

Research Article

Leveraging Artificial Intelligence (AI) for personalized and inclusive STEAM education: Strategies for bridging learning gaps among diverse learners

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Abstract

Artificial Intelligence (AI) holds immense potential to transform STEAM (Science, Technology, Engineering, Arts, and Mathematics) education by enabling personalized, inclusive, and adaptive learning experiences that address the diverse needs of 21st-century learners. This paper examines the role of AI in mitigating disparities in educational access and engagement among underrepresented groups, including students with disabilities, those from low-income backgrounds, and learners with varied cognitive and learning styles. Through the deployment of AI-driven educational tools, educators can create adaptive learning environments that provide tailored instruction, real-time feedback, and differentiated support, ensuring that all students progress at their own pace and according to their individual learning pathways. The study emphasizes how AI can support culturally responsive pedagogy, delivering context-aware and identity-affirming content that enhances engagement and promotes equity in STEAM education. It also highlights the opportunities AI presents for expanding access to high-quality resources, particularly in underserved and remote communities. Assistive technologies powered by AI can enhance inclusion for students with special needs, while personalized learning platforms can democratize access to quality instruction. Despite these promising prospects, the paper also addresses critical challenges in AI integration, such as algorithmic bias, data privacy concerns, digital infrastructure gaps, and insufficient teacher preparedness. In response, the paper proposes a framework for the ethical deployment of AI in education, grounded in the principles of fairness, equity, transparency, and accountability. Key recommendations include the development of inclusive AI systems, targeted capacity-building programs for educators, and policies that ensure equitable access to AI tools and infrastructure across all educational settings.

Keywords: Artificial Intelligence, Inclusive Education, Personalized Learning, and STEAM Education, Equity

1. Introduction

Artificial Intelligence (AI) is rapidly transforming the educational landscape, offering novel approaches to instruction, learning, and assessment. AI refers to the ability of computer systems to perform tasks typically requiring human intelligence, such as learning, reasoning, pattern recognition, and decision-making. These systems operate through complex algorithms and data-driven models that allow machines to improve their performance over time with minimal human input. While AI has been widely adopted in fields such as healthcare, finance, and logistics, its application in education; particularly in STEAM (Science, Technology, Engineering, Arts, and Mathematics) education, is gaining increased attention due to its capacity to enhance both personalization and inclusion.

Traditional educational systems have often employed standardized, one-size-fits-all instructional models that fail to

accommodate the diverse needs of learners. This has resulted in persistent disparities in educational outcomes, especially among students from marginalized communities, those with disabilities, and learners with diverse cognitive styles. AI offers promising solutions to these challenges through adaptive learning platforms, intelligent tutoring systems, and automated feedback mechanisms. These tools are capable of assessing learners' strengths, weaknesses, and preferences in real-time, and adjusting content accordingly. Such personalization enables students to learn at their own pace and receive targeted support, which is particularly valuable in complex STEAM subjects that require differentiated instruction (Ajani et al., 2024; Das et al., 2023).

In addition to personalization, AI technologies hold significant potential for promoting educational equity. In low-resource settings where access to qualified teachers and quality materials is limited, AI-powered tools can bridge

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gaps by delivering interactive content, virtual laboratories, and real-time tutoring. These innovations help democratize learning by making high-quality educational experiences available to students irrespective of their geographic location or socioeconomic status (Fazal et al., 2025; Glushkova & Malinova, 2024).

Moreover, AI has proven effective in supporting inclusive education. Tools such as speech-to-text applications, real-time translation services, and assistive technologies for students with visual or hearing impairments ensure that learners with disabilities are not excluded from meaningful educational engagement (Skowronek et al., 2021). These applications align with global educational equity goals and can significantly enhance access and participation in STEAM education for all learners.

As the demand for digital skills and STEAM competencies continues to grow in the global economy, it is imperative that education systems evolve to meet the needs of diverse learners. AI presents an opportunity to create more engaging, responsive, and inclusive educational environments that prepare students for participation in a technologically advanced world (Sharma, 2024).

This paper investigates the transformative role of AI in promoting personalized and inclusive STEAM education. It explores how AI-driven approaches can reduce barriers to learning, support diverse student populations, and address systemic inequities in access to quality education. By examining current research, technologies, and practical applications, this study aims to provide a framework for the ethical deployment of AI in education—one that aligns with the principles of fairness, equity, and social inclusion.

2. Literature Review

2.1. The Role of AI in Personalized STEAM Education

AI plays a crucial role in personalized learning within STEAM education by allowing students to progress at their own pace, tailored to their unique strengths, challenges, and interests. This customization fosters improved engagement and academic performance. Through sophisticated algorithms, AI analyzes student performance in real-time, adjusting the curriculum to meet individual needs. For instance, if a student struggles with a concept like algebra in math or coding in computer science, AI can offer targeted exercises to reinforce understanding. Conversely, if a student excels, AI can provide more advanced materials to challenge them further. This adaptability helps ensure students are neither overwhelmed nor left behind (Babu et al., 2025).

Moreover, AI-driven systems offer real-time feedback, enabling students to identify and correct mistakes promptly. This instant response prevents misconceptions from becoming ingrained, leading to a deeper understanding of the material. This dynamic interaction keeps students engaged and active in their learning journey, fostering curiosity and a sense of ownership in their education (Das et al., 2023).

In addition to enhancing personalized learning, AI also streamlines administrative tasks, such as grading, progress

tracking, and data analysis. By automating these functions, educators have more time to focus on teaching and providing individualized support to students, creating a more dynamic and supportive classroom environment (Babu et al., 2025). AI also contributes to a more efficient educational system overall, with intelligent tutoring systems that provide additional learning materials, answer questions, offer extra support beyond regular class hours. This "always-on" learning environment ensures that students have access to resources and help whenever they need it, which is especially beneficial for those who may struggle with complex STEAM concepts or require more flexible learning schedules (Fazal et al., 2025).

By fostering independent and self-directed learning, AI encourages students to explore subjects at their own pace, in line with their interests. This approach is particularly valuable in STEAM education, where critical thinking, innovation, and adaptability are essential. By offering personalized learning pathways, AI equips students with the skills necessary for success in the rapidly changing, interdisciplinary landscape of STEAM fields (Skowronek et al., 2021).

Ultimately, AI's role in personalized learning within STEAM education enhances student engagement, performance, and overall success. Through adaptive learning systems, real-time feedback, automation of administrative tasks, and continuous support, AI helps create a more efficient, inclusive, and empowering learning environment. As AI continues to evolve, its potential to improve student outcomes in STEAM fields grows, offering students the personalized attention and resources they need to thrive.

2.2. Bridging Educational Gaps with AI

AI in STEAM education has the potential to address educational equity by providing scalable, adaptive solutions that bridge gaps in underserved communities. Many students, particularly from lower socio-economic backgrounds or remote areas, face barriers to quality education. AI-powered tools like intelligent tutoring systems, virtual laboratories, and automated assessments help personalize learning, offer immediate feedback, and ensure no student falls behind (Fazal et al., 2025; Glushkova & Malinova, 2024).

Virtual labs enable hands-on learning in fields like biology and chemistry, even without physical equipment, democratizing access to STEAM education (Das et al., 2023). Automated assessments provide real-time feedback, track progress, and reduce biases, offering fairer evaluations, especially in resource-limited environments (Babu et al., 2025).

AI also promotes digital inclusion by supporting students with disabilities through tools like speech recognition and text-to-speech systems (Skowronek et al., 2021). These innovations make STEAM more accessible to diverse learners, ensuring everyone can succeed regardless of background or ability.

In developing countries, AI can transform education

systems by providing cost-effective, mobile-accessible resources, making quality education available even in remote areas (Skowronek et al., 2021). AI's role in personalized learning and fostering digital inclusion promises a more equitable educational landscape, empowering underserved students to thrive in STEAM fields.

2.3. Fostering Inclusivity in STEAM Education

In addition to providing personalized learning experiences, Artificial Intelligence (AI) plays a pivotal role in fostering inclusivity within STEAM (Science, Technology, Engineering, Arts, and Mathematics) education. Inclusivity is a critical element in modern educational frameworks, ensuring that all learners, regardless of their abilities, backgrounds, or learning styles, have access to quality education. AI has the potential to transform educational environments by adapting to diverse learning needs, enabling a more equitable learning experience for every student. As highlighted by Skowronek et al. (2021), AI-driven educational tools offer significant support for a broad spectrum of learners, particularly those with disabilities, by providing assistive technologies tailored to individual needs.

For instance, AI-powered tools such as speech-to-text software, real-time language translation, and predictive text systems are essential for making STEAM subjects more accessible to students with disabilities or those who speak different languages. Speech-to-text technologies allow students with visual or auditory impairments to participate in classroom activities by converting spoken language into written text, ensuring that they can engage with the material in real time. Similarly, real-time language translation tools enable students from diverse linguistic backgrounds to follow lessons, participate in discussions, and understand complex scientific or technical content, thus reducing the barriers posed by language differences (Skowronek et al., 2021). These tools are invaluable in fostering an inclusive classroom where every student has the opportunity to contribute to and benefit from the learning process, regardless of their individual challenges.

Moreover, AI facilitates inclusivity by supporting a variety of learning styles and helping to create personalized learning pathways. AI algorithms can analyze individual student performance and adapt instructional materials to suit each learner's unique needs. For example, students who struggle with certain concepts in mathematics or engineering can be provided with supplementary exercises or interactive tutorials to reinforce their understanding, while more advanced learners can be offered enrichment activities to extend their knowledge. This flexibility ensures that no student is left behind, fostering an environment where learners of all levels can thrive (Suresh Babu et al., 2025).

AI's ability to support inclusive pedagogies also extends to teachers, enabling them to customize their teaching strategies to meet the diverse needs of their students. According to Sharma (2024), AI tools provide educators with insights into student performance, helping them identify

students who may need additional support. This data-driven approach allows teachers to make informed decisions about their teaching methods, ensuring that their strategies are inclusive and effective. Teachers can use AI to create customized learning experiences, adjusting the pace of instruction, the complexity of content, or the format of assignments to suit different learning preferences. For example, visual learners may benefit from video tutorials or interactive simulations, while kinesthetic learners may engage more effectively with hands-on experiments or physical tasks facilitated by AI-powered devices.

The inclusive potential of AI extends beyond supporting students with disabilities or language barriers. It also plays a crucial role in promoting diversity and equity in STEAM education by recognizing and valuing the unique contributions of students from various cultural and socio-economic backgrounds. By leveraging AI, educators can ensure that all students, regardless of their background, have access to the same high-quality educational opportunities. This fosters a learning environment that celebrates diversity and encourages all students to pursue careers in STEAM fields, which have historically been underrepresented by certain demographic groups, such as women, minorities, and students from low-income families (Ajani et al., 2024).

In addition to improving individual student outcomes, AI-driven inclusivity enhances the overall classroom dynamic by promoting collaboration and interaction among students with diverse backgrounds and abilities. The use of AI tools encourages peer-to-peer learning, where students can share their unique perspectives and skills. For example, AI can facilitate group projects by allowing students to collaborate on virtual platforms, even if they are from different geographical locations. This not only promotes inclusivity but also prepares students for the collaborative nature of modern work environments, especially in STEAM fields, which often require interdisciplinary teamwork.

Furthermore, the widespread integration of AI in education also has the potential to challenge and dismantle existing biases in traditional teaching methods. As AI systems analyse large datasets and provide personalized feedback, they can help identify and correct biases related to gender, race, or socio-economic status, ensuring a more equitable learning experience for all students (Fazal et al., 2025). This is particularly important in STEAM education, where underrepresentation of certain groups has been a persistent issue. AI can help level the playing field by providing equal opportunities and resources for students from diverse backgrounds, ultimately fostering a more inclusive STEAM workforce in the future.

AI's role in fostering inclusivity in STEAM education is multi-faceted and transformative. By providing assistive technologies, enabling personalized learning, and supporting inclusive pedagogies, AI ensures that every student—regardless of ability, background, or learning style—can fully participate in and benefit from STEAM education. As

AI continues to evolve, its potential to create more inclusive, equitable, and diverse learning environments will play a crucial role in shaping the future of education, ensuring that all learners have the opportunity to succeed in these critical fields.

