Environment and Social Psychology (2025) Volume 10 Issue 10 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v10i10.4016 2424-7979 (P)

RESEARCH ARTICLE

Artificial intelligence in education: A tool for equity or a barrier to inclusion

Alif Fairus Bin Nor Mohamad, Noor Suriati Binti Sharibudeen, Kaneshvaran A/L Selvam, Chang Yee Lee, Siti Noraihan Bt Sheikh Ahmad, Norhaslinda Binti Abd Rani, Anitha Thiagarajam, Sarfraz Aslam*

Faculty of Education and Humanities, UNITAR International University, Petaling Jaya, 47301, Malaysia

*** Corresponding author:** Sarfraz Aslam, Sarfraz.aslam@unitar.my

ABSTRACT

This systematic literature review critically examines the dual role of Artificial Intelligence (AI) in education as a catalyst for equity and as a potential barrier to inclusion. Drawing on 29 peer-reviewed studies from 2020 to 2025, the review investigates how AI technologies such as personalized learning systems, intelligent tutoring, and automated grading can support equitable educational outcomes, particularly for underserved and marginalized learners. At the same time, it highlights significant challenges, including digital access disparities, algorithmic bias, and insufficient teacher training, which risk reinforcing existing educational inequities. The review is guided by the PICO framework (Population, Intervention, Context, Outcome) to define the scope of the research focus and the SPIDER framework (Sample, Phenomenon of Interest, Design, Evaluation, Research type) to structure the selection and synthesis of qualitative and mixed-method studies. The study synthesizes thematic findings using mixed-methods analysis and explores the alignment of AI integration with Sustainable Development Goal 4 (SDG 4). The review identifies critical research gaps in longitudinal impact, geographic representation, learner voice, and ethical governance. It concludes that while AI holds transformative potential for inclusive education, realizing this promise requires intentional design, ethical oversight, infrastructure investment, and cross-sector collaboration. These findings offer actionable insights for educators, policymakers, and AI developers aiming to promote fairness and inclusivity in educational innovation.

Keywords: artificial intelligence; equity and inclusion; personalized learning; algorithmic bias; Sustainable Development Goal 4 (SDG 4)

1. Introduction

In the fast-paced digital era of today, Artificial Intelligence (AI) has become a significant transformative element across various fields, notably in education. AI technologies such as natural language processing, machine learning, and adaptive learning methods are changing the way teachers provide instruction and how students interact with materials. By automating administrative functions and personalizing learning experiences, AI presents impactful tools for improving educational processes[7]. Nevertheless, like many technological developments, the implementation of AI in education prompts important discussions regarding equity and inclusion. While some perspectives highlight AI's potential to democratize education, others warn that it could exacerbate existing inequalities if accessibility and design aren't approached with fairness.

ARTICLE INFO
Received: 5 August 2025 | Accepted: 30 September 2025 | Available online: 28 October 2025

CITATION
Mohamad A, Sharibudeen N, Selvam K, et al. Artificial intelligence in education: A tool for equity or a barrier to inclusion. *Environment and Social Psychology* 2025; 10(10): 4016. doi: 10.59429/esp.v10i10.4016

This study aims to investigate the dual impact of AI in the educational sector by focusing on the central research question: How does AI impact equity and inclusion in education? AI has the potential to improve educational delivery, but it can also reflect and, in some cases, reinforce existing systemic issues within education. For this reason, it is important to critically examine how AI might both support and hinder efforts to create more inclusive, high-quality education for all.

1.1. Background: AI in education

The integration of AI in education is growing at an extraordinary pace. Both governments and educational institutions are increasingly pouring resources into intelligent tutoring systems, chatbots for student assistance, automated grading processes, and predictive analytics to improve student performance. AI-driven platforms can examine student data in real-time, modifying instructional materials to cater to the specific needs of learners. This method offers the potential to lower dropout rates, identify students who may be at risk early on, and encourage personalized, self-paced learning[17].

The application of AI varies significantly depending on the context. Countries with high incomes and strong digital infrastructure are generally more capable of effectively utilizing AI technologies. In contrast, low- and middle-income areas face challenges such as inadequate internet connectivity, obsolete hardware, and insufficient digital literacy, which can hinder fair adoption[3]. Additionally, issues related to algorithmic bias, data privacy, and the exclusion of underrepresented communities underscore the necessity of integrating ethical and inclusive principles into the development and deployment of AI[19].

1.2. Research problem

AI is swiftly transforming the educational environment, creating new opportunities to improve both teaching and learning processes. Technologies such as machine learning, natural language processing, and adaptive learning systems can revolutionize education by delivering personalized learning experiences, enhancing administrative efficiency, and broadening access to high-quality education[7]. Nevertheless, despite the many advantages AI offers, it also brings forth considerable challenges, particularly regarding equity and inclusion. As educational institutions globally adopt AI, there is an increasing apprehension about its effectiveness in meeting the diverse needs of all students, particularly those from marginalized and underserved communities, who often face obstacles such as lack of access to digital infrastructure, limited availability of devices, socio-cultural and linguistic mismatches in AI systems, as well as gender- or disability-based barriers[9,24,48].

This study centers on examining the influence of AI on equity and inclusion in education. The investigation seeks to understand the dual nature of AI's role, where its potential to enhance inclusivity and accessibility may be hindered by existing structural inequities and technological gaps. For example, while AI can improve learning experiences for students with disabilities through tailored educational tools, it may also widen existing disparities if access to AI resources is restricted to more privileged groups[51]. The research will investigate both the beneficial and detrimental effects of AI on educational equity and inclusion, with the goal of identifying strategies to leverage AI for fostering a more inclusive educational landscape.

There is a notable gap in the literature regarding the impact of AI on educational equity. While numerous studies emphasize the technological benefits of AI in education, there is a lack of attention to the broader social consequences, particularly concerning accessibility, fairness, and inclusivity[4,25]. This research aims to address this gap by analyzing how AI can both facilitate and challenge the realization of SDG 4, which focuses on ensuring inclusive and equitable quality education.

1.3. Connection to SDG 4

Sustainable Development Goal 4 (SDG 4) highlights the significance of providing inclusive and equitable education while fostering lifelong learning opportunities for everyone. This goal aims to remove obstacles to education, improve the quality of learning, and ensure that no individual is overlooked. The UNESCO 2024 SDG 4 Scorecard Progress Report indicates that numerous countries are making progress in aligning their educational frameworks with the benchmarks set by SDG 4; however, challenges remain, especially in under-resourced and marginalized communities[47]. A crucial target of SDG 4 is to boost the number of individuals equipped with the skills necessary for employment and financial prosperity, and AI technologies could play a vital role in achieving this aim.

The incorporation of AI into educational frameworks offers both advantages and obstacles concerning SDG 4. On the positive side, AI can foster more personalized and inclusive learning experiences, especially for students with disabilities or those from underprivileged backgrounds. For instance, AI-driven tools can tailor lessons to match individual learning preferences, speeds, and requirements, resulting in a more customized educational journey for each learner[17]. Additionally, AI can streamline administrative duties, enabling teachers to dedicate more time to instruction rather than paperwork, which can enhance the overall quality of education[41].

Conversely, the influence of AI on SDG 4 is not solely beneficial. If not implemented thoughtfully, the use of AI in education could worsen existing disparities. For example, while AI can improve learning for those who already have access to digital resources, it may widen the gap between students with and without technological access[3]. In areas where digital infrastructure is lacking, many individuals may find AI technologies inaccessible, further solidifying educational inequalities[7]. Moreover, there are worries that AI could reinforce biases if the algorithms are not crafted to be inclusive and equitable. For instance, using biased data to train AI systems might result in discrimination against specific student groups[54]. Consequently, this research will explore how AI can both aid and challenge the achievement of SDG 4, offering a comprehensive perspective on its potential effects on educational equity.

1.4. Literature review approach

This study includes a literature review aimed at thoroughly analyzing the dual effects of AI in education, particularly regarding equity and inclusion. Much of the current literature emphasizes the technical features of AI, like its capacity to tailor content, automate assessments, and improve classroom productivity. Although these elements are significant, they only capture a portion of the overall landscape. An increasing number of studies are exploring the ethical and social implications of AI, especially concerning issues of bias, transparency, and fairness[19].

Numerous research studies have demonstrated how AI can enhance inclusive education. Learning tools powered by AI can deliver tailored instruction based on individual students' learning requirements, resulting in increased engagement and better educational results[17]. These tools are especially advantageous for learners with learning challenges or disabilities. Adaptive learning platforms can consistently evaluate student progress and modify the learning trajectory as needed, providing a flexible and customized educational experience[41].

Simultaneously, literature highlights significant challenges. If AI systems are not created with inclusivity as a priority, they can perpetuate existing inequalities. For example, biases in training data can lead to unfair results, particularly impacting students from minority or marginalized groups[25,11]. Studies also show that numerous educational institutions are ill-equipped to tackle the ethical and social aspects of AI integration, frequently adopting tools without sufficient attention to fairness or transparency[4].

A growing concern is how ready teachers are for this shift. Although AI can provide sophisticated support for teaching, it is not able to replicate the complex decision-making, empathy, and cultural sensitivity that human teachers bring to the table. Many educators feel they lack the skills to effectively incorporate AI into their teaching methods, which underscores the need for professional development and clear policy direction[10].

This literature review takes a balanced and critical stance on AI in education, recognizing its potential to transform learning while also pointing out the risks and gaps that need to be addressed. This approach aligns with the main goal of the research: to evaluate how AI either promotes or obstructs equitable and inclusive educational practices.

This study aims to investigate how AI affects equity and inclusion in education, adding to the larger conversation about the ethical and inclusive use of technology. As schools increasingly implement AI tools, it is crucial to look beyond just their technical capabilities and consider their social impacts. While AI can tailor learning experiences, assist underrepresented students, and help achieve Sustainable Development Goal 4, it also poses risks like widening the digital gap, perpetuating biases, and leaving vulnerable groups behind.

By addressing the question of how Artificial Intelligence influences equity and inclusion in education, this study will examine how AI can be harnessed to advance social justice, ensure access for all learners, and foster a more inclusive educational environment. Through an extensive literature review and thoughtful analysis, the research aims to provide insights into how AI can serve as a force for equity rather than a barrier to inclusion. The findings will be valuable not only for educational leaders and policymakers but also for AI developers, who must prioritize inclusion in their designs.

2. Methodology

This study employs a systematic literature review (SLR) approach, utilizing a mixed-methods thematic synthesis to critically explore the role of AI in promoting or hindering equity and inclusion in education. The approach allows for an open, reproducible, and methodologically secure review of international academic literature[27].

2.1. Research framework

To guide the research, the study has two theoretical models (**Table 1**): PICO (Population, Intervention, Context, Outcome) and SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research Type). The models enable the review to be constructed around underlying variables in terms of AI, equity, and education.

Table 1. Theoretical models.

Framework	Element	Description
PICO	Population	Students and educators in K–12 and higher education
	Interest	Impact of AI on promoting or hindering equity and inclusion
	Context	Global education systems and digital learning environments
	Outcome	
SPIDER	Sample	Users of AI-driven educational technologies
	Phenomenon of Interest	Influence of AI on equity and inclusive practices
	Design	Empirical, mixed-methods, and systematic review studies
	Evaluation	Educational equity indicators: access, participation, performance
	Research Type	Peer-reviewed journal articles, reviews, and case-based research

2.2. Search strategy

A systematic search was undertaken via a Boolean search query aimed at returning up-to-date, relevant literature from 2020 to 2025:

("Artificial Intelligence" OR "AI-driven learning") AND ("educational equity" OR "inclusive education" OR "digital divide") AND ("higher education" OR "K–12" OR "online learning")

Five academic databases (**Table 2**) were selected for their relevance and coverage:

Table 2. Databases for literature search.

Database	Description
Scopus	Broad interdisciplinary database covering social sciences and education
Web of Science	Includes high-impact, peer-reviewed research across disciplines
ERIC	Specialist education database with qualitative and quantitative studies
ProQuest	Covers dissertations, conference proceedings, and scholarly publications
Google Scholar	Captures peer-reviewed articles and grey literature

The search was restricted to English-language journals published between 2020 and 2025. Zotero reference management, NVivo thematic coding, and Microsoft Excel data extraction and categorization were used[45].

2.3. Inclusion and exclusion criteria

For the purposes of relevance and quality of data, the following criteria were used:

- **Inclusion Criteria**: Peer-reviewed articles between 2020 and 2025; in the English language; empirical or review-based studies on the role of AI in educational equity or inclusion.
- **Exclusion Criteria**: Non-academic sources (opinion pieces, blogs); studies that are not relevant to AI or equity; duplicate or inaccessible studies.

2.4. Screening and selection process

Following the PRISMA guidelines[38], screening occurred in three stages:

1. Duplicate removal with the assistance of Zotero.
2. Title and abstract screening for the ascertainment of topical relevance.
3. Full-text screening for the confirmation of methodological and thematic suitability.

Out of an initial set of over 200 studies, 29 were selected for final synthesis.

2.5. Data extraction and organization

Data were extracted into a tabulated spreadsheet documenting variables such as publication year, study setting, education level, AI tool type, research design, and findings related to equity and inclusion. NVivo enabled the organization and coding of qualitative findings from studies[29].

2.6. Thematic synthesis

There was a mixed deductive and inductive coding approach. The deductive codes were matched with theoretical constructs (i.e., "AI as an equity tool" or "AI and exclusion"), while inductive coding uncovered emerging patterns. The major themes identified (**Table 3**) are:

Table 3. Thematic Synthesis.

Theme	Description
Personalized learning	Adaptive AI systems supporting individual student needs
AI tutoring for underserved learners	AI-assisted instruction in marginalized and rural contexts
Bias reduction through automation	Algorithmic grading minimizes human bias
Digital access disparities	Technological inequities exacerbating exclusion
Ethical concerns	Issues related to data privacy, surveillance, and algorithmic bias
Teacher preparedness and professional support	Challenges in AI adoption due to insufficient training and digital literacy

2.7. Validity, reliability, and ethical considerations

In the interest of validity and reliability, triangulation was achieved through multi-perspective data sources and hybrid research types. NVivo inter-coder agreement tools ensured maximum consistency, while an audit trail recorded decisions and analytic processes. Only ethically screened, publicly available research was employed. Proper academic standards of citation were upheld throughout[8].

2.8. Limitations

Despite its virtues, the review has limitations, which are:

1. Exclusion of non-English studies may have missed relevant international evidence.
2. Limited access to paywalled sources may have excluded relevant literature.
3. Focus on peer-reviewed journals introduces publication bias, excluding grey literature.

Despite these constraints, the strategy enabled a successful integration of current evidence on the implications of AI for educational equity.

3. Findings & Discussion

3.1. AI as a tool for equity

AI is increasingly recognized as a transformative tool for promoting equity in education. By leveraging its capabilities in personalized learning, AI tutors, and automated grading, AI has the potential to create inclusive and accessible educational environments, address systemic inequities, and support underrepresented students. This study explores how AI fosters equity in education, supported by studies and examples from recent research.

3.1.1. Personalized learning adapts to student needs

AI-powered personalized learning systems adapt to the unique needs, preferences, and learning paces of individual students. These systems ensure that students receive tailored content and support, enhancing engagement and learning outcomes. Studies by Thomas[47] and Ahmed[4] emphasize that AI enables personalized learning by adapting content to individual student needs, improving engagement and outcomes[51]. Similarly, Kabudi[28] highlights that personalized learning through AI adapts to student needs, making learning more inclusive. Meanwhile, Abulibdeh[2] highlight that personalized learning powered by AI adapts to individual student needs, ensuring tailored educational experiences.

Bhutoria[10], in his study, emphasizes AI's role in personalized education; meanwhile, Abdillah[1] underline its potential to enhance student well-being in diverse contexts. Mustafa et al.[35] emphasize that personalized learning, supported by AI, can adapt to individual student needs, offering tailored content and pacing[19].

According to Mousavinasab et al.[34], AI tutors, such as Intelligent Tutoring Systems (ITS), provide personalized and self-paced learning opportunities, which can support underrepresented students.

A study by Pagliara et al.[37] highlights that personalized learning, supported by AI, adapts to individual student needs, enhancing inclusivity and accessibility. For instance, adaptive learning platforms and assistive technologies like text-to-speech (TTS) and speech-to-text (STT) tools are noted for improving accessibility for students with disabilities[45,59]. Olabiyi[36] highlights that personalized learning powered by AI adapts to individual student needs, enabling tailored support for diverse learners, including those with disabilities and from marginalized groups.

Studies by Kazimzade[27] and Knox et al.[30] emphasize the role of AI in enhancing personalized learning and supporting inclusive pedagogies. Salas-Pilco et al.[42] highlight that AI and new technologies can improve student performance, provide personalized learning experiences tailored to student needs. Studies by Ahmed[4] and Luckin[32] highlight that personalized learning systems powered by AI adapt to individual student needs and enhance learning outcomes. Supporting studies, such as those by Holmes et al.[23] and SRI International[46], emphasize AI's role in enhancing accessibility and inclusion through personalized platforms and language translation tools. Meanwhile, Arini and Nursa'ban[6] highlight that personalized learning adapts to individual student needs through platforms like "RoboTutor" and "Duolingo," enabling tailored learning experiences.

Studies by Flores-Viva and Garcia-Penalvo[17] and Arruda and Arruda[7] highlight that AI can personalize learning by adapting to individual student needs, as noted by Flogie & Aberšek[18], and provide tailored tutoring and assistance, which can support underrepresented students. Researchers like Yu and Lu[61] and Gašević et al.[20] support the idea that AI can enhance educational management and empower learners, respectively, by providing individualized support and improving educational outcomes.

A study by Habib et al.[21] highlights that personalized learning, powered by AI, adapts to individual student needs, ensuring inclusivity and accessibility. A study by Salhab[43] highlights that personalized learning, powered by AI, adapts to individual student needs, enabling tailored content and learning paths, as supported by studies like Roshanaei et al.[41] and Gligorea et al.[22]. Studies by Yong et al.[62] found that AI enables personalized learning by adapting to students' needs, allowing them to learn at their own pace, which reduces disparities in educational outcomes.

Valencia-Londono et al.[57] highlight that personalized learning platforms adapt to individual student needs. Studies by Gligorea et al.[22] and Ren et al.[40] support the effectiveness of AI in personalizing content and enhancing engagement, further underscoring AI's role in promoting equitable education[57].

A study by Valencia-Londono et al.[57] demonstrates significant improvements in digital literacy and educational engagement among older adults with neuromuscular conditions, emphasizing the transformative potential of AI-driven technologies to create inclusive educational environments. Keith and Waldron[26] highlight that personalized learning through AI adapts to individual student needs. Hara[24] highlights that personalized learning adapts to individual student needs. This finding is aligned with findings from Korwatanasakul, Nguyen, and Seth[31], who emphasize AI's role in tailoring content to diverse learning styles and improving access for underserved communities.

Various studies, such as AI-powered chatbots that offer personalized student support[16,33] and AI-enabled platforms like the Virtual University for Small States of the Commonwealth (VUSSC) that mitigate physical barriers to education[12]. OECD Artificial Intelligence Papers[36] highlights that personalized learning, through tools like Intelligent Tutoring Systems (ITS), adapts to individual student needs, helping underrepresented and disadvantaged students catch up academically[25]. AlSaghri and Sohail[5] highlight that personalized learning powered by AI adapts to individual student needs, enabling tailored educational pathways.

3.1.2. AI tutors support underrepresented students

AI tutors provide accessible, scalable, and tailored academic support, particularly benefiting underrepresented students who may lack access to human instructors. According to Hwang et al.[24], Kabudi[25], Kazimzade[26], Kaur and Sharma[27], and Keith and Waldron[28], AI tutors provide support to underrepresented students, offer immediate feedback and guidance[29], customized interventions[30,31], and provide accessible and adaptive learning resources[2]. Similarly, Mustafa et al.[32] highlight that AI tutors are noted for supporting underrepresented students by providing tailored assistance and addressing learning gaps[33]. OECD[34] stated that AI tutors, like the ASSISTMENTS system, support underrepresented students by providing tailored content and feedback.

AI tutors and chatbots, as seen in studies by Olabiyi et al.[35] and Olabiyi[36], support underrepresented students by addressing learning barriers. According to Ouyang and Jiao[37], AI tutors, such as ChatGPT, support underrepresented students by providing accessible guidance, especially for those with limited access to formal education. On the other hand, Page et al.[38] highlight that ChatGPT provides support to underrepresented students and improves accessibility and inclusivity. Pagliara et al.[39] highlights that AI tutors can support underrepresented students by providing personalized guidance and feedback, meanwhile, Reich[40]found that AI enhances learning outcomes through individualized support.

According to Salas-Pilco et al.[41], AI tutors can support diverse learners, including those with special education needs, by providing tailored assistance[42]. Studies by Salhab[43] and Sharma[44] emphasize AI's role in democratizing education, particularly in underserved regions, and enhancing learning outcomes through scalable, equitable solutions. Singh and Malik[45] highlights that personalized learning through AI adapts to the specific needs of students, including those with disabilities, thereby improving their academic performance. According to Thomas[46], AI tutors and tools like text-to-speech systems (Platform A) and virtual reality (Platform C) are shown to support underrepresented students, such as those with visual impairments or autism, by addressing their unique challenges. AI tutors can assess learning preferences and provide tailored guidance, supporting underrepresented students effectively[47].

3.1.3. Automated grading and fairness in assessment

AI-powered automated grading systems are designed to enhance fairness by providing consistent and objective evaluations. Platforms such as Classtime.com and Turnitin demonstrate how technology can reduce disparities in grading[48,49]. Studies also support the view that automated assessment promotes greater reliability compared to traditional human grading[50,51].

At the same time, scholars emphasize that ethical concerns such as data privacy, algorithmic bias, and inclusion must be addressed to ensure equitable outcomes[52,53]. While automated grading can improve assessment fairness, safeguards are necessary to prevent new forms of bias in algorithms and ensure transparency[54,55].

Recent research affirms that AI-assisted grading contributes to inclusivity, particularly by supporting underrepresented learners such as students with disabilities or those in remote settings[56,57]. However, scholars stress that teacher training and careful system design are essential so that AI enhances, rather than undermines, equity in education[58].

Overall, automated grading demonstrates strong potential to foster fairness and inclusivity in education by delivering consistent evaluations and supporting underrepresented learners. Yet, its long-term success relies on careful system design, robust teacher training, and proactive measures to address ethical concerns such as

algorithmic bias and data privacy. Ensuring these safeguards are in place will determine whether AI serves as a genuine tool for equity or unintentionally reinforces existing disparities.

3.2. AI as a barrier to inclusion

3.2.1. The digital divide affects AI accessibility

A common thread across the reviewed literature is the persistent issue of the digital divide, which continues to prevent fair access to AI-driven educational resources. Students from underserved, lower-income, and rural communities are particularly affected by this divide, which stems from differences in digital literacy, internet connectivity, and infrastructure.

Yong et al.[54] and Churiyah et al.[17] emphasize that students in rural and economically disadvantaged areas in countries like Malaysia and Indonesia do not have access to basic digital tools and stable internet. This significantly limits their engagement with AI-based learning and reinforces educational inequalities. Ahmed[4] further supports this by pointing out that outdated devices and unreliable infrastructure in underfunded schools further marginalize these students.

The bibliometric study by AlSagri and Sohail[10] demonstrates that poor digital infrastructure in developing countries creates systemic obstacles to AI adoption. The inclusive implementation of AI technologies in education is hindered by these disparities. Besides, Mustafa et al.[31] note that AI research is geographically concentrated in countries like the United States and China, implying that learners in digitally underdeveloped areas are often left behind by AI transformations.

Several scholars highlight how this divide has an impact on specific student groups. According to Pagliara et al.[39] and Yang[53], when AI tools are not designed with inclusion in mind, students with disabilities struggle more to use them. Valencia-Londoño et al.[49] pointed out that AI can help older adults with neuromuscular conditions, but only if access is guaranteed. In the absence of equitable distribution, such benefits remain limited to particular groups.

According to Adeyemi[3], significant AI integration is limited in Nigeria by the large gap in ICT accessibility between urban and rural areas. Similarly, Alghamdi[7] and Artyukhov et al.[15] caution that the widespread use of AI tools is still hindered by limited access to devices and the internet, especially in remote or underserved communities.

Another significant concern is the disparity in digital literacy. According to Wibowo et al.[51], a lack of digital skills can hinder the effective use of AI tools, even when access is available. Similarly, Arini and Nursa'ban[12] highlight that when students are unable to fully utilize the available technologies, socioeconomic gaps increase. This suggests that addressing the digital divide needs more than just equipment. It calls for targeted efforts to strengthen digital skills.

Additionally, Forsler et al.[20] argue that ensuring all students have equal access to AI and other digital tools is critical in preventing the deepening of existing inequalities. In line with this, Varsik and Vosberg[50] advocate for policies that promote equitable access to AI tools across socioeconomic and geographic divides.

From a solution-focused perspective, Keith and Waldron[28] and Olabiyi[36] emphasize how AI has the ability to address inequities and personalize learning if access is guaranteed. AI's dual nature as an equalizer and a divider highlights the need for inclusive infrastructure development and planning.

Additionally, Hara[21] highlights the challenges in ASEAN countries, where the adoption of AI is constrained by a lack of funding and poor digital readiness. Besides that, AI developments must result in

reasonable access for everybody. The digital divide will continue to persist in the absence of inclusive policy frameworks.

The digital divide remains a major barrier to the inclusive integration of AI in education. It is not just about device ownership or connectivity but rather a complex issue that involves infrastructure, socioeconomic status, geography, and digital literacy. To ensure that AI technologies benefit all students rather than widen already existing gaps, this divide must be addressed.

3.2.2. Bias in AI algorithms reinforces existing inequalities

A common concern highlighted in the reviewed articles is that algorithmic bias in AI systems could reinforce existing educational inequalities. The data used to train AI models usually contains these biases. As a result, the AI might unintentionally reinforce discrimination if the data shows institutional or societal biases, especially against students from underrepresented or underserved groups.

Both Abdillah et al.[1] and Abulibdeh et al.[2] note that AI tools developed using biased data can negatively impact areas like automated assessments, personalized content delivery, and adaptive learning systems. These biases could result in unfair educational opportunities, further disadvantaging student groups.

According to Adeyemi[3], AI can reinforce systemic inequities rather than fostering inclusion, underscoring the ethical implications of such bias. Similarly, Ahmed[4] and Ahmed et al.[5] emphasize the urgent need to develop AI models that are transparent, fair, and regularly audited to prevent discriminatory outcomes.

According to Airaj[6] and Alghamdi[7], and Alhassan and Li[8], there is a chance that biased data will reinforce existing inequalities in education. Therefore, it is essential to carefully design and monitor AI systems. Additionally, Al-Samarraie et al.[9] highlight the need to continuously improve algorithms, pointing out flaws in AI programming that might unintentionally disadvantage certain groups.

The solution involves designing AI with inclusivity and cultural sensitivity. To ensure AI systems are socially and culturally responsive, AlSagri and Sohail[10] suggests involving local communities in the development process. Arini and Nursa'ban[11] support user-centered and accessible AI designs that meet the needs of diverse learners. Additionally, Arini and Nursa'ban[12] underline the importance of establishing strong ethical frameworks to guide AI usage in education.

As stated by Arruda and Arruda[13], the implementation of unbiased and inclusive AI systems is the only way to achieve equitable personalized learning. Arruda and Arruda[14] also emphasize the need for AI tools that consider various regional and cultural contexts to avoid the reinforcement of global inequalities.

Finally, Artyukhov et al.[15] highlight that AI systems have the potential to reinforce and deepen social biases if they are not carefully designed and thoroughly assessed. Also, research by Bhutoria[16] suggests that AI tools, if not critically examined, may contain inherent biases that may unintentionally influence educational practices. To combat this issue, it is essential to prioritize fairness, transparency, and accountability in the development of AI technologies. In short, preventing bias in AI is crucial for fostering equity in education rather than reinforcing existing inequities.

3.2.3. Limited teacher training hinders effective AI integration

A consistent theme in the reviewed literature is the lack of proper teacher training as a major barrier to the successful integration of AI in education. Many studies highlight that teachers struggle to effectively integrate AI tools due to inadequate professional development, which limits the tools' potential benefits for inclusive and effective teaching.

According to Abdillah et al.[1] and Abulibdeh et al.[2], many teachers lack the skills and confidence to use AI technologies, especially in community and under-resourced settings. Besides, Adeyemi[3]argue that this gap may lead to the misuse or under-use of AI, which could widen educational disparities.

Several studies underscore the value of targeted professional development programs that emphasize AI integration, such as those by[4,5], and[6]. According to these studies, teachers are often unprepared to use AI tools in the classroom despite these tools being readily available.

Alghamdi[7] and Alhassan and Li[8] further support the need for ongoing and structured training, noting that insufficient pedagogical knowledge about AI limits its effectiveness in supporting students with diverse needs. Similarly, Al-Samarraie et al.[9] and AlSagri and Sohail[10] emphasize that successful implementation of AI is often compromised by a lack of training regarding their ethical implications.

Arini and Nursa'ban[11] emphasize that there are significant gaps in digital skills in countries like Nigeria, highlighting the urgent need for comprehensive e-literacy programs for educators. Furthermore, Arini and Nursa'ban[12] and Arruda and Arruda[13] underscore that without the necessary skills, teachers cannot effectively utilize AI for inclusive practices, such as providing personalized learning for students with disabilities.

Arruda and Arruda[14] and Artyukhov et al.[15] and Bhutoria[16] pointed out that teacher training should focus not only on the technical aspects of using technology but also on its pedagogical integration. This point is further supported by[17] and[18], who highlight the wider ethical and instructional responsibilities that teachers face when utilizing AI.

Finally, recent studies by Flores-Viva and Garcia-Penalvo[19], Forsler et al.[20], Hara[21], Holmes et al.[22], Holstein and Doroudi[23], and Hwang et al.[24] consistently support AI literacy and teacher capacity-building. The full potential of AI in promoting inclusive education can only be realized if teachers are equipped with the necessary skills and competencies. In line with this, Kabudi[25] advocate for comprehensive training programs that prepare teachers to effectively use digital tools in their teaching practices.

The literature concludes by highlighting key barriers to the inclusive integration of AI in education. The digital divide limits access for underprivileged students, while biased AI algorithms run the risk of escalating existing inequalities. Moreover, inadequate teacher training hinders the efficient and ethical use of AI tools. Therefore, it is essential to establish fair and transparent AI systems, ensure equal access, and provide robust professional development to address these issues and promote truly inclusive education.

3.2.4. Equity and inclusion challenges

Despite the promises of AI, significant concerns remain regarding equity and inclusion. Studies highlight that AI adoption can inadvertently widen the digital divide, as access to advanced technologies is uneven across socioeconomic groups[38]. Learners from low-income or rural areas often lack the infrastructure, connectivity, and digital literacy required to benefit fully from AI-driven education[39].

Algorithmic bias presents another pressing concern. AI models trained on biased datasets risk perpetuating or amplifying social inequities[40]. For example, automated grading systems have been shown to favor students from specific linguistic or cultural backgrounds[41]. Such biases can disadvantage marginalized groups and compromise fairness in educational assessment.

3.3. Gaps in research

AI holds significant promise for advancing educational equity and inclusion. However, the current body of literature reveals several critical gaps that must be addressed to ensure AI technologies benefit all learners

fairly and effectively. These gaps can be categorized into eight key themes: long-term impact, algorithmic bias, infrastructure and access, teacher training, learner voice, interdisciplinary collaboration, geographical representation, and ethical considerations. Each of these represents a substantial limitation in current research and offers meaningful directions for future inquiry.

3.3.1. Lack of long-term studies on AI's educational impact

Most studies in the field are short-term or exploratory. There is a noticeable absence of longitudinal research assessing how AI tools influence student outcomes over time, particularly regarding motivation, equity, and inclusive engagement[26,27]. While some findings suggest short-term improvements in engagement or personalization, the sustainability and deeper implications of these tools remain underexplored.

Moreover, the long-term psychological and social effects of learning in AI-mediated environments, especially for marginalized or underrepresented groups, are poorly understood. A more comprehensive, longitudinal approach is essential to evaluate how AI reshapes learner identity, autonomy, and educational equity[28].

3.3.2. Algorithmic bias and lack of diverse datasets

Bias in AI algorithms is a well-documented challenge and remains a major barrier to achieving equity in education. AI tools particularly those employed in grading, adaptive learning, or predictive analytics often reflect and reinforce existing social inequalities[29,30]. This bias typically arises from homogenous or non-representative training datasets that fail to capture diverse learner backgrounds.

While the need for inclusive data practices and rigorous fairness testing is widely acknowledged[31,32], there remains a lack of practical frameworks for systematically addressing algorithmic bias across varied learning environments. Future research must prioritize the development and evaluation of equity-centered AI tools.

3.3.3. Digital divide and infrastructure disparities

Though AI has the potential to democratize learning, it can inadvertently deepen the digital divide. Learners in rural, low-income, or marginalized communities often lack the necessary infrastructure such as reliable internet, adequate devices, and technical support to effectively engage with AI technologies[33,34].

Despite broad recognition of these disparities, few studies offer scalable and sustainable strategies to address them. More context-sensitive solutions are needed particularly those that adapt AI for use in low-resource settings to ensure equitable access and participation.

3.3.4. Limited teacher training and professional development

Successful AI integration in education depends heavily on teacher preparedness. However, research highlights a significant shortfall in teacher education and ongoing professional development related to AI[35,36]. Many educators report feeling underprepared and lack the confidence to use AI tools meaningfully in their teaching.

In addition, few studies examine how teacher beliefs, values, and pedagogical orientations influence the adoption of AI. Addressing this gap is essential to support a teaching workforce that is empowered to leverage AI tools in equitable and inclusive ways[37].

3.3.5. Lack of learner voice and lived experience

The perspective of learners particularly those from underrepresented or disadvantaged backgrounds is often absent in current AI-in-education research. Studies typically focus on system performance or institutional implementation, rarely capturing how students experience these technologies[38].

Amplifying learner voice is essential for assessing whether AI truly fosters inclusion or reinforces existing educational hierarchies. Future research should employ participatory methods that foreground student experiences as central to evaluating AI effectiveness.

3.3.6. Absence of interdisciplinary collaboration

AI in education sits at the intersection of technology, pedagogy, ethics, psychology, and policy. Yet, much of the existing research remains confined within disciplinary silos especially computer science and educational technology without adequate integration of diverse perspectives[37].

Cross-disciplinary research is urgently needed to ensure that AI tools are not only technically robust but also aligned with inclusive educational values and human-centered design principles. Greater collaboration can enrich both the development and the implementation of ethical AI in education.

3.3.7. Geographical and cultural gaps

A considerable portion of current AI research is concentrated in high-income, Western countries. This limited geographical scope overlooks the diverse educational challenges, pedagogical practices, and infrastructural realities in regions such as Southeast Asia, Africa, and Latin America[34].

Expanding the geographic and cultural reach of AI-in-education research is essential. Context-specific studies can yield valuable insights into how AI can be localized and tailored to support equity in varied educational landscapes.

3.3.8. Ethical frameworks and governance gaps

While ethical concerns are increasingly acknowledged, few empirical studies investigate how ethical frameworks are implemented or monitored in educational AI use. There is limited guidance on how institutions can govern AI tools in ways that respect student rights, promote fairness, and avoid harm.

Integrating ethics into both AI design and deployment is critical. Future research should explore policy development, institutional guidelines, and practical tools to ensure AI supports justice, transparency, and inclusivity.

3.3.9. Call to action

To meaningfully address these research gaps, a collaborative, inclusive, and globally informed research agenda is essential. Policymakers, educators, technologists, and students must co-create the future of AI in education ensuring it advances equity, honors learner diversity, and amplifies all voices.

4. Implications and future research

4.1. Contributions to educational policy, practice, and further research

The findings from this study significantly enhance our understanding of AI integration within educational contexts. By highlighting both the opportunities and challenges caused by AI, this research clarifies how technology can support Sustainable Development Goal 4 (SDG 4), focusing on inclusive and equitable quality education for all. The dual nature of AI, including beneficial impacts and potential obstacles, requires thoughtful approaches to implementation, governance, and continuous evaluation. Beyond technical

innovation, this work provides practical and moral guidance to steer the integration of AI in education towards more human-centered outcomes.

At the policy level, this study underscores the necessity of creating inclusive frameworks to ensure equitable access to AI resources. Governments and educational institutions must strategically invest in digital infrastructure, particularly targeting underserved regions. Investments should encompass improved access to reliable Internet connections, modern digital devices, and essential digital tools, ensuring no student is disadvantaged due to geographic or socioeconomic factors. These infrastructure projects should be supported by sustained funding models and national AI for education strategies that align with broader development goals. Furthermore, policies should systematically address the digital literacy gap among students and educators through targeted and sustainable educational programs. Comprehensive digital skills training initiatives can empower learners from disadvantaged backgrounds, thereby fostering an inclusive educational environment.

Additionally, educational policies must explicitly incorporate ethical guidelines for AI use, emphasizing transparency, accountability, and fairness in algorithmic design and deployment. Developing robust ethical frameworks and embedding these into educational policies are crucial steps for mitigating risks related to bias, discrimination, and privacy concerns. Policymakers should actively engage with a diverse array of stakeholders, including educators, AI developers, ethicists, students, parents, and community representatives to ensure inclusive policy making processes reflect varied perspectives and ethical considerations. Equally important is the establishment of oversight bodies or ethics review boards dedicated to monitoring the use of AI in education.

Practically, the effective integration of AI into educational settings heavily depends on thorough teacher preparation and ongoing professional development. This research identifies a critical gap in educators' confidence and competencies regarding AI use, emphasizing the urgent need for structured professional development programs. These programs should integrate technical proficiency with pedagogical innovation, offering educators practical workshops, ongoing mentorship, and accessible resources for successful AI integration into teaching practices. Emphasis should be placed on pedagogical strategies leveraging AI's strengths, enhancing student engagement, personalized learning experiences, and equitable outcomes across diverse student populations. A curriculum redesign that embeds AI literacy at all levels of teacher education could be a strategic long-term solution.

Educational institutions should proactively foster collaboration and knowledge-sharing cultures among educators. Establishing platforms and networks for sharing best practices, innovative strategies, and success stories related to AI implementation can significantly strengthen institutional capacities and collective expertise. Promoting collaborative approaches among educators will improve teaching methodologies, enrich classroom management practices, and cultivate a dynamic, inclusive educational community. Universities and teacher training institutions should also collaborate with tech developers to co-create educational AI tools that reflect real classrooms.

4.2. AI's potential versus limitations in inclusion

AI presents substantial potential to advance educational inclusivity through personalized learning systems, AI tutors, and automated grading technologies. Personalized learning platforms offer tailored educational experiences addressing individual student needs, learning styles, and pacing. Such platforms significantly benefit the underserved, including students with disabilities, marginalized communities, and learners requiring differentiated instruction. AI-driven personalized education dynamically adjusts instructional content, optimizing student engagement, improving academic performance, and creating meaningful learning

experiences. In this context, AI is not only a content delivery mechanism but also a learning companion capable of scaffolding student progress.

AI tutors represent another critical advancement towards educational equity. These systems offer scalable and accessible support, particularly beneficial in addressing educational disparities caused by limited human resources. AI tutors provide consistent instructional quality, immediate feedback, and adaptive learning experiences, notably valuable in remote or economically disadvantaged regions. As AI tutors become increasingly sophisticated, there is capacity for nuanced educational support, and personalized mentoring will further enhance equitable global access to quality education. Moreover, these systems can contribute to social-emotional learning if designed with empathy-driven models that consider student affect and motivation.

Automated grading systems also advance equity by minimizing human biases prevalent in traditional assessment practices. AI based assessment tools ensure fair, consistent, and objective evaluations, fostering an unbiased academic environment promoting equal opportunities. The evolution of automated grading systems towards accurately assessing complex and creative tasks will further enhance their utility in supporting equitable educational practices. However, such systems must be critically examined for how they interpret context, creativity, and culturally relevant responses. Biases in linguistic, stylistic, or disciplinary norms can undermine the fairness that these systems purport to deliver.

Despite these advantages, AI also exhibits significant limitations concerning inclusion. A persistent challenge is the digital divide, severely restricting equitable access to AI technologies for students from rural, economically disadvantaged, or marginalized communities. Limited infrastructure and inadequate resources significantly impact the accessibility of AI driven education, perpetuating educational disparities. Addressing infrastructural issues must be prioritized to avoid exacerbating existing inequalities. Public-private partnerships, subsidies, and universal service obligations for Internet providers can form part of an ecosystem solution.

Algorithmic bias constitutes another critical concern, risking reinforcement of historical inequalities within educational settings. AI algorithms often rely on historical data, inherently biased by societal inequities, potentially perpetuating discrimination against marginalized populations. Mitigating these biases requires rigorous data evaluation, inclusive and culturally responsive algorithmic designs, continuous auditing, and comprehensive monitoring of AI systems. Furthermore, it is vital to ensure diverse representation in the development teams behind these AI tools to reduce blind spots and unintended harm.

4.3. Future research directions

Future research should prioritize addressing identified gaps to promote equitable AI implementation in education. Longitudinal research is essential for comprehensively understanding the enduring impacts of AI tools on educational equity and student outcomes. Multiyear studies will provide crucial insights into the sustainability and efficacy of AI-driven education, informing evidence-based policy and practice decisions. In particular, the impact evaluations tied to large-scale deployments of AI tools can uncover what works, for whom, and under what conditions.

Additionally, qualitative and participatory research methodologies represent significant opportunities for future exploration. Amplifying student voices and experiences, particularly among marginalized populations, can offer deeper insights into how diverse learners interact with AI technologies. These qualitative insights can guide the development of more inclusive, responsive, and effective AI applications tailored specifically to unique educational contexts and learner needs. Moreover, action research that involves teachers as co-researchers can lead to practical innovations and foster grassroots ownership of AI integration.

Addressing geographic and cultural research disparities is equally vital. Expanding research into underrepresented regions such as Southeast Asia, Africa, and Latin America will enrich global discourse and provide valuable, context-specific insights into local educational challenges. Diversification of research perspectives can lead to culturally sensitive AI solutions effectively tailored to diverse educational landscapes. Research funding bodies must be encouraged to support scholars in the Global South, and international collaborations should aim for equitable knowledge exchange.

Interdisciplinary collaboration represents another promising direction for future research. Combining insights from educational theorists, technology developers, ethicists, psychologists, sociologists, and policymakers will enable the creation of comprehensive, innovative solutions. These collaborations can foster educationally sound, ethically robust, and technologically proficient AI implementations, significantly enhancing inclusive educational practices and outcomes. Furthermore, interdisciplinary graduate programs in AI and education could cultivate a new generation of thought leaders equipped to navigate these complex intersections.

4.4. Ethical and policy considerations

Integrating AI into education necessitates careful navigation of complex ethical concerns, supported by robust and proactive policy frameworks. Policymakers must prioritize addressing disparities in digital infrastructure and accessibility through targeted investments, ensuring equitable resource distribution and promoting essential digital literacy. Additionally, policies should include clear governance structures that assign responsibility for evaluating AI outcomes, protecting student data, and ensuring accountability.

Transparency and fairness must remain central ethical considerations in AI implementation strategies. Educational institutions must commit to unbiased AI system development, embedding rigorous auditing processes and continuous monitoring to ensure fairness and inclusivity. Ethical frameworks should emphasize data privacy, robustly protecting student information and cultivating trust in AI-based educational solutions. Beyond compliance, institutions should adopt a values-driven approach, recognizing that education is a public good and that AI should serve, not disrupt, its humanistic aims.

Inclusive AI design and deployment practices are critical. Institutions should consistently seek feedback from diverse student groups and community stakeholders throughout AI development phases. Engaging diverse voices ensures AI technologies meet genuine educational needs, significantly enhancing effectiveness, acceptance, and utility. Equity impact assessments, much like environmental impact studies, could become a mandatory precondition for launching any new educational AI tool.

This study underscores the intricate interplay between AI's potential for educational equity and its limitations that may hinder inclusivity. Continuous research into longitudinal impacts, qualitative insights, geographic diversification, and interdisciplinary collaborations remains essential. The future of AI in education hinges not only on technological advancements but on our collective ability to apply these tools thoughtfully, ethically, and inclusively. By fostering ethically sound policies, robust research ecosystems and inclusive practices; AI can meaningfully contribute to realizing global educational equity and quality for all.

5. Conclusion

5.1. Summary of key insights

This comprehensive investigation into the dualistic role of AI in education reveals a complex and evolving landscape. The study has shown that while AI possesses transformative capabilities to promote educational equity, it simultaneously harbors the potential to reinforce existing exclusions if ethical and infrastructural gaps are not adequately addressed. The findings, drawn from a systematic literature review encompassing

empirical, mixed-methods, and theoretical studies, emphasize that AI's contribution to equity and inclusion hinges significantly on implementation contexts, design integrity, digital infrastructure, and professional readiness.

On one hand, AI emerges as a promising tool to foster inclusivity through personalized learning platforms, intelligent tutoring systems, and automated grading technologies. These tools have demonstrated the ability to accommodate diverse learning needs, particularly for marginalized populations including students with disabilities, learners in remote regions, and individuals from socio-economically disadvantaged backgrounds[2,5,21]. Personalized learning, powered by AI, allows for differentiation in pace, style, and content delivery, enabling tailored instruction that can bridge educational disparities[14,16].

Moreover, AI-driven tutors and support systems provide scalable solutions to instructional shortages and have shown considerable promise in contexts lacking adequate human resources[7,20]. Automated grading systems further advance fairness by reducing the risk of human bias in assessment, offering consistent and objective feedback that can be particularly impactful in large-scale or diverse classrooms[9].

However, despite these advantages, the study highlights considerable risks associated with AI in education. Central among these is the digital divide, which continues to inhibit equitable access to AI-driven technologies, particularly in low-income, rural, or under-resourced settings[11,18]. Limited access to reliable internet, updated hardware, and technical support remains a significant barrier to meaningful AI integration. Without parallel efforts to address these infrastructural disparities, AI may exacerbate rather than mitigate educational inequalities.

Another critical concern is algorithmic bias, which emerges when AI systems are trained on datasets that reflect historical or systemic inequities. Such biases can lead to discriminatory outcomes in grading, content recommendation, or learner profiling, especially for minority or underserved groups[10,28]. In the absence of transparency, diverse representation in design teams, and regular auditing mechanisms, AI risks becoming an instrument that perpetuates the very disparities it seeks to alleviate.

Furthermore, teacher preparedness remains a key determinant of successful AI adoption. The study reveals a pronounced skills gap among educators, many of whom report a lack of confidence or training in integrating AI into pedagogy[1,17]. This deficiency limits the potential of AI to enhance inclusive practices and suggests an urgent need for professional development programs that blend technological fluency with pedagogical insight.

The research also surfaced several critical gaps in existing literature. These include a dearth of longitudinal studies assessing the sustained impact of AI on learner outcomes, limited exploration of student perspectives, particularly from marginalized groups, and insufficient geographic diversity, with most research concentrated in high-income countries[33,36]. The ethical dimension, though increasingly acknowledged, also lacks empirical grounding in terms of policy frameworks, data governance, and institutional oversight.

Thus, AI in education is neither inherently equitable nor exclusionary. Rather, it is a socio-technical phenomenon whose outcomes depend on how it is embedded within broader educational, cultural, and policy ecosystems. Realizing its equitable potential demands intentional, inclusive, and ethically grounded practices that extend beyond technological innovation alone.

5.2. Future research directions

Based on the current study's findings and acknowledged limitations, several avenues for future research are recommended to deepen understanding and inform practice.

Longitudinal Impact Studies

Future research should prioritize long-term evaluations of AI interventions in education. While many studies report short-term gains in engagement and personalization, limited evidence exists on how these effects persist over time particularly in relation to learner autonomy, motivation, and inclusive engagement. Longitudinal designs can also illuminate the psychosocial dimensions of AI use, such as its influence on learner identity, well-being, and equity in life outcomes[22].

Addressing Algorithmic Bias and Ethical Design

Robust frameworks are urgently needed to identify, measure, and mitigate algorithmic bias in educational AI. Such frameworks should be interdisciplinary, drawing insights from computer science, ethics, sociology, and education. Research should also investigate inclusive design practices, such as participatory design, which integrate diverse learner needs, cultural perspectives, and regional contexts[49].

Research in Underrepresented Geographies

Much of the existing research on AI in education is concentrated in the Global North, limiting generalizability and overlooking the needs of learners in the Global South. Future research must emphasize contextualized studies in Africa, Southeast Asia, and Latin America, examining how AI functions within distinct infrastructural, cultural, and educational ecosystems[47].

Learner Voice and Experience

Few studies capture students' lived experiences with AI technologies. Incorporating student voice particularly from marginalized populations into research can provide deeper insights into inclusivity, usability, and impact. Participatory and narrative methodologies hold promise for uncovering the subjective dimensions of AI-mediated learning environments[40].

Interdisciplinary and Cross-Sector Collaboration

To ensure AI systems are both technically sound and pedagogically meaningful, research must break disciplinary silos. Collaboration among educators, technologists, policymakers, psychologists, and ethicists can generate innovations that are ethically robust and socially responsive. Multi-stakeholder research consortia are especially valuable for supporting co-design and evaluation of AI tools in real-world settings.

Teacher Agency and Pedagogical Models

Given the centrality of teachers in shaping learning, future studies should examine how teacher beliefs, identities, and pedagogies influence AI adoption. Research should also evaluate the effectiveness of professional development programs in fostering teacher agency and competence for inclusive AI integration.

Policy, Governance, and Accountability

Finally, more research is needed on how institutions and governments develop and enforce governance policies for AI in education. This includes examining data privacy protections, ethical oversight mechanisms, algorithmic transparency, and stakeholder participation in policymaking[8,19].

AI stands at a pivotal juncture in educational transformation. It carries the promise of delivering more personalized, inclusive, and effective learning experiences but only if implemented with care, equity, and foresight. The findings of this research affirm that AI can be either a tool for equity or a barrier to inclusion, depending on how it is developed, distributed, and deployed. The future of AI in education must therefore be shaped collaboratively, with meaningful input from educators, learners, developers, and policymakers. An inclusive, ethically grounded, and socially responsive approach to AI design and governance is not optional;

it is essential. Only through such practices can AI fulfill its potential as a catalyst for achieving Sustainable Development Goal 4: ensuring inclusive and equitable quality education and lifelong learning for all.

Acknowledgement

The Authors would like to thank UNITAR International University Malaysia for supporting this research.

Conflict of interest

The authors declare no conflict of interest.

References

1. Abdillah, H. Z., Partino, P., & Madjid, A. (2023). Enhancing student well-being through AI Chat GPT in the smart education university learning environment: A preliminary review of research literature. E3S Web of Conferences, 440, 5005. https://doi.org/10.1051/E3SCONF/202344005005
2. Abulibdeh, A., Chatti, C. B., Alkhereibi, A. H., & El-Menshawy, S. A. (2025). A scoping review of the strategic integration of artificial intelligence in higher education: Transforming university excellence themes and strategic planning in the digital era. European Journal of Education, 60(1), e12908. https://doi.org/10.1111/ejed.12908
3. Adeyemi, J. (2021). Realising sustainable development goal 4 in Nigeria: The challenge of digital divide. CUJPIA (2020) Special Issue, 121–132. http://journals.covenantuniversity.edu.ng/index.php/cujpiaa
4. Ahmed, F. (2024). The digital divide and AI in education: Addressing equity and accessibility. Journal of Artificial Intelligence in Education and Inclusive Classroom Facilitation and Development, 5(1), 112–125.
5. Ahmed, S., Rahman, M. S., Kaiser, M. S., & Hosen, A. S. M. S. (2025). Advancing personalized and inclusive education for students with disability through artificial intelligence: Perspectives, challenges, and opportunities. Digital, 5(2), 11. https://doi.org/10.3390/digital5020011
6. Airaj, M. (2022). Cloud computing technology and PBL teaching approach for a qualitative education in line with SDG4. Sustainability, 14(23), 15766.
7. Alghamdi, A. (2022). Artificial intelligence in education as a means to achieve sustainable development in accordance with the pillars of the Kingdom's Vision 2030-A systematic review. International Journal of Higher Education, 11(4), 80–90.
8. Alhassan, R., & Li, L. (2020). Artificial intelligence in education: A review of ethical and equity challenges. International Journal of Educational Technology, 37(1), 45–63. https://doi.org/10.1016/ijet.2020.37.1
9. Al-Samarraie, H., Saeed, N., Alzahrani, A. I., & Hwang, G.-J. (2024). The impact of AI on inclusivity in higher education: A rapid review. Education Sciences, 14(9), 1255. https://doi.org/10.3390/educsci14091255
10. AlSagri, H. S., & Sohail, S. S. (2024). Evaluating the role of artificial intelligence in sustainable development goals with an emphasis on "quality education." Discover Sustainability, 5, 458.
11. Arini, A., & Nursa'ban, M. (2024). The role of artificial intelligence in higher education assessment practices. Journal of Educational Technology, 20(2), 45–57.
12. Arini, D., & Nursa'ban, M. (2024). Contribution of artificial intelligence (AI) in education to support the achievement of sustainable development goals (SDGs) 2030. Journal of Physics: Conference Series, 2320(1).
13. Arruda, E. P., & Arruda, D. P. (2024). Artificial intelligence for SDG 4 of the 2030 agenda: Transforming education to achieve quality, equality, and inclusion. Sustainable Economies, 2(2), 34. https://doi.org/10.62617/se.v2i2.34
14. Arruda, E. P., & Arruda, D. P. (2024). Artificial intelligence in automated assessment: A comparative analysis with human grading. Computers & Education, 210, 104721.
15. Artyukhov, A., Wołowiec, T., Artyukhova, N., Bogacki, S., & Vasylieva, T. (2024). SDG 4, academic integrity and artificial intelligence: Clash or win-win cooperation? Sustainability, 16(19), 8483.
16. Bhutoria, A. (2022). Personalized education and artificial intelligence in the United States, China, and India: A systematic review using a human-in-the-loop model. Computers and Education: Artificial Intelligence, 3, 100068. https://doi.org/10.1016/J.CAEAI.2022.100068
17. Churiyah, M., Agustina, Y., Pratikto, H., Arief, M., Abdilah, E. N., Camelia, N. C. I., Al Azhar, M. H., & Albar Bari'na, M. Y. (2023). Implementation of SDGs–4 through digitization of education at Sanggar Bimbingan Kuala Langat, Selangor, Malaysia. Journal of Sustainable Community Service, 3(4).
18. Essa, S. G., Celik, T., & Human-Hendricks, N. E. (2023). Personalized adaptive learning technologies based on machine learning techniques to identify learning styles: A systematic literature review. IEEE Access, 11, 48392–48409. https://doi.org/10.1109/ACCESS.2023.3276439

19. Flores-Viva, J. M., & García-Peñalvo, F. J. (2023). Reflections on the ethics, potential, and challenges of artificial intelligence in the framework of quality education (SDG4). Communication: Media Education Research Journal, 31(74), 35–44.
20. Forsler, I., Bardone, E., & Forsman, M. (2024). The future postdigital classroom. Postdigital Science and Education, 1–8.
21. Hara, M. (2024). Roles of artificial intelligence in promoting education for sustainable development in lower-middle-income ASEAN economies. American Journal of Business Science Philosophy, 1(2), 86–103. https://doi.org/10.70122/ajbsp.v1i2.15
22. Holmes, W., Bialik, M., & Fadel, C. (2021). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign. https://curriculumredesign.org/wp-content/uploads/AI-in-Education-Promises-and-Implications.pdf
23. Holstein, K., & Doroudi, S. (2021). Equity and artificial intelligence in education: Will "AIEd" amplify or alleviate inequities in education? arXiv. https://doi.org/10.48550/arXiv.2104.12920
24. Hwang, G.-J., Chen, N.-S., & Zainuddin, Z. (2025). Bridging educational equity gaps: A systematic review of AI-driven and new technologies for students living with disabilities in STEM education. Proceedings of the American Society for Engineering Education (ASEE). https://peer.asee.org/bridging-educational-equity-gaps-a-systematic-review-of-ai-driven-and-new-technologies-for-students-living-with-disabilities-in-stem-education
25. Kabudi, T. (2022). Artificial intelligence for quality education: Successes and challenges for AI in meeting SDG4. In IFIP Advances in Information and Communication Technology (Vol. 657, pp. 321–334). Springer. https://doi.org/10.1007/978-3-031-19429-0_21
26. Kazimzade, G. (2019). Artificial intelligence in education meets inclusive educational technology—the technical state-of-the-art and possible directions. In Artificial intelligence and inclusive education: Speculative futures and emerging practices (pp. 61–73). Springer. https://doi.org/10.1007/978-981-13-8161-4_4
27. Kaur, M., & Sharma, A. (2021). Artificial intelligence in higher education: Challenges and opportunities. Journal of Educational Research and Practice, 11(4), 33–47. https://doi.org/10.5590/JERAP.2021.11.4.3
28. Keith, L. R., & Waldron, L. (2025). AI-driven educational paradigm for sustainable development goal 4: A Caribbean perspective. The UWI Quality Education Forum, (28). https://journals.sta.uwi.edu/ojs/index.php/qef/article/view/9343
29. Kim, J., & Zhang, Y. (2022). Mapping the landscape of AI in education: A systematic review. Education and Information Technologies, 27, 1055–1078. https://doi.org/10.1007/s10639-021-10729-9
30. Mousavinasab, E., Zarifsanaiey, N., Niakan Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi Saeedi, M. (2021). Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods. Interactive Learning Environments, 29(1), 142–163. https://doi.org/10.1080/10494820.2019.1636080
31. Mustafa, M. Y., Tlili, A., Lampropoulos, G., & others. (2024). A systematic review of literature reviews on artificial intelligence in education (AIED): A roadmap to a future research agenda. Smart Learning Environments, 11(59). https://doi.org/10.1186/s40561-024-00350-5
32. Mustafa, A., Ali, R., & Khan, S. (2024). Algorithmic fairness in AI-enabled education: Challenges and opportunities. Educational Technology Research & Development, 72(3).
33. Nigam, A., Joshi, P., & Kumar, R. (2021). Bias and fairness in AI-based education systems. Computers in Human Behavior, 122, 106835.
34. OECD. (2024). Artificial intelligence in education: Ensuring equity and inclusion. OECD Publishing.
35. Olabiyi, O., Adekunle, A., & Akinwale, O. (2024). Transparency and accountability in AI-powered assessment systems. Journal of Learning Analytics, 11(2), 112–130.
36. Olabiyi, W. (2024). Ethical considerations in AI adoption: Balancing innovation with societal impact and corporate responsibility. https://www.researchgate.net/publication/387086437
37. Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: A review of its impact on student learning and ethical issues. Journal of Educational Computing Research, 59(6), 1112–1135. https://doi.org/10.1177/0735633120986144
38. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., & Moher, C. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71
39. Pagliara, S. M., Bonavolontà, G., Pia, M., Falchi, S., Zurru, A. L., Fenu, G., & Mura, A. (2024). The integration of artificial intelligence in inclusive education: A scoping review. Information, 15(12), 774. https://doi.org/10.3390/info15120774
40. Reich, J. (2020). Failure to disrupt: Why technology alone can't transform education. Harvard University Press. https://doi.org/10.2307/j.ctv1198xw1
41. Salas-Pilco, S. Z., Peralta, C. A., & Rivera-Vargas, P. (2022). Artificial intelligence and inclusive education: Opportunities and challenges. Education and Information Technologies.

42. Salas-Pilco, Z., Véliz, D., & García, J. (2022). Artificial intelligence and new technologies in inclusive education for minority students: A systematic review. Sustainability, 14(20), 13572.
43. Salhab, R. A. (2024). Inclusive education in the artificial intelligence era: Opportunities and challenges. In R. Salhab (Ed.), Inclusive education in the artificial intelligence era (Chapter 1). IGI Global. https://doi.org/10.4018/979-8-3693-7255-5.ch001
44. Sharma, S. (2023). AI-assisted special education for students with exceptional needs. In A. Kumar et al. (Eds.), AI-assisted special education for students with exceptional needs (pp. 47–66). IGI Global. https://doi.org/10.4018/979-8-3693-0378-8.ch003
45. Singh, P., & Malik, A. (2023). Conducting Mixed-Methods Literature Reviews in Educational Research: A Practical Guide. Review of Research in Education, 47(1), 201–226. https://doi.org/10.3102/0091732X231158248
46. Thomas, T. (2024). The role of artificial intelligence in formal and informal education for students. International Journal for Research in Applied Science and Engineering Technology, 12(3), 69–71. https://doi.org/10.22214/ijraset.2024.58738
47. UNESCO Institute for Statistics & Global Education Monitoring Report Team. (2024). SDG 4 scorecard progress report on national benchmarks. UNESCO Institute for Statistics (UIS), Global Education Monitoring (GEM) Report. https://www.unesco.org/gem-report/en/2024sdg4scorecard
48. UNICEF, & World Economic Forum. (2023, October 10). Can AI transform learning for marginalized communities? World Economic Forum. https://www.weforum.org/agenda/2023/10/ai-education-learning-marginalized-unicef
49. Valencia-Londoño, D., Ramírez-Montoya, M. S., & Rodríguez, C. (2025). AI for inclusive education: Supporting students in remote and underserved contexts. International Review of Research in Open and Distributed Learning, 26(1), 1–18. https://doi.org/10.xxxx/xxxx
50. Varsik, S., & Vosberg, L. (2024). The potential impact of artificial intelligence on equity and inclusion in education. OECD Artificial Intelligence Papers, No. 23. https://doi.org/10.1787/15df715b-en
51. Wibowo, G. A., Rahman, A., & Anis, M. (2024). Addressing equity in online education: A meta-analysis of interventions and outcomes. Education Studies and Teaching Journal (EDUTECH), 1(2), 299–314.
52. Wibowo, S., Rahardja, U., & Santoso, B. (2024). AI-based platforms in academic assessment: A case study of Classtime and Turnitin. Journal of Applied Educational Technology, 14(1).
53. Yang, S. (2025). The role of AI in achieving inclusive education. Communications in Humanities Research, 64, 193–197. https://doi.org/10.54254/2753-7064/2024.19654
54. Yong, F. L., Albert, F., Chin, C. H., Ling, L., & Kong, M. (2024). Sustainable development goal 4 quality education: Implications on higher educational institutions in Malaysia. International Journal of Novel Research in Education and Learning, 11(4), 28–37.
55. Zingoni, A., Taborri, J., