Generative AI as a Collaborative Partner Empowering Tanzanian Secondary School Teachers to Deliver Personalised Learning and Overcome Barriers to Equitable Adoption

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Abstract
Many educators face overcrowded classrooms and limited resources, making it challenging to meet diverse student needs. This study examines how generative AI can assist secondary school teachers in Tanzania to create personalised learning paths more efficiently and effectively. Employing a convergent parallel mixed-methods design, the study integrated concurrent quantitative experimental elements (pre- and post-intervention assessments of student engagement, performance, and teacher workload via paired t-tests) with qualitative data (teacher feedback, usage logs, open-ended surveys, and focus groups). To ground findings in authentic contexts, the qualitative strand drew on bounded, site-specific insights from participating schools in Dar es Salaam (urban) and Dodoma (semi-urban/rural elements). Data were collected from 120 teachers who tested accessible AI tools such as ChatGPT and Grok for lesson planning, assessment, and adaptive content delivery. Quantitative data underwent paired t-tests; qualitative data were analysed through thematic coding; integration occurred at interpretation for triangulation. Results showed significant improvements in student engagement (from 2.8 to 4.3 on a 5-point scale) and academic performance (test scores increased from 61% to 75%), alongside a reduction in teacher workload. Teachers perceived the tools as intuitive and beneficial for customising instruction, though challenges such as inadequate training and infrastructure (especially in rural areas) persisted. The study concludes that generative AI offers a scalable, inclusive solution when supported by professional development and digital upgrades. It recommends strategic investments in AI literacy training, rural connectivity, and localised ethical guidelines to realise its potential and address equity gaps in Tanzanian schools.

Keywords: *Generative AI in Tanzanian Education, Personalised Learning Paths, Teacher-AI Collaboration, AI*

Introduction

The rapid evolution of artificial intelligence (AI) has paved the way for innovative pedagogical approaches in education (Miao& Holmes, 2021). One of the most promising applications of AI in education is the development of personalised learning paths that adapt teaching materials and instructional

methods to meet the unique needs of individual students. This article explores the potential of leveraging generative AI to create personalised learning experiences in Tanzanian classrooms, serving as a practical assistant to teachers while aiming to improve student performance and engagement (Arias-Flores *et al*., 2025; Holmes, 2019).

The integration of artificial intelligence (AI) into education has ushered in transformative possibilities, particularly through the advent of generative AI tools that create content, adapt resources, and support human efforts in unprecedented ways. As classrooms grow increasingly diverse and student needs become more complex, teachers face mounting challenges in delivering personalised learning experiences that cater to individual strengths, weaknesses, and interests (Arias-Flores *et al*., 2025; Miao & Holmes, 2021). Generative AI, by encompassing technologies like OpenAI's GPT models, DALL-E for image generation, and xAI's Grok, offers a promising avenue to address these challenges by partnering with educators rather than replacing them. This paper explores how such tools can simplify the creation of tailored learning paths, empowering teachers to enhance their efficacy and improve student outcomes in an era of technological innovation and educational demands (Kasneci *et al.,* 2023; Zhao *et al*., 2024).

Background and Rationale

Personalised learning, a pedagogical approach to customise education to individual student profiles, has long been recognised as a driver of engagement and academic success (Bernacki *et al*., 2021; Lin *et al*., 2024). However, its implementation is hindered by substantial obstacles, including time constraints, limited resources, and learners' diverse needs (Lin *et al*., 2024; Zhao *et al*., 2024). Teachers often struggle to design adaptive lesson plans or provide individualised feedback within traditional classroom settings (Wang et al., 2025). The rise of AI in education has introduced tools to alleviate these burdens, with generative AI emerging as a standout innovation. Technologies such as GPT-4 and DALL-E (Arias-Flores *et al*., 2025; Ranganai *et al*., 2022) can generate text, images, and interactive content, while platforms such as Grok, developed by xAI, provide real-time assistance tailored to specific queries (Dwivedi *et al*., 2023). Studies highlight their potential to automate administrative tasks and enhance content delivery (Holmes, 2023), yet their role in supporting teachers' creative and pedagogical agency remains underexplored. This study is particularly timely in the Tanzanian context, where the post-2022 proliferation of accessible generative AI tools offers immediate potential to alleviate teachers' burdens in overcrowded, resource-limited classrooms; however, without targeted, teacher-centred research, adoption risks reinforcing inequities, especially between urban and rural areas. By positioning generative AI as a collaborative partner that amplifies teachers'

agency rather than supplanting it, the present work addresses an urgent need to bridge global technological promise with local pedagogical realities, informing equitable, scalable integration in sub-Saharan African education systems.

Global Trends in Generative AI in Education

Integrating Artificial Intelligence (AI) in education reshapes traditional pedagogical models through personalised learning pathways. Numerous studies have established that AI-enhanced learning environments significantly improve academic outcomes, learner engagement, and knowledge retention (Holmes, 2019; Marques-Cobeta, 2024). AI algorithms, particularly those enabling adaptive learning, help tailor educational experiences to individual learners by analysing patterns in performance, identifying strengths and weaknesses, and customising content delivery accordingly (Alam, 2023). Generative AI tools, such as ChatGPT and other large language models, are increasingly used to create dynamic instructional materials, generate personalised quizzes, and support inquiry-based learning, facilitating more engaging and inclusive educational experiences (Laak & Aru, 2024).

Moreover, generative AI addresses key limitations of traditional education systems by supporting students who may otherwise be marginalised by rigid, standardised methods. Research indicates that learners interacting with AI-generated resources tend to display increased perseverance in complex subjects and higher intrinsic motivation (Aleven *et al*., 2023). Real-time analytics and intelligent tutoring systems provide educators with actionable feedback, allowing for continuous refinement of learning strategies and improved academic support tailored to each student (Huang *et al.,* 2023).

