Full text open access online (Since 2009)

PRINT: ISSN 0975-1122 ONLINE: ISSN 2456-6322
Int J Edu Sci, 54(3): 421-431 (2026)
DOI: 10.31901/24566322.2026/54.3.1500

Advancing Geography Education with Artificial Intelligence (AI): Exploring Personalised Learning Strategies

Lundi Nomlala[1] and Zenande Nonkula[2]

[1]Humanities and Creative Arts Education Department, Walter Sisulu University, Queenstown, South Africa
[2]Department of Hydrology, University of Zululand, Empangeni, South Africa
E-mail: [1]<lundinomlala90@gmail.com>,
[2]<zenandenonkula@gmail.com>

KEYWORDS Adaptive Systems. Constructivist Learning Theory. Digital Divide. Information and Communication Technology. Spatial Reasoning. TPACK

ABSTRACT This study examines how AI-driven tools enhance pedagogical experiences in tertiary geography in South Africa. Adopting an interpretivist qualitative case study, researchers surveyed 20 student teachers to analyse the adoption of adaptive technologies. Results indicate that these systems markedly advance conceptual mastery, scholarly results, and intrinsic motivation. Nevertheless, infrastructural constraints, scholastic integrity hurdles regarding citation, and potential cognitive dependency remain prominent barriers. Although AI serves as a powerful augmentation to conventional instruction, its efficacy depends on reforming digital frameworks and ethical standards. The findings urge institutions to prioritise professional faculty development and robust connectivity to navigate the 21st century educational transformation.

INTRODUCTION

In the 21st century, the educational landscape is being fundamentally reshaped by technological innovation. At the forefront of this transformation is Artificial Intelligence (AI), a branch of computer science dedicated to developing systems capable of executing tasks that normally require human intelligence. In education, AI's application is driving a shift from a "one-size-fits-all" model to personalised learning, an approach that tailors the learning experience to each student's unique needs, interests, and learning style (Vorobyeva et al. 2025). This study focuses on the integration of these AI-driven personalised learning strategies specifically within the discipline of geography education. Geography, as a subject, requires not only the acquisition of factual knowledge but also the development of complex spatial reasoning, critical thinking, and an understanding of human-environment interactions. The confluence of these fields presents a unique opportunity to enhance learning outcomes and make the subject more dynamic and engaging. This is particularly relevant in South Africa, where educational institutions, including universities in the Eastern Cape, are grappling with challenges like oversized classes and limited resources, making it difficult to implement personalised learning (Mncube et al. 2023).

The academic literature has extensively explored the potential of AI in various educational contexts (Jian 2023; Ayeni et al. 2024; Kaswan et al. 2024). Artificial intelligence tools, such as smart tutoring systems, can improve the educational process, and adaptive learning platforms are lauded for their ability to provide immediate feedback and dynamic content, thereby enhancing student engagement and academic performance. Despite this growing body of research, several critical gaps and inconsistencies persist, particularly within geography. The benefits of artificial intelligence in education are widely acknowledged and well documented, however, there is a dearth of empirical research that explicitly validates the pedagogical value of AI in enhancing core geographical skills, such as spatial thinking, mapping, and data analysis. Much of the existing literature is theoretical or focuses on general applications, leaving a gap in the understanding of how AI effectively supports the unique demands of the geography curriculum (Lee 2023).

Furthermore, recent scholarship has highlighted significant controversy over the ethical implications of AI in education. Concerns about data privacy, algorithmic bias, and the potential for increased student dependence on technology are frequently raised but rarely addressed with robust, practical solutions (Ferrara 2024). There is an inconsistency

between the perceived potential of AI and its actual implementation. These issues are particularly pertinent in South Africa, where equitable access to technology and data security are major concerns (Aruleba and Jere 2022). This study addresses these gaps by providing a qualitative analysis of lived experiences, moving beyond a technical focus to explore AI integration's socio-pedagogical and ethical dimensions.

Research Question

How can Artificial Intelligence be effectively integrated into Geography education to personalise learning experiences and improve student outcomes?

Objective

The central objective of this research is to investigate how Artificial Intelligence (AI) can be effectively integrated into Geography education to facilitate personalised learning experiences and enhance student outcomes. More specifically, the study aims to assess the current extent of AI adoption within Geography pedagogy, identify the unique challenges and opportunities associated with AI-driven instruction in the South African context, and evaluate the perceived impact of these technological tools on student engagement and academic achievement.

Literature Review

The Current State of AI Integration in Geography Education

The integration of AI into geography education is still in its formative stages, but a growing body of literature reveals several key applications. AI-powered tools such as Geographic Information Systems (GIS), which use AI for spatial analysis and predictive modelling, are being used to help students understand complex patterns in geographical data (Rana and Bhambri 2025). Virtual Reality (VR) and Augmented Reality (AR), often enhanced by AI, are creating immersive learning experiences that allow students to explore geographical environments in simulated 3D spaces, thereby enhancing their spatial awareness (Al Balushi et al. 2024). Other applications include AI chatbots that address various questions, while intelligent tutoring systems deliver tailored feedback that can serve as a "24/7" teaching assistant, answering student queries and providing instructional support.

While the potential is clear, the actual level of integration remains uneven. Studies from other contexts, like South Africa, show that a primary obstacle is the lack of adequate digital infrastructure, particularly in rural areas, and a shortage of qualified educators with the digital literacy to effectively implement these tools (Soekamto et al. 2022). A survey of students at a rural Eastern Cape university found that, while there is awareness and interest in AI, challenges such as slow network speeds and limited access to technology are significant barriers to its widespread adoption (Sithole and Mbukanma 2024). This highlights a critical need to improve teacher training and expand digital infrastructure to ensure that the benefits of AI in geography education are not limited to urban or well-resourced institutions.

Perceived Benefits of Using AI-based Personalised Learning Tools in Geography Education

The primary benefit of AI in geography education is its ability to facilitate truly personalised learning experiences (Jian 2023). By analysing student data with algorithms, AI can tailor content and learning paths to an individual's specific needs, learning pace, and style (Admane et al. 2024). This marks a notable advancement over teaching methods that apply the same approach to everyone, allowing students to focus on areas where they need the most support and accelerate in topics they grasp quickly. For example, a student struggling with climate patterns could be provided with targeted simulations and explanations. At the same time, another who excels in that area could be given more advanced data analysis tasks. Tools powered by artificial intelligence boost engagement and motivation by transforming learning into a more interactive and lively experience. Using VR, AR, and interactive GIS platforms transforms abstract concepts into tangible experiences, fostering a deeper interest in the subject. Students highlight that AI tools make learning "fun" and help them better understand concepts. The ability of AI chatbots to provide immediate feedback and serve as a constant source of information also empowers students, allowing them to gain greater control over their learning experi-

ence and providing a form of academic support that may not always be available from teachers and lecturers.

The Impact of AI-driven Personalised Learning Strategies on Student Engagement and Academic Performance in Geography

Research consistently indicates a positive correlation between the use of AI tools and student engagement and academic performance. Studies have shown that personalised learning experiences that cater to an individual student's strengths and interests can improve their overall educational experience, engagement, motivation, and conceptual mastery (Selvakumar et al. 2025). By providing real-time feedback and adaptive content, AI platforms can help students address knowledge gaps and solidify their understanding of complex geographical concepts, which is often reflected in improved grades and test scores (George 2023). A study examining student engagement with AI tools found a robust positive correlation between behavioural engagement and academic performance, suggesting that when students actively use these tools, their academic performance improves. It is crucial to note that AI tools are most effective when they serve as an addition to traditional teaching methods rather than a replacement. The human element of instruction remains central to fostering meaningful learning interactions, critical thinking, and social-emotional skills. AI platforms are most impactful when they free educators from administrative responsibilities, allowing them to focus on teaching and offer personalised mentorship (Vashista et al. 2023). Students express that AI tools improve their understanding and academic level, but not to the extent of replacing the teacher entirely (Chan and Tsi 2024).

Challenges and Ethical Concerns Faced by Students when Using These Tools

The use of artificial intelligence (AI) in the education sector, particularly in South Africa, is becoming increasingly prevalent but is also fraught with challenges and ethical concerns. One of the most significant issues is the digital divide, which, in marginalised communities, exacerbates existing educational inequalities by unequal access to technology and reliable internet connectivity. This can create a situation in which only a select group of students can benefit from these advanced tools, leaving others behind. Furthermore, the lack of clear institutional policies on AI use creates confusion among students and educators about academic integrity and plagiarism (Tarisayi 2025). In Nwozor's (2025) study, many students are unsure how much they can rely on AI-generated content without crossing the line into academic dishonesty, highlighting the urgent need for a standardised protocol.

Beyond academic integrity, other ethical concerns include data privacy and algorithmic bias. AI systems rely on large datasets, and there is a risk that these datasets may contain biases that could be perpetuated by the AI, leading to unfair outcomes for certain student groups (Ferrara 2024). There are also concerns about the potential for excessive student dependency on AI, which could deteriorate critical thinking and problem-solving skills. The research by Zhai et al. (2024), Çela et al. (2024), George et al. (2024) and Szmyd and Mitera (2024) indicates that students are aware of this risk, with some consciously limiting their use of AI to avoid overreliance. Therefore, a careful balancing act is required to leverage the benefits of AI while safeguarding human-centric skills and ethical principles.

Theoretical Framework

This study is underpinned by the Technological Pedagogical Content Knowledge (TPACK) (Mishra and Koehler 2006) framework and Constructivist Learning Theory (Piaget 1971; Vygotsky 1978), which provide a strong foundation for understanding the use of AI-driven personalised learning in Geography education. TPACK highlights the need for teachers to integrate content knowledge (what to teach), pedagogical knowledge (how to teach), and technological knowledge (which tools to use) to design meaningful lessons (Mishra and Koehler 2006). In Geography, this involves selecting appropriate AI tools that support map work, spatial analysis, and geographic inquiry while ensuring that content and pedagogy remain aligned.

Constructivist Learning Theory, rooted in the work of Piaget (1971) and Vygotsky (1978), emphasises that learners actively build knowledge through experience, interaction, and problem-solving. From

this perspective, AI's adaptive features can provide scaffolding within each learner's zone of proximal development by adjusting tasks to their prior knowledge, offering real-time feedback, and encouraging inquiry-based learning. This ensures that Geography students engage meaningfully with concepts such as scale, projection, and spatial processes rather than relying solely on rote learning. As shown in Figure 1, these theories, TPACK and constructivism, complement each other in grounding this study.

TPACK ensures that the integration of AI into Geography education is both pedagogically sound and content-appropriate, while constructivism explains how AI personalisation promotes deeper, student-centred learning. This integration is particularly relevant in the South African higher education context, where students enter with diverse academic backgrounds and require adaptive, learner-centred approaches to support their engagement and success in Geography. Integrating AI into geography education presents a transformative opportunity to move beyond traditional pedagogical methods and provide more personalised, engaging, and effective learning experiences. The literature overwhelmingly points to AI's potential to enhance student understanding and academic performance through adaptive content, immersive technologies, and real-time support.

METHODOLOGY

This research is grounded in the interpretivist paradigm, which emphasises the subjective interpretation of human experiences. Interpretivism was chosen because the study seeks to understand how students perceive and interpret the use of AI-driven personalised learning in their Geography education (Omodan 2022; 2024). Rather than generalising findings to all students, the study focuses on the meanings and experiences of a specific group, allowing for rich, contextualised insights. This paradigm aligns with the study's exploratory nature and supports the generation of nuanced understandings of how AI is integrated into Geography teaching and learning.

The study used a qualitative research approach, which is particularly suited to exploring participants' perceptions and experiences in depth. Qualitative research was appropriate because it prioritises participants' voices and provides descriptive insights that cannot be captured through numerical data alone (Tracy 2024; Lim 2025). By using open-ended questions, the study elicited detailed accounts of students' experiences with AI tools, their challenges, and their perceived benefits of personalised learning in Geography education. This approach ensured that the complexities of AI integration in education were adequately explored. A case study design was adopted, focusing on one South African university, Walter Sisulu, in the Eastern Cape. The case study approach was suitable because it allowed for an in-depth exploration of the phenomenon within its real-life context (Priya 2021), that is, the experiences of Geography teaching students with AI. The case study design enabled the researcher to examine not only individual perspectives but

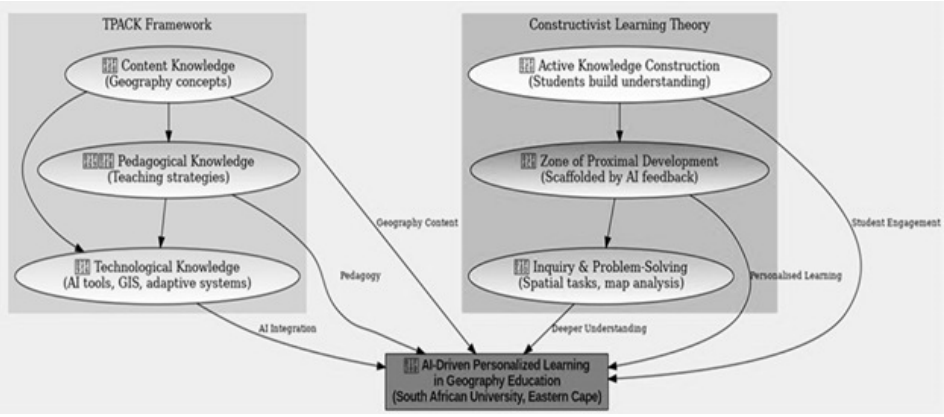

Fig. 1. Correlation of these theories to the study
Source: Authors 2026

also patterns and themes across participants, providing a holistic understanding of how AI is perceived in the specific educational setting. This grounded the research contextually and made it relevant to teacher education in South Africa.

To address the requirement for methodological clarity regarding data collection, this study is an empirical inquiry based on primary field data. The study population comprised third-year B.Ed. Humanities students registered for Geography teaching at a South African university. From this population, a purposive sample of 20 students was selected. Purposive sampling was used to specifically target students with prior experience using AI tools, as their perspectives were directly relevant to the research questions. This sampling strategy ensured that participants were well-positioned to provide meaningful insights into the application of AI for personalised learning in Geography education. The manageable sample size allowed for detailed data collection and thematic analysis. Data were collected via a Google Forms survey with open-ended questions designed to capture students' experiences and perspectives on AI-driven personalised learning. The online survey format offered flexibility, convenience, and accessibility, allowing participants to respond at their own pace. Google Forms also facilitated efficient data management and ensured that responses were stored securely. The open-ended nature of the questions enabled students to articulate their thoughts in detail, providing rich qualitative data aligned with the study's interpretivist and qualitative orientation.

The data collected through Google Forms were analysed using thematic analysis. Following Braun and Clarke's (2006) framework, the researcher engaged in a step-by-step process of familiarising with the data, generating initial codes, identifying themes, reviewing and refining these themes, and producing a structured narrative, an approach later refined by Braun and Clarke (2022) to foreground reflexivity and researcher positionality in theme development. Thematic analysis was appropriate as it allowed the researcher to identify patterns and recurring ideas across participants' responses while also capturing unique perspectives. This method ensured that the analysis remained grounded in the data and reflective of participants' lived experiences with AI in Geography education.

To maintain trustworthiness and rigour, the study adhered to the criteria of credibility, transferability, dependability, and confirmability (Ahmed 2024). Credibility was enhanced by aligning the survey questions directly with the research objectives, ensuring that responses addressed the study's focus. Transferability was supported by providing a detailed description of the research context and participants, enabling others to determine the relevance of findings in similar settings. Dependability was strengthened by maintaining consistency in the data collection process, while confirmability was ensured by minimising researcher bias and keeping a clear record of the analysis process. Although the study did not require a formal ethical clearance certificate, as it was conducted as a topic survey on the "application of ICT in Geography", ethical principles were upheld. Participants were informed of the study's purpose and assured that their responses would remain anonymous and confidential. Participation was voluntary, and students could withdraw at any point. No personal identifiers were collected, and the data were used solely for academic purposes. By adhering to these ethical practices, the study safeguarded the dignity and rights of all participants. To maintain anonymity and confidentiality, participants were identified as P1-P20 rather than by name. The study faced certain limitations, including its small sample size of 20 participants, which may limit the generalisability of the findings beyond the selected university context. Furthermore, data collection via Google Forms limited the opportunity to probe responses in greater depth, as would be possible in interviews. However, the study also had clear delimitations, as it intentionally focused only on third-year B.Ed. Humanities students specialising in Geography teaching with prior AI experience. These delimitations were necessary to ensure that the data collected were relevant to the study's objectives, even if they narrowed the research's scope.

RESULTS

The thematic analysis of data collected via the Google Forms survey revealed four key themes regarding participants' perceptions and experiences with AI-driven personalised learning tools in geography education. The findings are presented below, incorporating both qualitative narratives and quantitative context to explain the data trends. As illustrated in Figure 2, the themes represent a holistic view of the educational impact, ranging from cognitive gains to infrastructural and ethical barriers.

Fig.2. Themes represent a holistic view of the educational impact, ranging from cognitive gains to infrastructural and ethical barriers
Source: Authors 2026

Theme 1: Improved Understanding and Academic Performance

A predominant theme that emerged from the data was the students' belief that AI tools significantly improve their comprehension of geographical concepts and, consequently, their academic performance. Quantitatively, a significant majority of the 20 participants explicitly linked their improved grades to the use of these tools. Participants reported that AI's ability to provide tailored information and simplify complex topics was highly beneficial.

P1: "*The tools simplify some of the concepts that I find difficult to grasp; they even allow me to ask questions that a human might not be able to answer.*"

P2: "*It has improved my understanding to a great extent because it is easy to get information on this tool, and my results have improved.*"

P20: "*AI-based personalised learning tools provide a better understanding of Geography concepts. Largely improved my understanding because it is easy to get information.*"

These findings are consistent with the academic literature, which notes that AI-powered tools such as intelligent tutoring systems and adaptive learning platforms are lauded for their ability to provide real-time feedback and dynamic content, thereby improving student engagement and academic performance (Jian 2023; Ayeni et al. 2024; Kaswan et al. 2024). This directly aligns with the Constructivist Learning Theory, as students actively build on their prior knowledge with the aid of the AI. Many students also noted a direct correlation between their use of these tools and better grades, confirming the link between enhanced comprehension and academic outcomes.

P12: "*It played a significant role in improving my academic performance.*"

P2: "*It has improved my academic performance in the Geography module to a greater extent. My grades have improved.*"

The participants' responses underscore a strong belief in AI tools' capacity to serve as effective scaffolds for learning. They perceive these tools not merely as sources of information but as dynamic

aids that facilitate a deeper, more personalised understanding of complex geographical concepts.

Theme 2: Enhanced Engagement and Motivation

The findings indicated that AI tools make the learning process more engaging and interactive for the students. Qualitative feedback suggests that the visual nature of AI-driven geography tools acts as a primary motivator for sustained study sessions.