2.4. Impact of AI with respect to Inclusivity

Research by Raza (2023) and other scholars (Das et al., 2023) demonstrates that Artificial Intelligence (AI) has a significant and transformative impact on student performance across educational settings. AI-enabled personalized learning systems are revolutionizing the way students engage with learning content, particularly in STEAM (Science, Technology, Engineering, Arts, and Mathematics) fields. These systems tailor their support and resources to the individual needs of each student, enhancing their ability to grasp complex concepts by adapting to their unique pace and learning style. Such adaptability ensures that students receive targeted, real-time feedback, and additional resources when necessary, which fosters a deeper understanding of the subject matter (Raza, 2023). This level of personalization helps create a more engaging and inclusive learning experience, which is particularly beneficial for diverse student populations.

In addition to personalized learning, AI-powered assessments have emerged as a valuable tool for educators. These assessments can provide more accurate, timely insights into a student's learning progression, identifying specific areas of strength and weakness. This allows educators to monitor student progress continuously and gain a nuanced understanding of their performance (Das et al., 2023). By leveraging data-driven approaches, AI can pinpoint where students are struggling and provide recommendations for targeted interventions to address these challenges. Such an approach is crucial in ensuring that no student falls behind, fostering an environment where every learner has the opportunity to succeed.

Furthermore, AI systems can help reduce the workload for teachers, allowing them to focus more on individualized instruction and student support. By automating routine tasks such as grading, AI frees up valuable time for educators to interact with students more effectively, creating a more supportive and efficient learning environment. The result is not only improved academic outcomes but also enhanced teacher-student relationships that are essential for student success.

Overall, the integration of AI into education offers promising potential for improving student performance, particularly through personalized learning and data-driven assessments. As these technologies continue to evolve, their impact on student achievement, engagement, and overall educational experience is expected to grow, benefiting a wide range of learners from various backgrounds and skill levels.

3. Challenges and Considerations

Despite the many opportunities AI presents in education,

there are several challenges and considerations that must be addressed to ensure its successful implementation and to avoid unintended consequences. One of the key issues is the digital divide, which refers to the unequal access to AI-powered tools and technologies due to factors such as infrastructure, internet connectivity, and the availability of devices. This divide can lead to significant educational disparities, particularly for students in rural or economically disadvantaged areas. Without reliable access to the necessary resources, students in these areas may be unable to fully benefit from AI-driven personalized learning systems and assessments, potentially widening the achievement gap (Ajani et al., 2024). The digital divide not only affects access to AI tools but also limits opportunities for students to develop the digital literacy skills that are increasingly necessary in today's world.

Another significant concern is data privacy and the ethical use of AI in education. As AI systems collect vast amounts of student data to personalize learning, there is a heightened risk that this sensitive information could be misused or inadequately protected. Ensuring that students' personal and educational data is kept safe and used responsibly is crucial to maintaining trust in these technologies. The ethical implications of AI's data collection processes raise questions about consent, the transparency of data usage, and potential biases in the data itself. These concerns are particularly relevant when considering the long-term impact AI can have on students' privacy, as well as the potential for discrimination or exclusion based on the data that AI systems use (Glushkova & Malinova, 2024).

Moreover, there is the issue of algorithmic bias, where AI systems, if not properly designed and monitored, can perpetuate existing biases in the educational system. AI models often rely on historical data, which may contain biases that reflect inequalities present in society. If AI systems are not carefully calibrated, they can reinforce stereotypes or discriminate against certain groups of students, whether based on race, gender, socio-economic background, or other factors. This could lead to unfair educational outcomes, undermining the intended benefits of AI in creating an equitable learning environment (Ajani et al., 2024).

Finally, teacher training and support is another challenge in the effective integration of AI into education. Teachers may face difficulties in adopting new technologies, especially if they are not provided with adequate professional development or on-going support. For AI to be fully effective in the classroom, educators need to be equipped not only with the technical skills to operate AI tools but also with a clear understanding of how these tools can complement their teaching strategies and support student learning. Without proper training, teachers may struggle to effectively integrate AI into their practices, limiting its potential impact on student performance.

While AI has the potential to revolutionize education,

these challenges must be carefully addressed to ensure its equitable, ethical, and effective implementation. Bridging the digital divide, safeguarding data privacy, eliminating algorithmic bias, and providing comprehensive teacher training are essential steps to ensure that AI can truly enhance educational outcomes for all students.

4. Opportunities of AI in Bridging Educational Gaps

Artificial Intelligence (AI) presents transformative opportunities to address longstanding educational inequalities in Nigeria, particularly by personalizing learning and expanding access to quality educational resources. One of the foremost advantages of AI is its capacity for personalized learning. AI-driven systems can tailor instructional content and pacing to meet the unique needs and abilities of individual students. This capability is especially crucial in clogged and under-resourced schools, where teachers often struggle to provide differentiated support. By adapting to each learner's pace and style, AI helps bridge disparities and fosters more equitable learning outcomes (Iroriteraye-Adjekpovu, 2024).

In addition to personalization, AI facilitates expanded access to quality learning materials. Digital platforms powered by AI deliver rich, interactive content such as videos, simulations, and virtual experiments. These resources are invaluable in remote or marginalized regions where qualified teachers and textbooks are scarce. Moreover, many AI systems are designed to operate effectively even in offline or low-bandwidth settings, mitigating infrastructural challenges prevalent in Nigeria's rural areas (Tanimu & Jibia, 2024).

Another significant opportunity lies in the use of AI for automated assessments and immediate feedback. AI-powered tools can continuously monitor student performance, providing timely evaluations that enable early identification of learning difficulties. This feedback loop empowers teachers to allocate their support more efficiently and intervene before students fall behind, thus improving learning outcomes (Agbarakwe & Chibueze, 2024).

AI also enhances educational inclusion for learners with disabilities through assistive technologies. Innovations such as speech-to-text systems, AI tutors, and screen readers make educational content more accessible to students with visual, auditory, or cognitive impairments. By supporting diverse learning needs, these tools promote greater participation and equity within STEAM education and beyond (Omiegbe, 2024).

Furthermore, AI extends its impact to vocational education and lifelong learning, which are essential for adult learners and out-of-school youth. For example, AI-driven platforms in Bayelsa State provide accessible skills training in entrepreneurship and technical fields, equipping learners with practical competencies needed for economic empowerment and social mobility (Ogah Aduwari, 2024).

In summary, AI offers Nigeria a powerful means to

democratize education and reduce inequities. When implemented thoughtfully and ethically, AI can serve as a critical equalizer; ensuring that all learners, regardless of geographic or socioeconomic status, have access to personalized, inclusive, and high-quality educational opportunities.

5. Conclusion

AI holds the potential to transform personalized and inclusive STEAM education by narrowing educational gaps and empowering a diverse range of learners. Through personalized learning experiences, increased engagement, and a focus on inclusivity, AI can play a crucial role in fostering a more equitable and effective education system. However, the successful integration of AI requires thoughtful attention to infrastructure, ethical considerations, and ensuring equal access for all students. As AI technologies continue to advance, they will undoubtedly reshape the future of education, equipping the next generation of innovators and problem-solvers with the skills needed to succeed in the 21st century.

Recommendations:

- Ensure equitable access to AI tools: Invest in infrastructure, connectivity, and devices for underserved communities to bridge the digital divide.
- Protect student data and uphold ethical standards: Enforce clear data privacy policies, promote transparency, and safeguard students' personal information.
- Design bias-free and inclusive AI systems: Use diverse data, conduct regular bias audits, and involve inclusive teams in AI development to prevent discrimination.
- Empower educators through AI training: Provide ongoing, practical professional development to help teachers effectively integrate AI into their STEAM instruction.
- Promote collaborative research and policy innovation: Support partnerships among educators, policymakers, and technologists to shape ethical, inclusive AI applications in education.
- Center AI tools around student agency: Involve students in design processes and prioritize AI that supports creativity, personalization, and learner autonomy.

Abbreviations

STEAM	Science Technology, Engineering, Arts and Mathematics
A.I	Artificial Intelligence

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Conflicts of Interest

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