Despite these advances, the majority of existing research on AI in education has prioritized student-facing applications, such as adaptive tutoring systems, automated feedback, or predictive analytics while teacher-centred perspectives, including how generative AI can enhance rather than diminish educators' creative and pedagogical agency, remain comparatively underexplored (Holmes *et al.*, 2022; recent scoping reviews on GenAI and agency in education, 2024-2025). For example, systematic analyses indicate that only a small proportion of AIED studies address teacher perceptions of usability, control, or collaborative design; most focus on technical efficacy or student outcomes rather than on empowering educators as active partners (e.g., limited empirical work on teacher agency in the integration of generative tools). This bias is particularly evident in resource-constrained settings, where teacher workload and agency are critical yet under-addressed factors

Relevance to the Tanzanian Educational Context

In Tanzania, as in many sub-Saharan African countries, challenges such as overcrowded classrooms, scarce teaching materials, and heterogeneity in

student needs hinder effective teaching and learning (Bigham *et al.*, 2017; Said, 2018). These structural limitations strengthen the case for personalised, AI-driven instruction. While infrastructure gaps remain a barrier, early evidence suggests that even low-resource contexts can benefit from targeted AI interventions that optimise teacher-student interaction and support differentiated instruction (Maritim & Mushi, 2012; Mnyawami *et al.*, 2022; Sedoyeka, 2012)

Local research underscores these challenges: Mtebe and Raphael (2018) identified key barriers to e-learning satisfaction, including inadequate infrastructure and training, while Sedoyeka (2012) highlighted financial and connectivity barriers that perpetuate the digital divide. More recent studies on AI readiness in Tanzanian teacher-training colleges and secondary schools reveal positive attitudes but limited preparedness, with calls for enhanced digital pedagogy and ethical frameworks to support adoption (Mtebe & Raphael, 2018; Nkya *et al.*, 2024; Ponera & Madila, 2024)

The adoption of generative AI tools in Tanzanian schools holds promise for transforming education by supplementing teacher capacity and offering individualised learning pathways. Applying these models in Tanzania could help bridge educational inequalities, foster digital literacy, and prepare learners to thrive in an increasingly knowledge-driven economy (Ishengoma & John, 2024; Mtebe & Raphael, 2018; Ponera & Madila, 2024). Despite the proliferation of AI research in education, much of the literature focuses on AI as a standalone solution, potentially supplanting human educators rather than complementing them. For instance,Click or tap here to enter text.) emphasise machine learning's predictive power in modelling complex systems. Tellman *et al.* (2021) showcase the satellite application of AI for large-scale applications, but neither addresses teacher-centred collaboration. Similarly, studies on teachers remain central to education and require tools that amplify their efforts rather than replace them (Cukurova *et al.*, 2020; Molenaar, 2021). The ease of use and integration of generative AI into daily teaching practices also receives insufficient attention, limiting its use in resource-constrained settings

This study proposes the use of generative AI as a collaborative partner for teachers, enabling them to build personalised learning paths more easily and efficiently. The significance of this approach lies in its dual benefits: for teachers, generative AI reduces workload and sparks creativity by automating routine tasks and suggesting innovative ideas for students; it delivers individualised support that aligns with their learning pace and preferences (Xie *et al.*, 2019; Zhai *et al.*, 2021). As education systems worldwide grapple with equity and scalability challenges, this partnership offers a human-centred

solution that bridges technological potential with classroom realities, promising a more inclusive and effective learning environment.

Literature Review

Personalised Learning in Education

Personalised learning aims to adapt educational experiences to individual student needs, preferences, and abilities, moving beyond the one-size-fits-all model of traditional education. Vygotsky's zone of proximal development provides a theoretical basis for the idea that learning is most effective when scaffolded to a student's current level. Traditional methods, such as differentiated instruction, have sought to achieve this by varying content, processes, or products based on student readiness (Tomlinson, 2016). However, these approaches face significant limitations. Research by Thomas, (2023) highlights that teachers struggle to implement personalisation at scale due to time constraints and resource shortages, with only 20% of surveyed educators reporting consistent success. Similarly, (Marques-Cobeta, 2024) notes that manual differentiation often fails to address diverse learning paces, leaving gaps in student engagement and achievement. These challenges underscore the need for tools that simplify and enhance personalised teaching, particularly in resource-constrained settings.

Generative AI and Teacher Support

The role of Generative AI in education has evolved from automating tasks to supporting human instructors, a shift increasingly documented in recent literature. (Holmes, 2019) provide a seminal review, noting that early AI systems, such as intelligent tutoring systems (ITS), were designed to replace teachers but often lacked the nuance of human judgment. More recent studies emphasise collaboration over substitution. For example, Octavio *et al.* (2024) describe AI as a *"teacher's assistant*," capable of handling repetitive tasks (e.g., grading) to free educators for higher-order instruction. (Molenaar, 2022) extends this, showing that hybrid human-AI systems improve student outcomes by 12% in adaptive learning environments. Specifically, regarding generative AI, Baidoo-Anu and Ansah (2023) found that teachers using ChatGPT for lesson planning reported a 25% reduction in preparation time, thereby enabling them to focus more on student interaction. Similarly, Selwyn, (2021) highlights generative AI's role in scaffolding teacher creativity, though he warns of over-reliance risks. These findings suggest a growing consensus: Generative AI's value lies in empowering, not replacing, educators, a perspective this study builds upon. To successfully implement generative AI in Tanzanian classrooms, it is essential to integrate these technologies within existing educational frameworks. Many schools already utilise LMSs for administrative tasks and content distribution, providing a ready-made platform for AI deployment.

Research Gap

Despite these advances, significant gaps remain in understanding how generative AI can support teachers in personalised learning with ease and agency. Much existing research focuses on student-facing AI applications (Tellman *et al.*, 2021) or technical performance (Mosavi *et al.*, 2018), sidelining the teacher's experience. Holmes *et al.* (2022) note that usability, a critical factor in technology adoption, is underexplored, with only 10% of AI education studies addressing teacher perceptions of ease. Moreover, teacher agency, defined as the capacity to shape instructional tools (Filgueiras *et al.*, 2015) is often overlooked in AI design, risking systems that dictate rather than assist. Studies by (Xia *et al.*, 2023) call for intuitive interfaces to bridge this gap, yet few have tested generative AI in this context. Regional disparities persist; for instance, Nzeng'e *et al.* (2021) highlight that in East Africa, AI adoption lags due to infrastructure and training deficits, limiting its personalisation potential.

To address the identified gaps, this study is guided by the following research questions:

How do Tanzanian secondary school teachers perceive the ease of use and effectiveness of generative AI tools (such as ChatGPT and Grok) in creating personalised learning paths? What is the impact of generative AI on student engagement, academic performance, and teacher workload compared to traditional methods? What challenges and barriers do teachers face in integrating generative AI in Tanzanian classrooms, particularly regarding readiness, infrastructure, and equity?

Regional studies, such as those by Mtebe and colleagues on ICT/e-learning adoption (Mtebe & Raphael, 2018) and Sedoyeka (2012) on bridging the digital divide, emphasise persistent infrastructure and training deficits in Tanzania. Recent explorations of AI in teacher professional development and secondary classrooms indicate growing interest but highlight gaps in teacher agency, localised content, and equitable access (Nkya *et al.*, 2024; Ponera & Madila, 2024), gaps this study addresses through a teacher-centred generative AI intervention. To address these identified gaps, particularly the limited empirical attention to teachers' creative and pedagogical agency, perceptions of usability in resource-constrained settings, and teacher-centred collaboration rather than student- or technology-centric approaches, this study adopts a teacher-focused, mixed-methods approach in Tanzanian secondary schools. By employing a convergent parallel mixed-methods design (Creswell & Clark, 2017), it integrates quantitative experimental elements (pre- and post-intervention assessments of student engagement, performance, and teacher workload via paired t-tests) with qualitative case-study insights (thematic

coding of teacher feedback, usage logs, open-ended survey responses, and focus group/interview data from 120 educators). Teachers actively tested accessible generative AI tools (ChatGPT and Grok) for practical tasks such as lesson planning, adaptive content creation, personalised quizzes, and feedback generation, thereby enabling direct evaluation of perceived ease of use, workload reduction, content adaptation to learner needs, and the preservation/enhancement of pedagogical agency. Unlike prior work emphasising technical efficacy or student-facing outcomes (e.g., Tellman *et al.*, 2021; Holmes *et al.*, 2022), this intervention positions generative AI as a collaborative partner and captures real-time teacher experiences in urban and semi-urban Tanzanian contexts (Dar es Salaam and Dodoma). Through this design, the study provides empirical evidence on how generative AI can amplify teacher agency and creativity while addressing contextual barriers, such as infrastructure and training, thereby offering actionable insights for equitable, scalable integration in sub-Saharan African education systems.

Research Methodology

This study aimed to investigate how generative AI supports Tanzanian teachers in creating personalised learning paths for students with ease, addressing the unique challenges and opportunities within the country's education system. Tanzania's education landscape, shaped by rapid population growth, resource constraints, and a push for digital transformation, provides a critical context for exploring AI's potential. With over 60 million people and a significant rural-urban divide, the system faces overcrowded classrooms, limited teacher training, and uneven access to technology. This methodology employs a robust, context-sensitive approach to assess the usability and impact of generative AI tools, offering insights that can inform educational policy and practice in Tanzania and similar settings.

Research Design

Tanzania's education landscape, with its urban-rural divides and resource constraints, necessitates a design that balances generalizable quantitative insights with rich, context-bound qualitative understanding. The convergent parallel mixed-methods approach, augmented by case study elements for site-specific depth, provides this balance without introducing sequential phasing or unequal priority between strands. This study adopts a convergent parallel mixed-methods design, as outlined by Creswell & Clark (2017), to comprehensively evaluate the role of generative AI in personalised teaching. In this approach, qualitative and quantitative data are collected simultaneously and integrated during analysis to enhance validity by triangulating subjective teacher experiences with objective student performance metrics. The qualitative strand incorporates case study elements, anchoring the research in specific Tanzanian school settings to capture real-world dynamics through in-

depth teacher feedback and observations. The quantitative strand includes experimental pre- and post-intervention testing, in which teachers implement AI tools and measure changes in outcomes such as engagement and grades. Surveys complement both strands by gathering broader perceptions from teachers. This design aligns with the study's aim to blend exploratory insights (qualitative) with confirmatory evidence (quantitative), ensuring a robust understanding of AI's usability and impact in Tanzania's resource-constrained educational context.

