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Qualitative Study on Digital Classrooms, Equal Futures: Artificial Intelligence-Powered Digital Pedagogy for Closing the Gender Digital Divide in STEM

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Abstract

The increase in Artificial Intelligence (AI), online learning platforms and virtual instructional technologies is definitely defining the possibilities for Science, Technology, Engineering and Mathematics (STEM) education. However, benefits of digital change are not equally shared. Girls and women still face difficulties regarding access to devices and connectivity, affordability, digital skills, confidence, gender stereotypes, safety and limited representation in STEM learning and careers. These differences are critical in Nigeria, where increase in digital education and AI creates opportunity to strengthen STEM participation but somewhat risks reproducing ongoing gender differences if technology is introduced without an explicit inclusion agenda. This paper investigates how AI-enhanced online and virtual STEM instruction can help to closing the gender digital divide, with attention to tertiary education and teacher education in Nigerian universities and colleges of education. The paper conceptualises AI-powered digital pedagogy as more than the use of generative AI tools; it incorporates adaptive learning, intelligent tutoring, learning analytics, virtual laboratories, automated feedback, AI-assisted content creation, collaborative platforms and AI literacy. The paper adds that these technologies cane enhance accessibility, personalisation, feedback, participation and exposure to female STEM role models when they are fixed within gender-responsive pedagogy. However, AI can also reproduce gender bias, widen disparities through unequal shared access, compromise privacy and create new forms of exclusion. A gender-responsive AI digital pedagogy framework is further proposed, organised around six principles: equitable shared access, inclusive design, personalised learning, agency and voice, human-centred teacher support, and ethical accountability. The paper ends with recommendations for Nigerian tertiary institutions, teacher-education programmes, lecturers, policymakers and technology providers. It suffices that the objective should not merely place girls in digital classrooms, but to redesign digital classrooms so that girls can participate, belong, succeed and eventually lead in STEM.

Keywords: Artificial Intelligence, Digital Pedagogy, Gender Digital Divide, STEM Education, Girls and Women, Tertiary Education, Teacher Education, Online Learning, Inclusive Education

Introduction

Digital technologies are nowadays crucial to how knowledge is produced, taught, assessed and shared. The existence of Generative Artificial Intelligence (GenAI), intelligent tutoring systems, adaptive learning platforms, virtual laboratories and learning analytics has made this change faster. According to Jomen and Ayua (2026), and Miao et al. (2021) AI can enhance personalised learning, automated aspects of assessment, generate learning resources, provide feedback, identify learning difficulties and extend educational opportunities beyond the physical classroom. A Systematic review of Almasri (2024) reveals applications of AI in science education for creating learning materials, quizzes, assessment support, prediction and the enhancement of learning environments, and easing academic research if ethical concerns and guided against (Ayua & Kwagh, 2026). Perhaps these digital and AI-supported education is taking place within an unequal social environment. The digital divide is not a matter to be liken to whether a learner has an internet connection. It is more than just having an internet connection, it has to do with the ownership and quality of devices available, affordability of data for use, digital knowledge and digital skills, frequency and quality of use, confidence, resilience, safety, access to relevant content and the ability to convert digital access into function lasting educational outcomes for sustainability and stability in the ever-evolving world. It has been observed globally that men still have higher internet use more than women. Research shows that in 2023, with 70% of men compared with 65% of women using the internet space. This difference is noticeably much in Africa, where approximately four in ten men and three in ten women were internet users (International

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Telecommunication Union [ITU], 2023). This categorically shows that Nigeria gender dimension of digital transformation needs urgent attention. ITU (2023) adds that digital skills in Nigeria persistently shows gender disparity in computer literacy, with regional differences and noticeable gaps in some northern zones. Also, Ayua et al. (2026a, 2026b) found that male undergraduates demonstrate greater adoption and benefit more from AI chatbots in developing research skills than females; implying the potential of AI chatbots to enhance research competence is not being equitably realized across gender. Adding that, without targeted intervention, this gap may exacerbate existing inequalities in digital literacy and research productivity. This yawning gaps in digital divide shows that all stakeholders have to put hands on desk for proper and functional lasting solution for equal shared access to technologies. Moreso, World Bank (2025) revealed gender disparities in digital access, use and outcome in Nigeria, with the gaps being smaller among more educated and wealthier groups but still being noticeable among disadvantaged populations. The problem is more critical and important for STEM disciplines. Although women and girls have made a remarkable educational shift globally, however, they are still small in number regarding many STEM disciplines and careers. United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2024) shows that women are found only about 35% of STEM graduates globally, and this depict that women representation in STEM subjects like engineering, Information and Communication Technology (ICT) is weak. These differences therefore, show the existence of two disparities: gender disparity in STEM (Ayua, et al., 2026c) and gender disparity in digital participation (Ayua et al., 2026a, 2026b). Higher educations in Nigeria, could be a solution to provide crucial institutional site for intervention. Universities and colleges of education in Nigeria may be responsible not only for nurturing future STEM professionals but also for building teachers who can shape the STEM goals and digital experiences of future generations. This driving force of educational technology units, computer laboratories, learning management systems, internet facilities, digital libraries and online teaching platforms creates basis to which AI-enhanced pedagogy can be developed for equal shared participation. Nigeria's National Digital Learning Policy (NNDLP) shows that both the potential of AI for personalised learning and the risks is related with overdependence, biased content, privacy, cybersecurity and unsafe use (Federal Ministry of Education [FME], 2023). Nigeria's National Artificial Intelligence Strategy (NNAIS] place attention on developing AI-related skills among young people: an explicit target that at least half of the young people reached can be women (Federal Republic of Nigeria [FRN], 2024). This paper investigates a scheme that AI-powered digital pedagogy can become an instrument for bridging gender digital divide, instead of reproducing, the gender digital divide in STEM. The target is on tertiary education: universities, colleges of education and teacher-training programmes. This paper unravels gender and digital divide and digital pedagogy and gender inclusiveness, while contributing to discussions of teachers, professional development and preservice teachers' perceptions.

Conceptualising the Gender Digital Divide in STEM

Gender Digital Divide (G2Ds) could be viewed as a multidimensional phenomenon. A myopic view may term it as unequal shared access to computers or internet connectivity. A critical and creative thinker may view gender digital divide in four organised themes including: access, capability, use and outcomes.

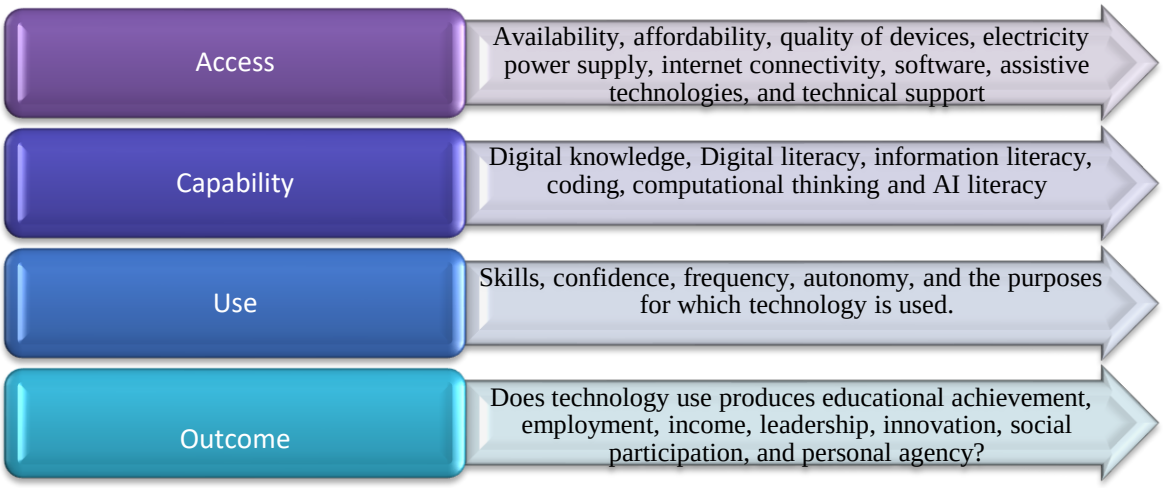

Figure 1: Levels of Digital Divide

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The access divide as shown in Figure 1 explicate that women and girls particularly those in rural areas may lack availability, affordability of quality devices, electricity power supply, internet connectivity, software, assistive technologies, smartphones, laptops, broadband and technical support. Cost may maybe the major shackle, where girl learners depend on mobile data. A girl student may be online while relying on unstable mobile connectivity and an entry-level smartphone that cannot run data-analysis or simulation software. Formal availability can therefore mask functional exclusion. The capability divide has to do with digital literacy, information literacy, coding, computational thinking and AI literacy as shown in Figure 1. The usage divide shows gaps in skills, confidence, frequency, autonomy, resilience and the purposes for which technology is used. The usage divide explains where people who have access to technology and may use it for substantially, different purposes or with different levels of intensity. To access social media does not actually imply the ability to search academic databases, evaluate AI-generated claims, write codes, analyse datasets, protect personal information, or troubleshoot software. Dogra and Kaushal (2024) found that lack of digital skills are obstacles even after access is readily available, alongside economic limitations, sociocultural norms, workplace discrimination, and psychological barriers. The outcome divide shows whether technology use enhance educational achievement, employment, income, leadership, innovation, social participation, and personal agency. Outcomes divide, in which unequal digital participation produces unequal educational, economic and professional opportunities.