P3: "*They help in making the topics more engaging.*"

P16: "*Yes, they do, because it becomes exciting when doing research.*"

P13: "*It makes teaching and learning fun, and students get more involved in the learning process.*"

This aligns with the Constructivist Learning Theory's emphasis on active and participatory learning. Students found that the dynamic nature of AI, including visual and interactive features, made learning enjoyable. This confirms findings from other studies that AI-powered tools enhance engagement and motivation by making learning more interactive and dynamic (Selvakumar et al. 2025). Using VR, AR, and interactive GIS platforms transforms abstract concepts into tangible experiences, fostering a deeper interest in the subject.

P3: "*It makes the topics more exciting and easier to grasp, especially when it comes to visual learning.*"

Theme 3: Challenges with Technology and Content Management

Despite the perceived benefits, participants also highlighted significant challenges. While 100 percent of the sample recognised the utility of AI, nearly half of the participants reported regular interruptions due to connectivity issues.

P4: "*The network speed starts to be slow.*"

P10: "*Network starts to be slow.*"

P14: "*My biggest concern is that it is hard to reference the information when doing an assignment, and it makes it hard to be a student and not just someone who takes information from AI.*"

These challenges relate directly to the Technological Knowledge (TK) component of the TPACK model, revealing a gap between the availability of technology and its effective implementation. The most common issues were slow network speeds and a lack of clarity on how to reference AI-generated content. These issues are consistent with the existing literature, which highlights the digital divide and the lack of clear institutional policies on AI use as significant barriers in the South African context (Aruleba and Jere 2022; Sithole and Mbukanma 2024; Tarisayi 2025).

P12: "*How to reference.*"

Theme 4: Concerns about Over-reliance and Teacher Replacement

The fourth theme reflects the students' apprehension about the potential negative consequences of AI integration. This thematic area highlights a critical tension between the tool's efficiency and the students' sense of academic agency.

P14: "*The biggest concern is that students may become lazy and not rely on their own skills and brains.*"

P20: "*That students may rely on AI only and ignore other learning methods.*"

While recognising the value of the tools, participants expressed concern that students could become overly dependent on AI, thereby diminishing their critical thinking and problem-solving skills. This is a crucial finding that aligns with the literature (Çela et al. 2024; George et al. 2024; Szmyd and Mitera 2024; Zhai et al. 2024), indicating that students are aware of this risk. There was strong consensus among participants that AI should complement, rather than replace, traditional teaching (Vashista et al. 2023; Chan and Tsi 2024).

P12: "*I think it can gradually replace traditional teaching. For now, no.*"

P3: "*I do not think it can fully replace a teacher because a teacher is important when it comes to discussions and explanations.*"

The evidence gathered suggests that while embracing AI as a valuable tool, the students in this study remain firm in their conviction that the human element of teaching is irreplaceable. Their responses underscore a clear preference for a blended approach in which AI serves as a support system, not a substitute, for the critical thinking, ethical reasoning, and social interaction that a teacher provides. This finding is significant as it demonstrates that even among "digital native" students, there is a sophisticated understanding of the limitations of automated systems. Consequently, these results reinforce the educator's central role in a constructivist, technology-enhanced classroom, where technology assists rather than governs the pedagogical process (Chan and Tsi 2024; Vashista et al. 2023).

DISCUSSION

The findings from this study confirm and significantly extend existing perspectives on integrating AI in education, particularly through the lens of the Technological Pedagogical Content Knowledge (TPACK) model and Constructivist Learning Theory. The following major observations are critically evaluated in relation to these frameworks and recent scholarship.

AI-Driven Tools Enhance Understanding and Academic Performance

This study observes that AI tools markedly improve conceptual mastery and academic outcomes, reinforcing a growing body of evidence. Recent scholarship by Rana and Bhambri (2025) and Karolcík and Marková (2025) suggests that AI is no longer a peripheral tool but a core component of "Smart Geography", where machine learning algorithms assist in processing complex spatial variables. When evaluated through a Constructivist lens, this synergy occurs because AI's ability to provide personalised, real-time feedback allows students to actively construct knowledge by addressing individual cognitive gaps. This confirms the findings of Jian (2023), Ayeni et al. (2024), and Kaswan et al. (2024) on the positive correlation between AI-driven adaptive platforms and student outcomes. However, newer insights from Vorobyeva et al. (2025) suggest that the "scaffolding" provided by AI is most effective when it moves beyond rote information retrieval toward higher-order analytical tasks. The TPACK framework explains that it is not merely the presence of the technology (TK) that improves performance, but its strategic alignment with effective pedagogy (PK) and specific geography content (CK). As participants noted that AI "simplifies difficult concepts", it becomes evident that the technology is bridging the gap between prior knowledge and advanced geographical inquiry. This finding is corroborated by Kgosi et al.'s (2026) South African TPACK-and-SAMR-informed study of pre-service teacher preparation, which similarly cautions that AI use clusters at the lower "Substitution" and "Augmentation" levels unless teacher educators deliberately scaffold tasks toward the transformative "Modification" and "Redefinition" levels of technology integration.

Sanli's (2025) systematic review of AI applications in geography teaching cautions that pedagogical gains are unevenly distributed across subdisciplines, with physical geography and mapping tasks benefiting more consistently than qualitative reasoning in human geography. This tempers the present study's optimism and suggests that the improved comprehension participants reported may be concept-specific rather than uniform across the discipline. Corroborating this, Lee's (2026) study of geography teachers found that gains from generative AI materialised only after structured professional development, not from unguided exposure to the tools themselves, implying that the positive outcomes recorded here are likely contingent on the students' prior digital literacy and on staff capacity to model effective AI-assisted inquiry, a boundary condition this study's sample cannot fully test.

AI Tools Increase Student Engagement and Motivation

The finding that AI makes learning "fun" and "engaging" aligns with contemporary research on the affective dimensions of educational technology (Selvakumar et al. 2025). Newer studies by Al Balushi et al. (2024) and recent reports on immersive geography Lee's (2026) emphasise that "gamified" AI environments significantly lower the cognitive barriers to entry for complex subjects such as meteorology and urban planning. By transforming abstract geographical data into tangible, interactive experiences, AI facilitates a core tenet of Constructivism that active engagement is the precursor to meaningful learning. Critically evaluating this, it can be seen that while older literature focused on the novelty of technology, recent scholarship in 2025-2026 shifts the focus to "sustained engagement" through AI-driven Virtual Reality (VR). When an educator leverages AI (TK) to simulate complex spatial processes (PK) within a geography lesson (CK), they demonstrate high-level TPACK mastery, effectively positioning technology as a fundamental catalyst for intrinsic motivation rather than a classroom distraction. Yet this optimism must be qualified: Sanli (2025) notes that immersive, VR-driven engagement is precisely the application most dependent on high-bandwidth infrastructure and specialised hardware, meaning the sustained-engagement gains reported in well-resourced contexts are unlikely to transfer directly to the network-con-

strained setting described by this study's own participants. Read critically, therefore, the participants' enthusiasm for AI likely reflects engagement with comparatively lightweight tools such as chatbots and search-based platforms rather than the fuller VR-based experiences highlighted in the wider literature, indicating that "engagement" in this South African case is a narrower construct than in infrastructure-rich settings.

Infrastructural and Technical Challenges Hinder AI Integration

Despite cognitive benefits, this study identifies critical barriers to slow network speeds and referencing ambiguities that mirror systemic inequities in South Africa (Aruleba and Jere 2022; Sithole and Mbukanma 2024; Tarisayi 2025). This directly echoes Mokoena and Seeletse's (2025) study of rural South African educators, which similarly found that unreliable connectivity, limited devices, and insufficient digital literacy training constrain AI adoption regardless of teachers' pedagogical willingness. Evaluating these observations through the TPACK model reveals a profound "Infrastructural TK Gap", a term increasingly used in 2026 literature to describe the disconnect between advanced software and regional hardware capabilities. Even with high pedagogical and content knowledge, the absence of robust digital frameworks prevents the full realisation of AI's potential. Recent 2025 scholarship by Nwozor (2025) explores the "Academic Honesty-Dishonesty Nexus", elaborating on the participants' concerns about referencing. This suggests that institutional policies are lagging. There is an urgent need to transition from "access-focused" policies to "fluency-focused" policies that incorporate ethical prompt engineering as an essential component of teacher training. A useful comparator is Yang's (2026) study of AI and assessment in geography education, which found that reactive, detection-based responses to referencing ambiguities were less effective than proactively redesigning assessment around project-based, data-driven tasks and the oral defence of student reasoning. Applied critically to the present findings, this suggests that the participants' referencing anxieties are not solely an infrastructural or policy gap but also a symptom of assessment formats that remain poorly matched to an AI-mediated learning environment; addressing the "Infrastructural TK Gap" without also reforming assessment design, as Yang (2026) argues, risks treating only half of the problem.

Students Perceive AI as a Complement, Not a Replacement for Teachers

A significant finding is the firm conviction that AI cannot replace the human educator, a sentiment aligned with studies emphasising social-emotional mentorship (Vashista et al. 2023; Chan and Tsi 2024). Ghamrawi et al.'s (2026) recent qualitative study of school principals in AI-active schools reaches a compatible but more precise conclusion: teachers remain indispensable not simply because they possess emotion or morality in the abstract, but because they perform specific, observable practices, such as requiring students to justify and critique AI-generated content and converting AI outputs into prompts for reflection, that AI cannot originate on its own. Read against this evidence, the present participants' generalised claim that "a teacher is important….when it comes to discussions and explanations" gains sharper meaning: it is not the teacher's mere presence but their active, judgement-based mediation of AI outputs that participants are implicitly valuing, a distinction the original data collection instrument did not probe directly and which future interview-based research should examine explicitly. A recent 2026 critique of generative AI in education suggests that while AI can replicate "teaching" (information delivery), it cannot replicate "educating" (moral and critical guidance). From a Constructivist perspective, learning is a social process requiring nuanced discussion. The TPACK model reinforces this by placing the teacher at the centre of decision-making. Elaborating on this, AI is increasingly viewed in Sanli's (2025) review of intelligent tutoring systems in geography education as an "automated teaching assistant" rather than a lead instructor. The results confirm that a blended approach where AI supports but does not govern is the most ethically sound and pedagogically effective path forward, ensuring that the human element of instruction remains irreplaceable in the age of automation.

CONCLUSION

The integration of AI-driven personalised learning tools into geography education offers a transformative pathway to enhance student outcomes and engagement. This research concludes that while these technologies significantly bolster conceptual mastery and intrinsic motivation by simplifying com-

plex spatial data, their utility is fundamentally contingent upon robust institutional support. The evidence indicates that AI functions most effectively as a digital scaffold that complements rather than replaces the essential human element of pedagogy. However, the persistence of the digital divide and ambiguities surrounding scholarly integrity remain significant barriers that must be navigated. Ultimately, successful adoption requires a deliberate alignment of technological tools with sound pedagogical strategies, ensuring that innovation empowers both educators and learners within the evolving South African higher education landscape.

RECOMMENDATIONS

To support the strategic integration of AI in geography education, several key initiatives must be prioritised. Institutions should invest in robust digital infrastructure to ensure equitable access while establishing comprehensive ethical policies and referencing guidelines for AI-generated content. Professional development programs must be implemented to equip educators with TPACK-aligned skills, ensuring that the curriculum effectively incorporates tools such as GIS to enhance spatial analysis. Educational stakeholders should prioritise curricular adaptations that foster digital literacy and mitigate over-reliance. Future research should expand into larger-scale, mixed-methods studies to examine the long-term impact of AI on critical thinking and to generalise these findings across diverse academic populations.

LIMITATIONS

This research explores the integration of AI-driven personalised learning tools in Geography education within a South African university context using a qualitative case study design. The study concludes that while AI significantly bolsters conceptual mastery and student engagement by acting as a dynamic instructional scaffold, its success is fundamentally contingent upon overcoming systemic barriers such as the digital divide and ethical ambiguities regarding academic integrity. Ultimately, the findings advocate for a blended pedagogical approach where AI serves as a powerful complement to, rather than a replacement for, the essential mentorship and critical guidance provided by the educator.

Int J Edu Sci, 54(3): 421-431 (2026)

ACKNOWLEDGEMENTS

The participants of this study are acknowledged for their voluntary and valuable contributions. Grateful appreciation is also extended to the Walter Sisulu University Research Directorate for its institutional policies regarding research capacitation and for providing the necessary funding for the publication of this manuscript.

REFERENCES

Admane R, Sawale PS, Jayasree R et al. 2024. Artificial Intelligence in education: Tailoring curriculum to individual student needs through AI-based systems. *Lib Prog: Lib Sci Inf Technol Comput*, 44: 8847-8856.

Ahmed SK 2024. The pillars of trustworthiness in qualitative research. *J Med Surg Public Health*, 2: Article 100051.

Al Balushi JSG, Al Jabri MIA, Palarimath S et al. 2024. Incorporating Artificial Intelligence Powered Immersive Realities To Improve Learning Using Virtual Reality (VR) And Augmented Reality (AR) Technology. In: *2024 3rd International Conference on Applied Artificial Intelligence and Computing (ICAAIC)*. IEEE, pp. 760-765. Salem, India, 5-7 June 2024.

Aruleba K, Jere N 2022. Exploring digital transformation challenges in rural areas of South Africa through a systematic review of empirical studies. *Sci Afr*, 16: e01190.

Ayeni OO, Al Hamad NM, Chisom ON et al. 2024. AI in education: A review of personalized learning and educational technology. *GSC Adv Res Rev*, 18: 261-271.

Braun V, Clarke V 2006. Using thematic analysis in psychology. *Qual Res Psychol*, 3: 77-101.

Braun V, Clarke V 2022. Conceptual and design thinking for thematic analysis. *Qual Psychol*, 9: 3-26.

Çela E, Fonkam MM, Potluri RM 2024. Risks of AI-assisted learning on student critical thinking: A case study of Albania. *Int J Risk Contingency Manag*, 12: 1-19.

Chan CKY, Tsi LH 2024. Will generative AI replace teachers in higher education? A study of teacher and student perceptions. *Stud Educ Eval*, 83: 101395.

Ferrara E 2024. The butterfly effect in artificial intelligence systems: Implications for AI bias and fairness. *Mach Learn Appl*, 15: 100525.

George AS 2023. Preparing students for an AI-driven world: Rethinking curriculum and pedagogy in the age of artificial intelligence. *Partners Universal Innov Res Publ*, 1: 112-136.

George AS, Baskar T, Srikaanth PB 2024. The erosion of cognitive skills in the technological age: How reliance on technology impacts critical thinking, problem-solving, and creativity. *Partners Universal Innov Res Publ*, 2: 147-163.

Ghamrawi N, Shal T, Ghamrawi NA 2026. Architecting the artificial intelligence-era principal: Teacher leaders reimagine school leadership. *Manag in Educ*. https://doi.org/10.1177/089202062614733

Jian MJKO 2023. Personalized learning through AI. *Adv Eng Innov*, 5: 16-19.

Karolcík S, Marková M 2025. How teachers perceive innovations in education. *J Res Innov Teach Learn*, 18: 39-55.

Kaswan KS, Dhatterwal JS, Ojha RP 2024. AI in personalized learning. In: G Adarsh, BV Babu, EB Valentina (Eds.): *Advances in Technological Innovations in Higher Education*. 1st Edition. CRC Press, pp. 103-117.

Kgosi AM, Botes W, Neethling S et al. 2026. A TPACK-informed study on equipping pre-service teachers with digital tools, artificial intelligence and open educational resources: Integrated strategies in STEM education. *Afr J Teach Educ Dev*, 5: Article 134.

Lee J 2023. Beyond geospatial inquiry: How can we integrate the latest technological advances into geography education. *Educ Sci*, 13: 1128.

Lee J 2026. Changes in teacher perceptions through professional development on integrating generative AI into geography inquiry activities. *J Geogr*, 125(2): 45-54.

Lim W 2025. What is qualitative research? An overview and guidelines. *Australas Mark J*, 33: 199-229.

Mishra P, Koehler MJ 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teach Coll Rec*, 108: 1017-1054.

Mncube DW, Ajani OA, Ngema T et al. 2023. Exploring the problems of limited school resources in rural schools and curriculum management. *UMT Educ Rev*, 6: 1-31.

Mokoena OP, Seeletse SM 2025. AI in rural classrooms: Challenges and perspectives from South African educators. *Int J Curr Educ Stud*, 4: 30-52.

Nwozor A 2025. Artificial intelligence (AI) and academic honesty-dishonesty nexus: Trends and preventive measures. *AI Ethics*, 27: 1-15.

Omodan BI 2022. A model for selecting theoretical framework through epistemology of research paradigms. *Afr J Inter/Multidiscip Stud*, 4: 275-285.

Omodan BI 2024. *Research Paradigms and Their Methodological Alignment in Social Sciences: A Practical Guide for Researchers*. 1st Edition. Routledge.

Piaget J 1971. *The Psychology of the Child*. USA: Basic Books.

Priya A 2021. Case study methodology of qualitative research: Key attributes and navigating the conundrums in its application. *Sociol Bull*, 70: 94-110.

Rana R, Bhambri P 2025. Harnessing AI and machine learning for enhanced geospatial analysis. In: D Darwish, H Chemingui (Eds.): *Recent Trends in Geospatial AI*. IGI Global Scientific Publishing, pp. 27-72.

Sanli C 2025. Artificial intelligence in geography teaching: Potentialities, applications, and challenges. *Int J Curr Educ Stud*, 4: 47-76.

Selvakumar P, Mishra BR, Mohanapriya T et al. 2025. Student engagement and motivation in personalized learning. In: *Integrating Personalized Learning Methods into STEAM Education*. USA: IGI Global Scientific Publishing, pp. 123-142.

Sithole V, Mbukanma I 2024. Prospects and challenges to ICT adoption in teaching and learning at rural South African universities: A systematic review. *Res Soc Sci Technol*, 9: 178-193.

Soekamto H, Nikolaeva I, Abbood AAA, et al. 2022. Professional development of rural teachers based on digital literacy. *Emerg Sci J*, 6: 1251-1265.

Szmyd K, Mitera E 2024. The impact of artificial intelligence on the development of critical thinking skills in students. *Eur Res Stud J*, 27: 1022-1039.

Tarisayi KS 2025. Lustre and shadows: Unveiling the gaps in South African university plagiarism policies amidst the emergence of AI-generated content. *AI Ethics*, 5: 245-251.

Tracy SJ 2024. *Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact*. USA: John Wiley and Sons.

Vashista N, Gugnani P, Bala M et al. 2023. The educator's lens: Understanding the impact of AI on management education. *Int J Educ Dev ICT*, 19: 9-27.

Vorobyeva KI, Belous S, Savchenko NV et al. 2025. Personalized Learning through AI: Pedagogical approaches and critical insights. *Contemp Educ Technol*, 17: ep574.

Vygotsky L 1978. Interaction between learning and development. In: G Cole (Ed.): *Readings on the Development of Children*. Scientific American Books, pp. 34-40.

Yang H 2026. Advancements in artificial intelligence and the reframing of student assessment in geography education. *J Geogr High Educ*, 1-11.

Zhai C, Wibowo S, Li LD 2024. The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. *Smart Learn Environ*, 11: 1-21.

Paper received for publication in April, 2026
Paper accepted for publication in August, 2026