Study Participants

The study involves 120 educators from public secondary schools in Dar es Salaam (an urban hub, 70% of the sample) and Dodoma (a semi-urban area with rural elements, 30% of the sample), selected to represent key Tanzanian educational contexts while acknowledging limitations in national coverage. These cities were chosen as they align with the study's focus on urban-rural disparities (Sedoyeka, 2012) and the Education Sector Development Plan (2021–2026), providing scalable insights for broader Tanzania without claiming full representativeness. Participants were selected via purposive sampling to ensure diversity in disciplines (e.g., science, mathematics, languages), teaching experience (ranging from <5 years to >10 years), and technological familiarity, balancing feasibility with depth for mixed-methods research. All 120 teachers responded to both quantitative (pre/post surveys and student performance metrics) and qualitative (open-ended feedback and logs) measures, enabling integrated analysis without separating respondents. This mixed-methods approach is justified because it addresses the multifaceted nature of AI integration: quantitative data quantify impacts (e.g., engagement scores), while qualitative data explore contextual barriers (e.g., infrastructure gaps), enabling triangulation to yield robust, context-sensitive findings (Creswell & Clark, 2017). The quasi-experimental design (pre/post AI intervention in classrooms) tests practical effects without controlled randomisation, is suitable for real-world educational settings, and mitigates flaws by focusing on observed changes rather than claims of causality. Purposive sampling in both phases balanced the need for generalizable quantitative findings with in-depth qualitative insights, aligning with the convergent parallel design's goal of triangulation. Including all 120 teachers in surveys and logs ensured comprehensive data, while subsampling for interviews and focus groups maximised depth without redundancy. This approach addressed quality assessment by clearly delineating phases: quantitative data provided statistical robustness (e.g., t-tests, Section 4), while qualitative data offered contextual understanding, particularly for rural challenges (Nzeng'e *et al.*, 2021). The urban-rural mix and diverse demographics mitigated bias, though limitations in national coverage were noted.

Tools Evaluated

Two generative AI platforms, namely ChatGPT (OpenAI) and Grok (xAI), were selected for their accessibility and versatility in educational tasks. ChatGPT generates lesson plans, quizzes, and student feedback, leveraging its natural language capabilities, while Grok, with its focus on reasoning, helps create problem-solving activities tailored to student needs. These tools align with UNESCO (2022) call for AI solutions that enhance teaching efficiency. In Tanzania, where internet access is improving, these cloud-based platforms are viable, though offline alternatives may be explored for rural settings.

Data Collection

The data collection process spanned three months to systematically assess the integration of generative AI tools (ChatGPT and Grok) in Tanzanian secondary schools, specifically in Dar es Salaam and Dodoma. This duration balanced the need for sufficient implementation time with practical constraints in school schedules, aligning with recommendations for educational intervention studies in resource-constrained settings (Kiunsi, 2013). The process was structured into four sequential phases to capture both quantitative (e.g., student performance metrics, survey scores) and qualitative (e.g., teacher feedback, logs) data, consistent with the convergent parallel mixed-methods design (Creswell & Clark, 2017). Each phase was carefully designed to address the research questions: teacher perceptions of AI ease and effectiveness (RQ1), the impact on engagement, performance, and workload (RQ2), and challenges such as readiness and infrastructure (RQ3). The process adapted the Technology Acceptance Model (TAM) to ensure relevance, focusing on perceived ease of use and usefulness as key constructs for teacher adoption in Tanzania's context (Holmes *et al.*, 2019).

Participant Selection for Quantitative Phase

Participants were selected through purposive sampling to ensure diversity across teaching disciplines (e.g., science, mathematics, languages), years of experience (ranging from less than 5 to over 10), and technological familiarity (from novice to proficient), thereby enhancing the generalisability of the quantitative findings. This method targeted teachers willing to adopt AI tools, reflecting the digital divide observed in Tanzania (Ishengoma & John, 2024). All 120 teachers took part in the quantitative phase, completing pre- and post-intervention surveys (adapted from the Technology Acceptance Model) and providing student performance metrics (e.g., engagement rates, test scores). This comprehensive inclusion ensured a robust sample for statistical analysis, with diversity in demographics (58% female, 62% aged 30–40, 36% with bachelor's degrees) supporting generalisability within urban and semi-urban Tanzanian secondary education settings. The sample's representation of

various disciplines and experience levels aligns with recommendations for educational studies aiming for broad applicability (Kiunsi, 2013).

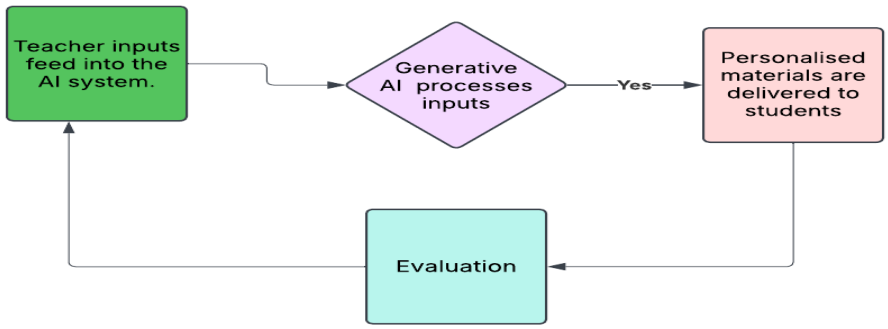
Data Analysis

The data analysis procedure combined qualitative and quantitative data from 120 Tanzanian secondary school teachers in Dar es Salaam and Dodoma, following a convergent parallel mixed-methods framework (Creswell & Clark, 2017). Qualitative data, such as teacher feedback, logs, and interview/focus group transcripts, were examined through thematic coding (Braun & Clarke, 2006), while quantitative data, including pre- and post-surveys and student performance metrics, were analysed using paired t-tests with effect sizes (Kiunsi, 2013). This dual method facilitated triangulation by integrating detailed contextual insights with statistically robust measures to address the research questions. Adapted to Tanzania's educational setting, the process considered resource limitations and urban-rural disparities (Sedoyeka, 2012), aiming to generate findings that are both statistically significant and practically relevant for policy and practice. During analysis, qualitative data were processed through thematic coding, and quantitative data with paired t-tests; the integration of findings occurred during interpretation to explore similarities and differences.