The Nigerian context demonstrates the importance of this multidimensional perspective. According to ITU (2023) assessment of Nigeria's digital economy identifies gender gaps in computer literacy and links digital inequality to poverty, low literacy, urban-rural disparities and disadvantages faced by women and girls. Students, maybe two can utilise a platform though, they may derive unequal benefits because one may have receive mentoring, recognition, and career opportunities while the other could have encounters stereotyping, harassment, or low expectations. All of these categories of digital inequality interact. Poor or weak connectivity can limit opportunities to enhance advanced skills; limited skills reduce confidence; low confidence can suppress participation; reduced participation leads to weaker outcomes; and weaker outcomes can reinforce beliefs that women are less suited to technology. Closing the gender digital divide therefore requires more than distributing devices. Institutions must cultivate meaningful, autonomous, safe, and productive participation. United Nations International Children's Emergency Fund (UNICEF) reveals that girls have limited access to digital devices and may need to borrow devices from family members or friends; nevertheless, when access is available, girls use digital technologies for educational purposes (UNICEF Nigeria, 2024). This dissimilarity is vital because by making available a computer laboratory does not assume gender equality. A girl may have access to a computer but lack confidence and resilience in programming; she may possess a smartphone but have inadequate data or broadband; she may participate in an online course(s) but may still be silent because of gender stereotypes; or she may use an AI tutor but receive biased or culturally inappropriate responses. The digital divide can also relate with the STEM contribution pipelines. Gender disparities can be more as girls advance through educational systems. A girl student who receives little or no exposure to technology, has few female STEM role models and encounters gender stereotypes may not want to select technology-intensive courses at higher education. At higher education, insufficient provision may add the probability of withdrawal from STEM programmes. Gender gap in higher STEM education according García-Holgado et al. (2022) found that stereotypes, stereotype threat and the educational and social environment are significant influences on STEM decision-making, while positive self-concept, self-reliance, resilience, confidence and self-efficacy are important for encouraging participation in STEM decision-making. Musso et al. (2022) has also connected STEM gender stereotypes with students' school experiences, empowerment and engagement. This explains that bridging gender digital divide demands more than connectivity. It needs a holistic change of educational experiences through which girls can encounter technology, STEM knowledge and their own identities as potential STEM professionals.

AI-Powered Digital Pedagogy

AI-powered digital pedagogy refers to integration of Artificial Intelligence (AI) into teaching and learning processes in ways that may improve learning, personalisation, inclusion, assessment, interaction and learner agency. This should not be equated to as permitting students to use ChatGPT, Gemini, Copilot and the likes.

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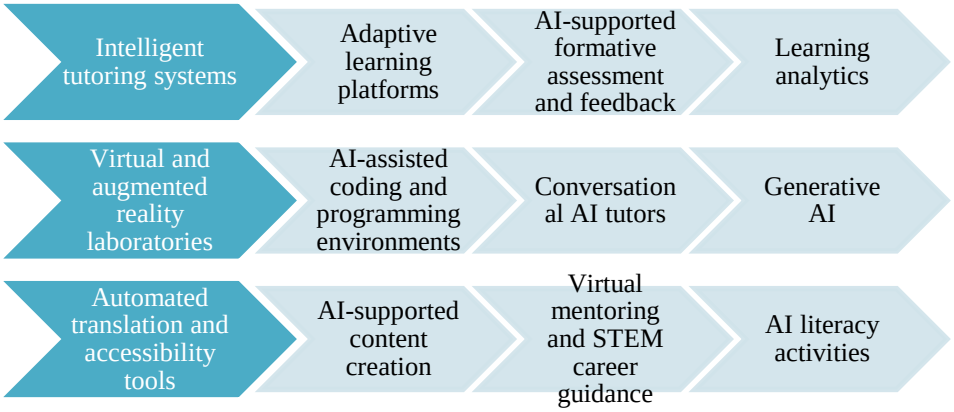

Figure 2: AI-powered digital pedagogy

Figure 2 reflect AI-powered digital pedagogy: intelligent tutoring systems which can provide individualised guidance; adaptive learning platforms which may adjust content to learners' progress; AI-supported formative assessment and feedback; learning analytics that could identify students who may require additional support; virtual and augmented reality laboratories; AI-assisted coding and programming environments; conversational AI tutors; generative AI which may help for brainstorming, explanation and simulation; automated translation and accessibility tools; AI-supported content creation; virtual mentoring and STEM career guidance; and AI literacy activities that students can critically observe how AI works and how it affects society. The educational worth creation of AI depends on pedagogy instead of technology only. Miao et al. (2021) lament that AI in education should support human-centred approaches, inclusion and equity instead of replacing teachers or reproducing existing differences. Digital Education Outlook: AI, learning analytics, robotics and other smart technologies can enhance personalisation and inclusion however, they need appropriate institutional, pedagogical and policy conditions (Organisation for Economic Cooperation and Development [OECD], 2021). The importance of AI literacy in education cannot be overemphasized as Casal-Otero et al. (2023) posits that AI literacy incorporates more than just technical knowledge and it may help learners comprehend better and interact critically and creatively with AI systems. Ng et al. (2022) view AI literacy as an emerging field and stressed the need for clearer explanations, pedagogical structures and assessment approaches. As higher institutions in Nigerian, AI may become integral part of the pedagogical ecosystem instead of an isolated technological add-on. For a good illustration a science teacher may learn not only how to ask an AI system to generate a chemistry lesson, however, it can also ask how to verify the scientific accuracy of the output, identify gender stereotypes in the examples provided, protect students' data and adapt the material to the Nigerian education setting.

Why AI-Powered Digital Pedagogy Can Benefit Girls in STEM

Here are the reasons to which AI-Powered Digital Pedagogy can benefit girls in STEM disciplines.

1. Personalised learning and differentiated support

A vital potential merit of AI in STEM education is the ability to promote personalised learning, because STEM courses can have cumulative knowledge structures including complexities in algebra that can affect physics; weak basic programming which may affect computer science; misconceptions in chemistry that could affect later learning. AI-supported platforms can enhance additional explanations, practice exercises, hints and feedback according to a learner's performance. This can be beneficial to students who are unwilling to ask questions in the public, unlike in a conventional classroom where a woman or girl student who may be fearful for being evaluated for making mistakes can remain silent. An AI tutor can pave way for a low-stake platform for recurrent inquiries. Technology has the strength to reduce social cost of making mistakes. Deng et al. (2024) lament that generative AI can enhance some dimensions of learning and ChatGPT, copilot or Gemini may have positive effects on academic performance and higher-order-thinking tendencies, however, the investigation did not find a corresponding improvement in self-efficacy. The finding is so critical for gender-responsive pedagogy in that technology can enhance performance without necessarily addressing confidence, resilience and identity. This means that human teachers may therefore, join AI-supported learning with encouragement, mentoring and opportunities for visible achievement.

