithmic bias is another significant ethical concern. AI systems can inadvertently perpetuate biases present in the data they are trained on, which can lead to discriminatory outcomes (Williamson, 2016). Ensuring that AI systems are designed and tested to minimise bias is crucial for promoting fairness and equity in educational applications. This involves using diverse and representative data sets and regularly auditing AI systems for potential biases.

Lastly, the **reinforcement of existing inequalities** is a concern, particularly in rural settings where disparities in access to technology and resources already exist (Hargittai, 2018). AI technologies should be designed to address, rather than exacerbate, these inequalities. This includes ensuring equitable access to AI tools and providing support to underrepresented and disadvantaged groups (Selwyn, 2016).

Theme 6. Opportunities for Innovation

Despite the challenges, the review identified several opportunities for innovation through the use of AI in rural African universities. AI technologies can facilitate **remote and asynchronous learning**, making high-quality educational resources and support available to students in isolated areas (Weller, 2020). This capability is particularly valuable in rural settings where traditional educational resources are scarce.

AI can also support **innovative pedagogical approaches** by providing tools for interactive and engaging learning experiences. For example, AI-driven platforms can offer virtual simulations, gamified learning activities, and collaborative tools that enhance the learning process (Holmes et al., 2019). These innovative approaches can help make learning more dynamic and engaging, which is especially important in contexts where conventional methods may be less effective.

Furthermore, AI technologies can aid in **scaling educational solutions** to reach a larger number of students. By automating certain aspects of the learning process, such as assessment and feedback, AI can help educators manage larger class sizes and provide personalised support to more students (Breslow, 2018). This scalability can help address the challenges of limited resources and support in rural educational settings.

while the integration of AI into rural African universities presents several challenges, it also offers significant opportunities for innovation. By leveraging AI technologies, these institutions can enhance educational experiences, improve accessibility, and develop new pedagogical approaches. Addressing the identified challenges and seizing these opportunities can lead to meaningful improvements in education for student teachers in rural settings.

Discussion.

The findings of this scoping review provide a comprehensive understanding of how artificial intelligence (AI) can support self-directed learning for student teachers in rural African universities, highlighting both significant opportunities and notable challenges. The review's analysis reveals that AI

has considerable potential to enhance personalised learning, but also faces considerable hurdles related to technological infrastructure, digital literacy, resistance to change, and ethical concerns.

AI's ability to personalise learning stands out as a major benefit, offering tailored educational experiences that can address individual student needs more effectively than traditional methods (Siemens, 2013). Adaptive learning systems, powered by AI, can modify content and feedback based on real-time data from student interactions, making learning more relevant and targeted (VanLehn, 2011). This personalisation can be particularly valuable in rural settings where resources are limited and educational needs are diverse. By providing personalised support, AI can help bridge gaps in knowledge and improve learning outcomes for student teachers (Breslow, 2018).

However, the implementation of AI in rural African universities is impeded by significant technological and infrastructure challenges. Reliable internet connectivity is crucial for AI technologies to function effectively, yet many rural areas face sporadic or inadequate internet access (McLaughlin, 2020). The lack of modern computing devices further exacerbates this issue, as outdated hardware can be incompatible with advanced AI applications (Hargittai, 2018). These challenges highlight the need for targeted investments in technology and infrastructure to support the successful integration of AI in education (Graham & Akyol, 2009).

Another critical barrier is the digital literacy and skill gaps among both educators and students. Effective use of AI requires a certain level of digital competence, which may be lacking in rural contexts (Selwyn, 2016). Educators with limited experience in digital technologies may struggle to integrate AI into their teaching practices, potentially diminishing the effectiveness of these tools (Holmes et al., 2019). Similarly, students who lack digital skills may find it challenging to engage with AI-driven learning platforms (Van Deursen & Van Dijk, 2019). Addressing these gaps through targeted training and professional development is essential for maximising the benefits of AI in education.

Resistance to technological change also poses a significant obstacle. In rural settings, where traditional teaching methods are deeply rooted, there may be scepticism about the effectiveness of AI (Kezar, 2014). Educators and students may fear that AI technologies could undermine established pedagogical practices or be perceived as unreliable (Blin & Munro, 2008). Building trust in AI systems and demonstrating their value through pilot projects and evidence of effectiveness can help address these concerns and foster a more positive attitude towards technological change (Williamson, 2016).

Ethical considerations are another important aspect of AI integration in education. Issues such as data privacy, algorithmic bias, and the reinforcement of existing inequalities must be carefully managed to ensure that AI technologies are used responsibly (Williamson, 2016). Ensuring that student data is protected and that AI systems are designed to minimise bias are crucial steps in addressing ethical concerns (Selwyn, 2021). Furthermore, AI should be used to address, rather than exacerbate, existing educational inequalities, which requires careful consideration of how these technologies are implemented and accessed (Hargittai, 2018).

Despite these challenges, the review highlights several opportunities for innovation through the use of AI. AI can facilitate remote and asynchronous learning, providing access to high-quality educational resources and support for students in isolated areas (Weller, 2020). This capability is particularly valuable in rural settings where traditional educational resources may be scarce. AI can also support innovative pedagogical approaches by offering interactive and engaging learning experiences, such as virtual simulations and gamified activities (Holmes et al., 2019).

The scalability of AI technologies further represents an opportunity to address the challenges of limited resources and large class sizes. By automating certain aspects of the learning process, such as assessment and feedback, AI can help educators manage their workloads and provide personalised support to a larger number of students (Breslow, 2018). This scalability can enhance the reach and impact of educational initiatives, making high-quality education more accessible to students in rural areas.

In summary, while AI presents significant opportunities for enhancing self-directed learning in rural African universities, its implementation is not without challenges. Addressing issues related to technology infrastructure, digital literacy, resistance to change, and ethical considerations is crucial for the successful integration of AI in these contexts. By overcoming these barriers and leveraging the opportunities for innovation, AI has the potential to transform education and improve learning outcomes for student teachers in rural settings.

Future research should focus on developing strategies to address these challenges and explore how AI can be effectively integrated into rural educational environments. This includes investigating methods to improve technological infrastructure, enhance digital literacy, build trust in AI technologies, and address ethical concerns. By addressing these areas, future studies can contribute to the successful implementation of AI in education and support the development of effective, equitable, and sustainable educational practices.

Overall, the integration of AI into rural African universities holds promise for transforming educational practices and improving learning experiences. However, realising this potential requires a concerted effort to address the identified challenges and seize the opportunities for innovation. By doing so, educational institutions can enhance the quality of education and support the development of self-directed learning for student teachers in rural contexts.

Implications and Recommendations.

The findings of this study have significant implications for the integration of artificial intelligence (AI) into self-directed learning for student teachers in rural African universities. Addressing the identified challenges and leveraging the opportunities presented by AI can transform educational practices and enhance learning outcomes. The implications and recommendations provided here are intended to guide policymakers, educational leaders, and technology developers in effectively implementing AI technologies in these contexts.

1. Enhancing Technological Infrastructure.

One of the most critical implications of the study is the need to improve technological infrastructure in rural universities. Reliable internet connectivity and modern computing devices are essential for the successful deployment of AI systems (McLaughlin, 2020; Hargittai, 2018). Policymakers and educational leaders should prioritise investments in infrastructure to ensure that these institutions have the necessary resources to support AI technologies. This includes upgrading internet access, providing updated hardware, and establishing robust technical support systems. By addressing these infrastructural needs, rural universities can create a more conducive environment for AI integration.

2. Addressing Digital Literacy and Skill Gaps.

The study highlights significant digital literacy and skill gaps among both educators and students (Selwyn, 2016). To maximise the benefits of AI, targeted professional development and training programs are essential. Educational institutions should implement comprehensive training initiatives to build digital competencies among educators, enabling them to integrate AI tools effectively into their teaching practices (Holmes et al., 2019). Additionally, students should receive support to develop their digital skills, ensuring they can engage with AI-driven learning platforms and benefit from personalised educational experiences.

3. Building Trust and Overcoming Resistance.

Resistance to technological change poses a considerable challenge to AI integration (Kezar, 2014). To overcome this resistance, it is crucial to involve educators and students in the planning and implementation processes. Engaging stakeholders in discussions about the benefits and potential of AI can help build trust and address concerns about the technology (Blin & Munro, 2008). Providing evidence of AI's effectiveness through pilot projects and case studies can also help demonstrate its value and encourage adoption.

4. Ensuring Ethical Use of AI.

The ethical implications of AI in education, such as data privacy and algorithmic bias, must be carefully managed (Williamson, 2016). Educational institutions should establish clear policies and guidelines to ensure that AI technologies are used responsibly and ethically. This includes implementing robust data protection measures, ensuring transparency in data practices, and regularly auditing AI systems to identify and address biases. By addressing these ethical concerns, institutions can build trust in AI technologies and ensure their responsible use.

5. Leveraging Opportunities for Innovation.

The study identifies several opportunities for innovation through AI, including remote learning and scalable educational solutions (Weller, 2020; Breslow, 2018). Educational institutions should explore and implement AI-driven innovations that can enhance learning experiences and increase accessibility. This may involve developing interactive and engaging learning tools, such as virtual simulations and gamified activities, that cater to the needs of students in rural settings. By embracing these innovative approaches, institutions can improve educational outcomes and provide high-quality learning experiences.

6. Developing Supportive Policies.

Effective integration of AI requires supportive policies and frameworks at the institutional and national levels. Policymakers should develop and implement policies that promote the use of AI in education while addressing the challenges identified in this study. This includes creating funding opportunities for technological infrastructure, supporting professional development programs, and establishing guidelines for ethical AI use. By developing comprehensive policies, governments and educational authorities can facilitate the successful integration of AI and support the development of self-directed learning in rural universities.

7. Promoting Collaboration.

Collaboration between educational institutions, technology developers, and other stakeholders is essential for the effective implementation of AI. Partnerships can help address technological and infrastructural challenges by leveraging expertise and resources from various sectors (Graham & Akyol, 2009). Collaborative efforts can also support the development of customised AI solutions that meet the specific needs of rural universities and enhance the overall impact of AI in education.

8. Future Research Directions.

Finally, further research is needed to explore additional strategies for overcoming the challenges identified in this study and to evaluate the effectiveness of AI in various educational contexts. Future studies should investigate methods for improving technological infrastructure, enhancing digital literacy, and addressing resistance to change. Additionally, research should focus on developing ethical guidelines and best practices for AI use in education. By addressing these areas, future research can contribute to the ongoing development and refinement of AI technologies, ensuring their successful integration into rural African universities.

In conclusion, the integration of AI into self-directed learning in rural African universities presents both significant challenges and promising opportunities. By addressing these challenges and embracing the opportunities for innovation, educational institutions can enhance learning experiences and improve educational outcomes for student teachers. Implementing the recommendations provided can support the effective use of AI and contribute to the development of more equitable and effective educational practices in rural contexts.

Conclusion.

In conclusion, the integration of artificial intelligence (AI) into self-directed learning for student teachers in rural African universities offers transformative potential but is fraught with challenges. The study highlights the significant opportunities AI presents for personalising education, enhancing learning experiences, and scaling educational solutions. However, overcoming obstacles such as inadequate technological infrastructure, digital literacy gaps, resistance to change, and ethical concerns is crucial for realising these benefits. By addressing these challenges through targeted investments, comprehensive training, stakeholder engagement, and ethical considerations, educational institutions can leverage AI to improve educational outcomes and support the development of self-directed learning in underserved contexts.

Limitations of the Study.

The study's primary limitation is its reliance on a scoping review methodology, which, while comprehensive, does not involve primary data collection. This means that the findings are based on existing literature, which may not fully capture the nuanced experiences and real-world contexts of

implementing AI in rural African universities. The scope of the review was limited to articles accessible through Scopus and Google Scholar, which might exclude relevant studies published in less accessible or non-English language sources. Consequently, the study may overlook important insights from local research or grey literature that could offer a more complete picture of the challenges and opportunities associated with AI integration.

Another limitation is the variability in the quality and scope of the reviewed articles. The selected studies, while peer-reviewed and published in English, may vary in their methodological rigor and relevance. This variability can impact the consistency and reliability of the findings, as studies with different research designs, sample sizes, and contexts may yield differing results. The thematic analysis conducted in this review might also introduce subjectivity in interpreting the literature, which could affect the generalisability of the conclusions drawn.

Finally, the focus on rural African universities presents its own set of limitations, as the findings may not be directly applicable to other educational contexts or regions. Rural settings in Africa have unique infrastructural, cultural, and socio-economic challenges that may not be present in urban or developed areas. As such, the insights from this study may not fully translate to other settings where AI is being implemented. Further research is needed to explore how AI integration can be adapted to diverse educational contexts and to validate the findings through empirical studies that capture the lived experiences of educators and students in different environments.

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