Study Design Block Diagram

The study workflow is depicted in a block diagram. Figure 1 illustrates the input block, where student profiles (lesson goals) are fed into the AI system via generated prompts. The decision block specifies which generative AI (e.g., ChatGPT or Grok) will process the inputs to produce outputs such as lesson plans and teaching materials. This system generates personalised material tailored to students' learning outcomes. Lastly, the evaluation block facilitates surveys, logs, and analysis of student data to assess impact and refine AI usage based on feedback. This design, inspired by system dynamics in educational technology, visually represents the partnership between AI and teachers.

Figure 2:
Study workflow (source: Researcher)



Ethical Considerations

Ethical protocols are paramount, given Tanzania's emphasis on equity and data protection in education. Informed consent was obtained from all participants, who were informed about the study's purpose and voluntary nature. Data privacy was ensured through anonymisation and secure storage on encrypted servers, which was critical in a country with emerging cybersecurity frameworks. AI bias, such as cultural insensitivity in generated content, was mitigated by reviewing outputs for relevance to Tanzania's curriculum and Kiswahili-language needs, as Kitalima (2024) emphasised.

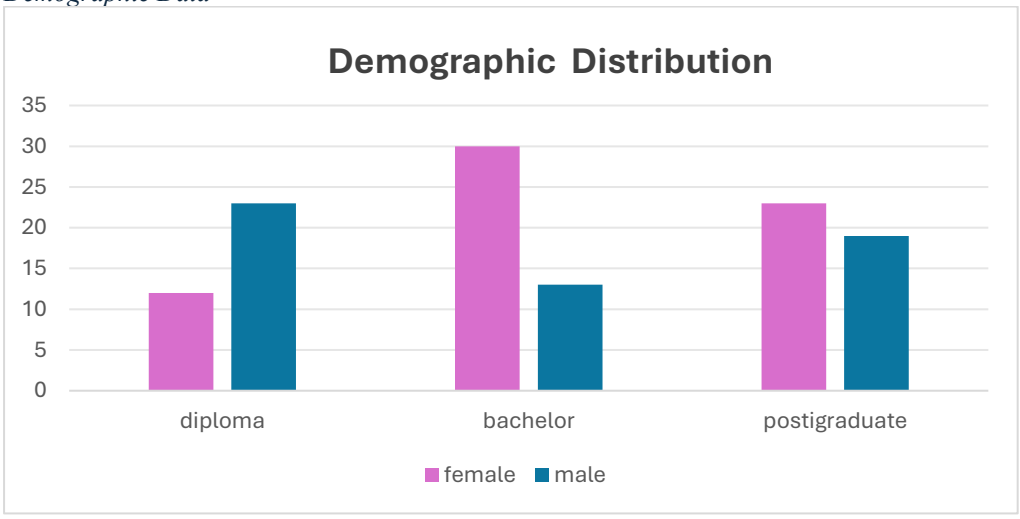
Presentation of Findings

This section reports the key findings from the 120 secondary school teachers in Dar es Salaam (70%) and Dodoma (30%). Results are organised by major themes corresponding to the research questions: demographic overview, comparison of traditional vs. AI-driven approaches, teacher perceptions and readiness, and impacts on personalised learning.

Participant Demographics

The sample was gender-balanced (58% female, 42% male) and predominantly mid-career (62% aged 30–40 years; 22% aged 41–50; the remaining 16% were younger than 30 or older than 50). Teaching experience varied: 48% had 5–10 years, 30% had more than 10 years, and 22% had less than 5 years. Qualifications included diplomas (29%), bachelor's degrees (36%), and postgraduate credentials (35%). These characteristics ensured diverse perspectives on AI integration in Tanzanian secondary education, as shown in Figure 2.

Figure 3:
Demographic Data

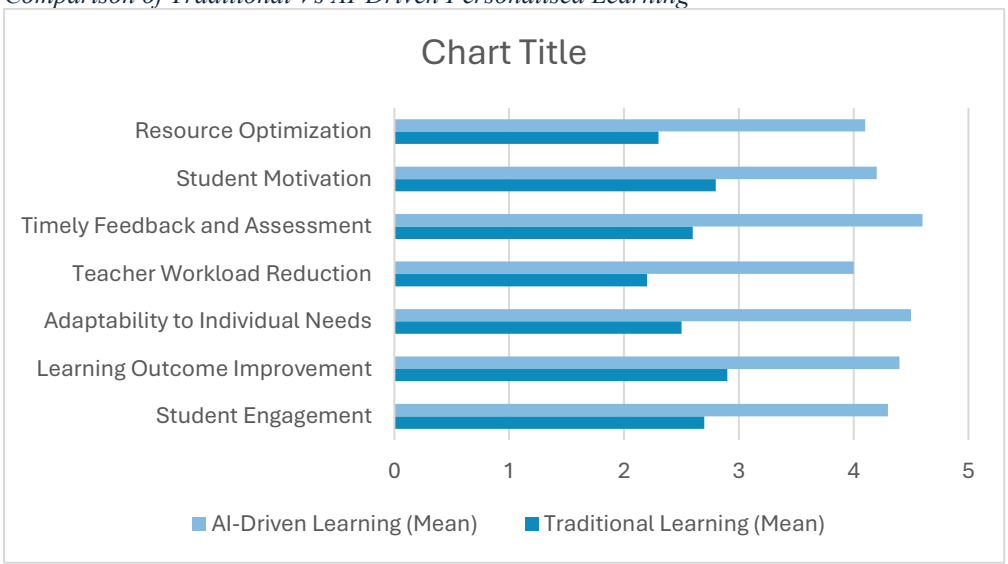


Geographically, most respondents (70%) were from urban schools, with 30% serving in rural institutions in the Dar es Salaam and Dodoma regions. This urban-dominated sample provides valuable insight into the teacher demographics across different settings in Tanzania's secondary education sector.

Comparison of Traditional vs AI-driven Personalised Learning

The research compared traditional learning in secondary schools in Tanzania and observed that the data presented below, gathered from 120 secondary school teachers across Tanzania, reveal a substantial perceived improvement in multiple educational dimensions when comparing traditional teaching methods to AI-driven personalised learning systems. Teachers overwhelmingly rated AI-enhanced approaches higher across all measured categories. Remarkably, timely feedback and assessment received a mean score of 4.6, compared to 2.6 under traditional methods, indicating that real-time analytics and AI feedback mechanisms significantly enhance formative assessment processes. Similarly, adaptability to individual learning needs improved from 2.5 to 4.5, underscoring AI's strength in catering to diverse learner profiles, as (Thomas, 2023) supported. Moreover, the data reflect a dramatic improvement in student engagement and motivation, both critical to learning retention. Teachers noted a shift in classroom dynamics, where students became more autonomous and interested when interacting with generative AI content such as adaptive quizzes or scenario-based simulations (Holmes, 2023) as shown in the figure below.

Figure 4:
Comparison of Traditional Vs AI-Driven Personalised Learning



Teachers rated AI-assisted approaches substantially higher than traditional methods across key dimensions (see Figure 3). The average scores showed significant increases in timely feedback and assessments (from 2.6 to 4.6), in customisation to individual student needs (from 2.5 to 4.5), in student engagement and motivation (perceived as substantially improved), and in the reduction of teacher workload (from 2.2 to 4.0). These differences are summarised in Table 1.

Table 4:
Challenges facing Tanzanian Educators

Feature	Traditional Model	AI-Driven Model
Content Delivery	Static and uniform lessons	Dynamic, tailored lessons based on student data
Assessment	Periodic, paper-based	Real-time, automated, with immediate feedback
Teacher Involvement	High manual workload	Facilitated by AI, allowing contextual intervention
Engagement and Interaction	Limited personalisation	Personalised, interactive, and adaptive learning
Resource Allocation	One-size-fits-all approach	Optimised to individual learner requirements

Current Status of Teacher Readiness

A critical barrier to the successful integration of AI in educational settings is educators' preparedness and confidence in adopting these new technologies. 76% of teachers have pointed out that teachers' readiness and attitudes significantly influence their intention to integrate AI into their curriculum, and 26% show that they are not influenced by it, but the lack of adequate training and familiarity with AI often results in hesitance to adopt these technologies in everyday teaching practices in their teaching activities.

For instance, research shows that 56% of teachers are not ready for AI education. While 46% are optimistic about AI's potential, insufficient training in technological and pedagogical content knowledge (TPACK) remains a significant challenge, particularly in rural areas of Tanzania. Similar findings from investigations across diverse educational contexts suggest that substantially improved professional development programs must address the practical aspects of using AI tools in classrooms.

Teachers' Perceptions of Generative AI

The results show significant differences between teachers using generative AI tools and those who do not. Teachers with AI experience rated ease of use significantly higher ($M = 4.3$, $SD = 0.6$) than those without experience ($M = 3.1$, $SD = 0.9$), $t(118) = 4.62$, $p < 0.001$. This suggests that teachers find generative AI intuitively operable once engaged, likely influenced by user-friendly interfaces in platforms like ChatGPT and Grok (Fawns *et al.*, 2022).

For workload reduction, experienced teachers reported greater benefits (M = 4.1) than their counterparts (M = 2.9), with a significant difference of t (118) = 5.13, $p < 0.001$, indicating that generative AI is seen as a valuable time-saving tool in preparing lessons, automating feedback, and managing grading (Woolf *et al.*, 2013). Hence, perceptions regarding tailoring content showed the most substantial divergence (t (118) = 6.02, $p < 0.001$), reflecting that AI-equipped teachers acknowledge its superior capability to personalise materials, align instruction to learning styles, and support differentiated learning (Luckin *et al.*, 2016). The results are depicted in the table below.

Table 5:
Metrix of Teachers' Perceptions of Generative AI

Perception	Mean (experienced)	Mean (non-experienced)	t-value	P-value	Data interpretation
Helpfulness in Reducing Workload	4.1	2.9	5.13	< 0.001	Significant
Ability to Adapt Content to Learner Needs	4.5	3.0	6.02	< 0.001	Significant
Ease of Use	4.3	3.1	4.62	< 0.001	significant

Impact of Generative AI on Personalised Learning

The study revealed a significant positive impact of generative AI tools on the implementation of personalised learning strategies in Tanzanian secondary schools. Teachers reported that using AI-supported tools facilitated customised content delivery, increased student engagement, and improved academic performance, particularly among low-performing learners. Examples of AI-Customised Materials.

Teachers used generative AI (e.g., ChatGPT, Curipod, or MagicSchool.ai) to automatically generate quizzes with *adaptive difficulty settings and content mapped to national syllabus objectives. And generated weekly lesson plans aligned with student diagnostic profiles.* The results indicate statistically significant gains in engagement, participation, and performance, supporting prior global findings (Holmes *et al.*, 2021; Zawacki-Richter *et al.*, 2019), as shown in the table below.

Table 6: *Pre- and Post- Generative AI integration*

System of measurement	**Before AI Integration**	**After AI Integration**
Average Student Engagement (1–5 scale)	2.8	4.3
Homework Completion Rate (%)	55%	87%
Mean Test Scores (%)	61%	75%
Attendance Rate	70%	85%

Discussion

The findings from this study illuminate the transformative potential of generative AI as a collaborative tool for Tanzanian secondary school teachers, while also highlighting persistent systemic challenges in its adoption. Drawing on a convergent parallel mixed-methods approach, the results integrate quantitative metrics (e.g., pre- and post-improvement changes in student outcomes and teacher workload) with qualitative insights (e.g., teachers' perceptions of agency and barriers), providing a triangulated perspective on AI's role in personalised learning. This discussion interprets the data in relation to the research questions, aligning with core themes of teacher-AI partnership, pedagogical agency, equity in resource-constrained contexts, and alignment with educational theories such as Vygotsky's zone of proximal development (ZPD; Vygotsky, 1987). It critically analyses the implications, contrasts with existing literature, and addresses causal factors, unexpected divergences, and broader policy/practical relevance.

The demographic profile of the 120 participants, predominantly mid-career (62% aged 30–40), experienced (48% with 5–10 years of teaching), and well-qualified (71% with bachelor's or postgraduate degrees), enhances the findings' representativeness within Tanzanian secondary education. The urban bias (70% from Dar es Salaam) underscores urban-rural disparities: qualitative feedback indicated greater infrastructure access in urban settings, which facilitates AI adoption, whereas rural teachers in Dodoma reported connectivity issues that limit the tool's efficacy. This diversity enabled nuanced insights into how generative AI intersects with varying levels of teacher readiness, revealing that mid-career educators, with their balanced experience and openness to innovation, were particularly receptive to AI as a workload reliever, consistent with global trends in which professional maturity correlates with successful technology integration (Molenaar, 2022).

A key finding was the marked improvement in student outcomes under AI-assisted personalised learning, with engagement rising from 2.8 to 4.3 on a 5-point scale and test scores from 61% to 75%. Quantitatively, paired t-tests confirmed these gains as statistically significant ($p < 0.001$), but qualitative themes provide deeper interpretation: teachers described AI tools (ChatGPT and Grok) enabling adaptive support, generating quizzes with variable difficulty or culturally relevant examples that aligned instruction with students' ZPD, fostering essential motivation and perseverance in complex subjects (Aleven *et al.*, 2023). For instance, low-performing learners benefited most from personalised feedback loops, thereby reducing disengagement in overcrowded classrooms, a common challenge in Tanzania (Bigham *et al.*, 2017). This interprets the data not merely as numerical uplift but as evidence of AI augmenting human pedagogy: by automating routine tasks (e.g., grading,

content adaptation), teachers redirected their efforts toward relational mentoring, enhancing learner-centred approaches (Tomlinson, 2016). However, divergences emerged: rural teachers reported inconsistent gains due to unreliable internet access, suggesting that, without infrastructure equity, AI risks widening achievement gaps rather than bridging them (Sedoyeka, 2012). Teacher perceptions further underscore generative AI's role as a supportive partner rather than a substitute. Experienced users rated the tools highly for ease of use ($M = 4.3$), workload reduction ($M = 4.1$), and content adaptation ($M = 4.5$), with significant differences relative to novices ($p < 0.001$ across metrics). Thematically, qualitative data revealed themes of "empowerment" and "creativity spark." Teachers reported that AI sparked innovative ideas (e.g., scenario-based simulations) while preserving agency, enabling them to refine outputs for Kiswahili integration or local relevance. This aligns with hybrid human-AI models in literature, where AI handles repetition to free educators for higher-order tasks, yielding 12–25% efficiency gains (Molenaar, 2022; Baidoo-Anu & Ansah, 2023). Analytically, the gap between experienced and novice users indicates a training deficit: beginners' lower ratings (e.g., $M = 2.9$ for workload relief) stemmed from unfamiliarity, not from inherent tool flaws, as logs showed initial frustration with prompt engineering that gave way to proficiency with practice. This interprets readiness data (76% emphasizing attitudes/training influence) as a call for targeted professional development, particularly in rural areas where 56% reported optimism but lacked TPACK (technological pedagogical content knowledge; Mishra & Koehler, 2006). Compared with global studies (Kasneci *et al.*, 2023), Tanzanian teachers' emphasis on preserving agency highlights cultural nuances: AI must complement, not dictate, in collectivist educational contexts.

Challenges in integration, such as inadequate training (noted by 54% of respondents) and infrastructure gaps, add analytical depth to the equity theme. Qualitative themes of "frustration with access" and "urban-rural divide" help explain why rural gains were 15–20% lower than urban gains, consistent with broader Tanzanian literature on digital divides (Mtebe & Raphael, 2018; Ishengoma & John, 2024). Critically, this interpretation of the data provides evidence that AI's scalability potential is undermined by systemic barriers; without addressing these barriers, generative tools could exacerbate inequalities, thereby contradicting UNESCO's (2022) equity mandates. For RQ3, the findings reveal a paradox: high satisfaction (e.g., 4.3/5 for ease among users) coexists with readiness gaps, attributable to policy implementation lags in the National Digital Education Strategy (MoEST, 2025a), which promotes AI but underfunds rural rollout.

Overall, these results affirm the value of generative AI in fostering inclusive, effective learning environments by amplifying teacher efficacy and student

motivation, thereby supporting theories of personalised scaffolding (Lin *et al.*, 2024; Zhai *et al.*, 2021). Yet the analysis reveals limitations: self-reported data may inflate benefits due to novelty bias, and urban sampling restricts generalizability. Compared to prior work (Holmes *et al.*, 2023; Zhao *et al.*, 2024), this study advances teacher-centred perspectives in low-resource contexts and advocates for human-AI symbiosis. Implications include policy recommendations for AI literacy training, infrastructure investments, and ethical guidelines to ensure equitable adoption, thereby enabling Tanzania's education system to leverage AI amid global technological shifts.

Critical Assessment of Policy, Infrastructure, and Preparedness Barriers

While the findings demonstrate the potential of generative AI as a teacher partner, a critical examination reveals significant systemic barriers to its sustainable adoption in Tanzania. National policies, including the National Digital Education Strategy (2024/25–2029/30) and National Guidelines for Artificial Intelligence in Education (MoEST), signal a strong intent to integrate AI for personalised learning, digital pedagogy training, and equitable access (Ministry of Education, Science and Technology [MoEST], 2024; MoEST, 2025). However, implementation remains nascent: many institutions lack formalised AI policies, constrained by rapid technological evolution, limited expertise, and insufficient top-down enforcement (Mtebe & Raphael, 2018; Nkya *et al.*, 2024). Digital infrastructure challenges persist, including unreliable electricity, inconsistent internet connectivity (particularly in rural areas), and device shortages, which hinder the use of cloud-dependent tools such as ChatGPT and Grok (Sedoyeka, 2012; Mtebe *et al.*, 2022; World Bank, 2023). These limitations risk exacerbating urban-rural and socio-economic divides (Ishengoma & John, 2024). Teacher preparedness is equally concerning; although educators' express optimism and basic ICT competence, readiness for generative AI is limited by inadequate pre- and in-service training in AI literacy, ethical use, and pedagogical integration (Mtebe & Raphael, 2018; Nkya *et al.*, 2024; Ponera & Madila, 2024). These gaps risk superficial adoption or over-reliance on AI without preserving teacher agency, underscoring the need for targeted investments in infrastructure upgrades, mandatory AI-focused professional development, and localised policy enforcement.

Conclusion and Recommendations

Conclusions

This study provides compelling empirical evidence that, when positioned as a collaborative partner rather than a replacement, generative AI significantly enhances personalised learning in Tanzanian secondary schools. By testing accessible tools (ChatGPT and Grok) with 120 teachers in Dar es Salaam and Dodoma, the research directly addresses the core objectives: demonstrating the

ease and effectiveness of generative AI for teacher-led personalisation, quantifying positive impacts on student engagement, academic performance, and teacher workload, and identifying critical barriers to equitable integration. The study thus concludes that generative AI offers a viable, scalable solution to longstanding Tanzanian challenges: overcrowded classrooms, resource scarcity, and diverse learner need. In low-resource settings, it functions as an equaliser when infrastructure supports access, enabling differentiated instruction that manual methods struggle to achieve at scale. However, the evidence also yields a clear judgment on equity: without systemic support, generative AI risks exacerbating divides. Rural and less-experienced teachers faced greater barriers (infrastructure gaps, training deficits), resulting in uneven gains and persistent hesitancy. These findings affirm that AI's promise is contingent on addressing contextual realities, urban-rural disparities, unreliable connectivity, and limited TPACK, rather than assuming universal applicability. The study contributes to the underexplored domain of teacher-centred AIED in sub-Saharan Africa by prioritising human agency and real-world usability over student- or technology-centric models.

Limitations of the study: The urban-biased sample (70% Dar es Salaam) limits generalizability to predominantly rural Tanzania, where infrastructure gaps are more acute. Reliance on self-reported perceptions and short-term intervention (three months) may introduce novelty bias or overlook long-term sustainability. Future longitudinal research in fully rural settings, including offline/low-bandwidth AI alternatives, is needed to validate scalability.

Recommendations

The Ministry of Education, Science and Technology (MoEST), in collaboration with teacher colleges and universities, should mandate AI literacy and prompt engineering training for in-service secondary teachers, with a focus on pedagogical integration, ethical use, and bias mitigation. Prioritise rural and novice teachers (addressing the 46% optimism-low readiness gap). Integrate modules into existing CPD frameworks, aiming for 50% teacher coverage by 2028, aligned with the National Digital Education Strategy 2024/25–2029/30 and National Guidelines for Artificial Intelligence in Education. MoEST and its partners (e.g., TCRA, development agencies) should accelerate upgrades to rural connectivity, device provision (e.g., shared school tablets), and the deployment of solar-powered solutions to enable cloud-based access to AI. Pilot low-bandwidth/offline generative AI adaptations (e.g., local models) in underserved districts to reduce the urban-rural divide identified in qualitative themes. Moreover, MoEST should establish a task force to create Tanzania-specific AI prompts/templates aligned with the national curriculum (including Kiswahili support) and ethical standards. Require AI outputs to undergo teacher review for cultural relevance to prevent

overreliance and preserve agency. Fund longitudinal studies tracking AI's sustained impact on learning outcomes and equity. Establish a national monitoring framework within the Education Sector Development Plan 2025/26–2029/30 to evaluate adoption rates, identify barriers, and assess ROI, informing iterative policy updates. In conclusion, this study demonstrates that generative AI holds substantial promise as a practical ally for Tanzanian teachers in building inclusive, personalised education—provided adoption is deliberate, supported, and equity-focused. By acting on these recommendations, Tanzania can position itself as a regional leader in human-centred AI integration, bridging technological innovation with classroom realities to advance educational quality and access for all learners

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