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2. Flexible access to STEM learning

The online and virtual learning can minimize boundaries related with time, distance, type of school and physical location. The students who may face transport challenges, family responsibilities or safety concerns, access to recorded lectures, digital simulations and online discussion forums may promote valuable flexibility. It is good to note that flexibility should not at all be confused with equity. If online learning adopts broadband regularly, individual laptops and uninterrupted electricity power supply, it can precisely advance the students it is intended to support. Gender-responsive online pedagogy can adopt low-bandwidth and mobile-friendly approaches. Groupe Spécial Mobile Association (GSMA, 2024) maintains that mobile technologies are important routes to internet access in low- and middle-income countries, but women still face problems to mobile ownership and use. This means that there is need for higher education in Nigeria to design digital STEM resources that can function through mobile devices, compressed video, downloadable materials, asynchronous discussion and offline access where possible.

3. Virtual laboratories and simulation

Real-life STEM education can be costly where laboratories are poorly equipped. Virtual laboratories and simulations can balance real-life laboratories by allowing students to observe procedures, manipulate variables and visualise concepts before undertaking real experiments. Regarding female students who may have limited opportunities to use specialised equipment, virtual platforms can help them to practice in such opportunities. AI can as well personalise such platforms by adjusting learning tasks to suit students' performance. Considering this for instance, a virtual physics laboratory could allow students to examine gravitational force, projectile motion, electric circuits or fluid dynamics. An AI tutor can ask questions to identify misconceptions and recommend students to another simulation. A virtual chemistry laboratory can also allow students to perform repeated experimentation without intense use of expensive reagents. It is however good to note that virtual laboratories should not replace or take over physical laboratories, instead, it can only phase out boundaries for more practice and as well prepare students for effective physical experiments.

4. Paving way for access to female STEM role models

Girls' ambassadors in STEM cannot be overemphasized, because girls who may not see women as Engineers, Computer Scientists, Mathematicians, Biologists, Chemists, or physicists may find it difficult to envision themselves in such careers. Undoubtedly, digital classrooms can improve access to female STEM professionals more than the geographical limitations of a physical classroom. Nigerian higher institutions can build "Virtual Women in STEM" seminar series involving women working in engineering, virology, medical physics, artificial intelligence, medicine, cybersecurity, renewable energy, data science and educational technology. AI-enabled environments can then join students' interests, and attitudes with vital career pathways. Gladstone and Cimpian (2021) asserts that STEM role models' effects depend on perceived competence, similarity and attainability, rather than presenting famous women as exceptional figures. Students in Nigeria may therefore, benefit from experience to applicable female STEM professionals who may explain everyday trails into STEM, like setbacks, family errands, financial limitations and strategies for overcoming boundaries in STEM.

5. Supporting collaborative learning

It is good to also note that digital pedagogy should not in any way turn learning into a lonely interaction between a student and a machine. Collaboratively learning is still vital for STEM identity and belonging. Kube et al. (2022) confirms that potential collaborative learning platforms can reduce gender stereotypes and promote inclusive participation, however their study cautioned that gender is often treated mere as a binary variable. AI can promote such collaboration by conveying mixed teams to authentic STEM problems, facilitating brainstorming, identifying unanswered questions and providing feedback. Teachers or lecturers can monitor participation patterns to make sure that male students don't unduly assume technical or leadership roles while female students are allotted note-taking or presentation-support roles.

6. Improving accessibility

There are AI platforms that can also support learners through translation, speech-to-text, text-to-speech, captioning, summarisation and other accessibility functions. These technologies can lessen linguistic and communication boundaries. Accessibility in higher education in Nigeria can also include sensitivity to local language practices, bandwidth restrictions and different levels of digital literacy. A gender-inclusive AI system cannot assume that all learners are technologically confident or that English-language interfaces are equally accessible to everyone.

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7. Digital Pedagogy and Gender Inclusivity

The gender-inclusive digital pedagogy needs attention to who participates, who speaks, who leads, whose experiences appear in learning materials and who benefits from technology. A gender-neutral approach means that technology is available to all, also a gender-responsive approach questions who can actually use it, under what conditions, for what purposes, and with what outcomes? This discrepancy is fundamental because technology may appear neutral while operating within unequal social conditions. UNESCO (2024) confirms that technology can help girls who can be excluded from conventional education, but digital disparities and gender stereotypes can also be reproduced through technological design and use. It is clear that AI can replicate gender bias because AI systems learn from social data that may already contain unequal representations (United Nations Entity for Gender Equality and the Empowerment of Women [UN Women], 2024). Thus, gender-inclusive digital pedagogy should address five pedagogical questions as shown in Figure 3.

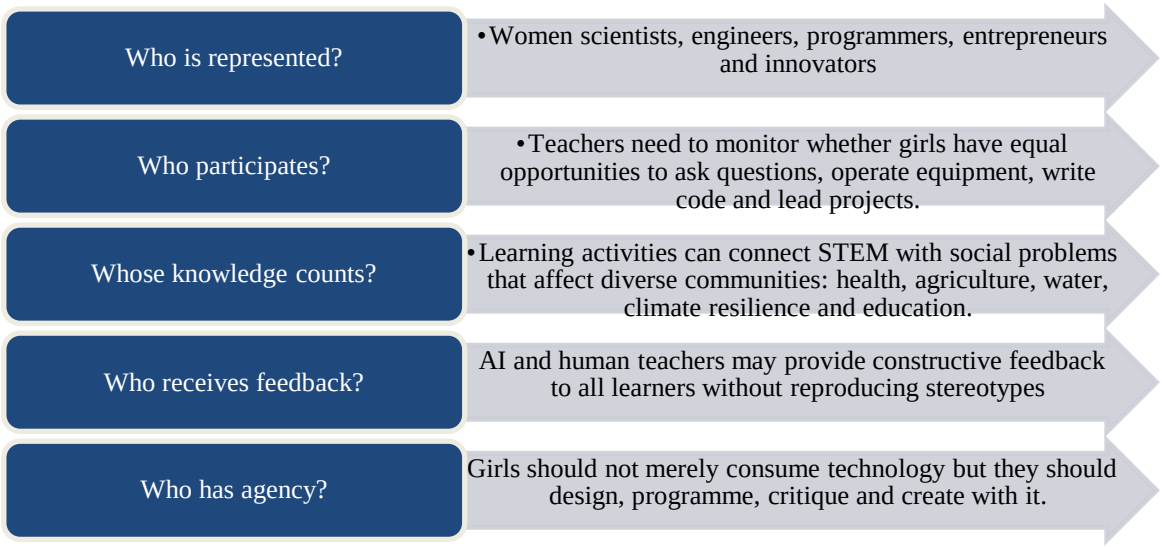

Figure3: Five Pedagogical questions Gender-Inclusive Digital Pedagogy can Adress

The Place of Nigerian Tertiary Education

It is captivating for locating this plan within Nigerian tertiary education. It is vital to note that universities and colleges of education in Nigeria provide institutional structures through which digital pedagogy can be integrated into formal preservice teachers. Science education, technology education, entrepreneurship education, computer science, engineering, mathematics education and educational technology programmes can set in AI literacy and gender-responsive pedagogy within an existing curriculum. Higher educations in Nigeria stand a greater chance to affect both present learners and future generations. A female undergraduate who becomes a science teacher may teach hundreds or thousands of learners. Thus, gender-responsive digital pedagogy in teacher education has a multiplier effect. Tertiary education in Nigeria may have access to learning management systems, computer facilities, internet-enabled classrooms, digital libraries and educational technology expertise. However, access is still uneven problem in Nigerian tertiary institutions, thus, making institutional savings and equity-sensitive practice is essential. There is an indication of growing student awareness of generative AI. Ezurike and Akinsulire (2024) confirms that undergraduates in Lagos reported substantial awareness and adoption of ChatGPT as a learning tool, with students identifying personalised learning and assistance with understanding complex concepts among its perceived benefits. It means that the question facing tertiary institutions in Nigeria is not whether students have encountered AI, but it is how institutions may guide that encounter. Nigeria's policy environment is being supportive of digital and AI development as shown by Federal Ministry of Education ([FME], 2023) that National Digital Learning Policy recognises AI's capacity to personalise learning while explicitly identifying concerns about bias, overdependence, privacy, cybersecurity and learning outcomes. Furthermore, the National AI Strategy has places human capital development and AI skills among its priorities and explicitly incorporates women into its youth-skills ambitions (FRN, 2024). Nigerian tertiary education therefore, epitomises appropriate joint for gender policy, digital transformation, teacher education and STEM development.

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AI-Powered Digital Pedagogy Framework for Gender-Inclusive STEM

The Gender-Inclusive AI Digital Pedagogy Framework (GI-AIDP) for STEM education in Nigeria. This framework is built around six equally strengthening philosophies.

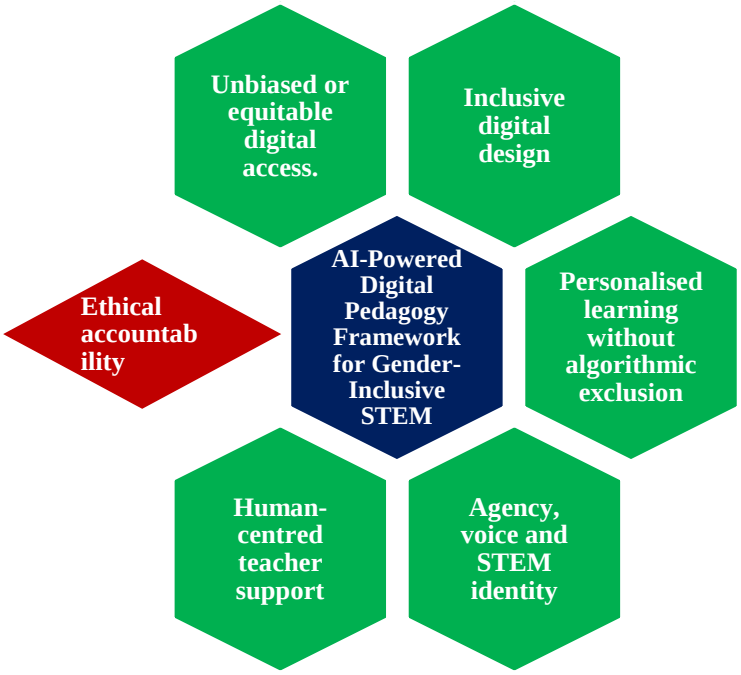

Figure 4: Gender-Inclusive AI Digital Pedagogy Framework (GI-AIDP) for STEM education in Nigeria

Philosophy 1: Unbiased or equitable digital access.

AI alone cannot bridge digital divide except all students can access it. This means that Nigerian tertiary institutions may provide the following: device-loan schemes, affordable or subsidised connectivity, campus Wi-Fi with gender-equitable access, charging facilities and alternative power supply solutions, computer laboratories with extended hours, downloadable and offline learning materials, mobile-compatible learning platforms, and targeted digital support for demerit female students. This focus is not only access to hardware but it has to do with meaningful and sustained access to educational technologies.

Philosophy 2: Inclusive digital design

Tertiary education system in Nigeria can make available digital STEM resources designed for all learners. Course designers may consider prior digital experience, cognitive load, accessibility, screen size, bandwidth and language. Instructional materials can intentionally involve women and girls as STEM creators instead of portraying them only as recipients of technology.

Philosophy 3: Personalised learning without algorithmic exclusion

Here AI systems can identify yawning gaps in learning and may recommend resources. However, Tertiary institutions in Nigeria could monitor whether algorithms create scientifically different recommendations for male and female learners. Adaptive system for instance may not interpret lower initial confidence among female students as evidence that they are less capable of advanced STEM work, instead, it can provide scaffolding while sustaining high opportunities.

Philosophy 4: Agency, voice and STEM identity

Nigerian tertiary institutions can ensure that students use AI to create instead of consuming. Gender-inclusive STEM activities can include girls in the following aspects programming, robotics, data analysis, AI model critique, scientific simulations, engineering design, digital storytelling, problem-based learning, innovative digital modelling, and entrepreneurship. AI could be situated as a tool that girls can control, handle, manipulate, question and redesign.

Philosophy 5: Human-centred teacher support

Lecturers and teacher educators can note that AI may only augment and not replace them. It is noticeable that human teachers are integral components for mentoring, emotional support, contextualisation, ethical judgement and the development of STEM identity. Lucas et al. (2021) posits that digital competence is influenced by confidence, resilience,

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openness to technology and the range of digital tools used in teaching. Also, digital competence should be treated as a multidimensional professional capacity rather than a simple technical skill (Basilotta-Gómez-Pablos et al., 2022). This means that NCE, B.Ed., M.Ed. and PhD programmes can be incorporated with practical AI pedagogy by Nigerian higher institution instead of limiting AI to theoretical discussion.

Philosophy 6: Ethical accountability

Universities and colleges of education should ensure that AI-supported education must protect students from privacy violations, discrimination, surveillance, and unsafe online platforms. The ethical dimension is vital for girls because digital participation may expose them to harassment, gender-based abuse and other forms of online violence. UN Women (2024) highlighted how AI can intensify gender-based digital harms. Thus, Nigerian universities and colleges of education may establish clearer policies regarding students' data protection, consent, academic integrity, AI-generated content, algorithmic bias, cyberbullying, online harassment, deepfakes, responsible use of generative AI, and procedures for reporting digital abuse (Ayua & Akaabo, 2016; Ayua, 2018; Ayua & Kwagh, 2026).

A Real-Life Model for Universities and Colleges of Education in Nigeria

This real-life model framework can be organised and operationalised in four-stage institutional model.

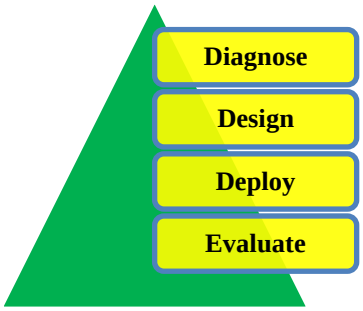

Figure 5: Real-Life Model Framework Stages

Stage 1: Diagnose

Universities and colleges of education can conduct gender-disaggregated audits in the following areas: STEM enrolment, device ownership, access to laboratories, internet access, digital skills, AI literacy, course completion, participation in online activities, academic performance, and students' confidence in technology usage. The purpose this audit is to identify and locate where this gender digital divide occurs.

Stage 2: Design

Courses could be redesigned in tertiary institution in Nigeria around gender-responsive digital pedagogy. Like in the instance of physics courses, it can contain video lectures, AI tutoring, virtual simulations, collaborative problem-solving and mentoring by female physicists. Computer science courses for example may use AI coding assistants meanwhile requiring students to explain, test and critique AI-generated code. This could prevent AI from being just a shortcut but turning it into a tool for computational thinking. Teacher-education programmes in Nigerian institutions can require preservice teachers to design AI-supported STEM lessons explicitly addressing gender inclusion.

Stage 3: Deploy

Nigerian universities and colleges of education can practice combined technology with human support. Female students in the universities and colleges may have access to the following: female STEM mentors, peer-learning groups, digital-skills clinics, AI-literacy workshops, coding and robotics clubs, research opportunities, virtual STEM communities, and academic advising counsellor. This approach is consistent with García et al. (2020) that sustained interventions combining inclusive pedagogies and role models are more advantageous for strengthening girls' STEM identity than isolated exposure.

Stage 4: Evaluate

Evaluation can go beyond just counting the number of students who logged into online platform. Nigerian universities and colleges of education can ensure full participation rates by gender, retention in STEM programmes, course achievement, AI literacy, digital confidence, digital resilience, STEM self-efficacy, STEM identity, progression to postgraduate study, participation in STEM research, technology entrepreneurship, and perceptions of belonging and inclusion. It is good to note that gender-disaggregated data are essential and without them, tertiary institutions in Nigeria may declare a digital initiative successful but girls may still remain disproportionately excluded.

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Implications for Teacher Preparation and Professional Development

The vital part of this study to NCE, B.Ed., M.Ed. and PhD Science Education programmes is actually good, because teacher educators can prepare preservice teachers to perform task at least in six roles as shown in Figure 5.

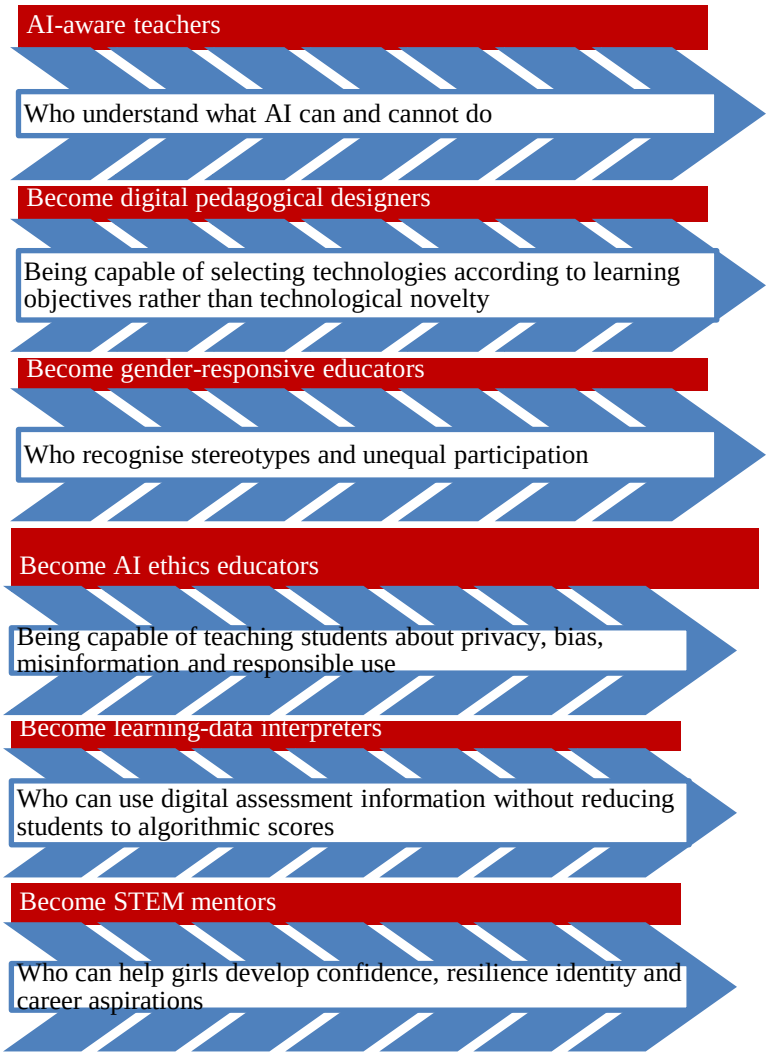

Figure 5: Roles of Teacher Preparation and Professional Development

These roles shown in Figure 5 needs professional development for Nigerian educators to move beyond one-off workshops. The digital competence can only be developed through practice, reflection and supporting experimentation. Reisoğlu and Çebi (2020) shows the importance of collaborative learning, role modelling and opportunities to put theoretical knowledge into practice. Therefore, teacher educators can establish AI pedagogical laboratories where preservice teachers can design, test and evaluate digital lessons. Such AI pedagogical laboratories can have the following: generative AI tools, virtual laboratory platforms, coding platforms, robotics kits, learning analytics dashboards and accessibility technologies. Viewing the vital aspects of this, professional development itself may be gender-responsive where female teacher educators and preservice teachers can be encouraged to accept leadership roles in institutional AI initiatives instead of being positioned only as beneficiaries.

Opportunities and Risks of Generative AI for Gender Equality

Generative AI reveals an integral inconsistency where it can democratise access to expertise while concurrently reproducing social disparities. A student can obtain explanations of complex mathematical, Biological, Chemistry or Physics concepts, receive programming assistance, generate practice questions or simulate a scientific discussion without waiting for a lecturer, this is an opportunity on the side of learners. This can be vital in large class sizes with limited instructor time. However, most times AI-generated information may be inaccurate, biased or stereotypical. Miao et al.

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(2021) confirms that AI systems can reproduce bias and that educational AI requires transparent, fair and inclusive governance. Gender bias in AI can reflects broader social disparities, also a greater participation by women in AI advancement is critical (UN Women, 2024). The problem of automation disparity is also a risk, because students with quality devices, stronger digital skills and more experience writing prompts may gain greater more from GenAI than students who are new to technology. Academic dependency is another risk to ponder upon, because if students could just copy AI-generated answers, they may complete assignments without developing scientific reasoning, critical thinking. FRN (2023), Jomen and Ayua (2026), confirm that excessive dependence on AI could weaken critical thinking, creative thinking and problem-solving of learners. The proper response to this is not to stop AI usage, however, learners can be taught how to use it critically. Regarding gender-responsive AI assignment might require students to do the following tasks: asks AI system to generate a solution, independently solve the problem, compare the two responses, identify errors or assumptions, examine potential gender or cultural bias, improve the AI response; and reflect on what the exercise reveals about AI. This can transform AI from a replacement for thinking into an object and instrument of creative and critical thinking.

Call for action in Research Agenda for Nigeria

There is need for gender-disaggregated research on AI adoption in Nigerian tertiary education system. Awareness of ChatGPT, copilot or Gemini does not really mean equitable or educationally productive use. Research can examine AI literacy among female preservice teachers. Studies may ask whether female and male preservice teachers differ in confidence, critical understanding, perceived usefulness and ethical awareness. Researchers could investigate AI-supported STEM retention. The critical outcome is not just whether girls use AI but whether they remain in STEM programmes and advanced into STEM careers. Researchers can investigate algorithmic bias in educational AI used in Nigeria. AI systems trained predominantly on non-African data may provide examples, explanations and assumptions that do not adequately reflect Nigerian learners. There is a need for intersectional research. Gender cannot be studied in isolation from poverty, disability, rurality, language, ethnicity, geographical location and socioeconomic status. Longitudinal research can examine whether AI-enhanced digital pedagogy changes STEM identity, resilience and self-efficacy. This is vital because learning performance and identity development may not have identical outcomes. Researchers may investigate into teacher professional development models that can sustainably integrate AI and gender-responsive pedagogy within universities and colleges of education in Nigeria.

Conclusion

The future of STEM education can be digital, intelligent and interconnected. The central question is not whether AI can enter the Nigerian classrooms, it has already entered. The vital question is whose educational opportunities may expand as AI has surrounded teaching and learning. AI-powered digital pedagogy has unique and novel potential to make STEM education more accessible to girls and women: personalised learning can promote additional support, virtual laboratories can expand opportunities for experimentation, online platforms can remove some geographical boundaries, AI-enabled accessibility tools can support individual differences, and digital mentoring can connect girls with women STEM professionals. We can still say that technology is not inherently inclusive. Without attention to intervention, AI can reproduce the gender stereotypes, unequal access and social exclusions which already exist in education. The gender digital divide cannot be merely solved by putting more computers in classrooms or making ChatGPT, copilot or Gemini available to students. The most integral part is gender-responsive digital change. It simply means integrating AI literacy, digital pedagogy, STEM mentoring and gender inclusiveness into universities and colleges of education in Nigeria. It means developing NCE, B.Ed., M.Ed. and PhD students to become teachers and researchers who can use AI critically and ethically. Moreso, designing digital learning environments in which girls are not passive consumers of technology but programmers, researchers, designers, problem-solvers and innovators. Gender-Inclusive AI Digital Pedagogical Framework rests on six philosophies: equitable access, inclusive design, personalised learning without algorithmic exclusion, learner agency, human-centred teacher support and ethical accountability. Collectively, these philosophies shift the focus from technological adoption to educational change. The core aim can be expressed not as AI for girls, but as AI with girls, by girls and for equitable STEM future. Digital classroom instruction can become equalising spaces but only when equality is intentionally designed into the technology, pedagogy, curriculum, teacher development and institutional policies that shape them. Regarding Nigeria, this has represented educational responsibility and opportunity to ensure that the country's transition into an AI-driven economy does not lock women and girls behind the door.

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Policy and Institutional Suggestions

The following are to be considered here.

1. Nigerian universities and colleges of education should develop institutional AI-and-gender strategies instead of adopting AI tools on an ad hoc basis. All digital-learning strategy should comprise gender-equity indicators. Tertiary educations in Nigeria should create device-loan structures and targeted digital-skills programmes for female students from challenged backgrounds. They should advance campus-based AI and STEM mentoring programmes to be headed by female academicians, researchers and industrial professionals.
2. Teacher-education should ensure to incorporate the following into her curricula: AI literacy, digital pedagogy, computational thinking, virtual STEM laboratories, gender-responsive teaching, algorithmic bias, digital citizenship, cybersecurity, data privacy, and responsible generative AI use. The target should be to produce teachers who can teach with AI, about AI and against the harmful uses of AI.
3. Government should prioritise affordable broadband, reliable electricity, digital devices and inclusive AI infrastructure. Digital-skills initiatives should collect gender-disaggregated data so that progress can be monitored. Nigeria's National AI Strategy provides an important policy foundation because it explicitly recognises youth AI skills and includes women within its human-capital objectives.
4. Technology providers of AI and educational-technology companies should involve women educators and STEM education experts in design and testing. Systems should be assessed for gender bias, language accessibility, cultural relevance, privacy and safety.
5. Nigerian research institutions should undertake longitudinal studies examining whether AI-supported interventions actually improve girls' STEM retention, achievement and career progression. Current literature contains substantial evidence on AI and education generally, but much less evidence directly examining gender-responsive AI pedagogy in African tertiary STEM education settings.

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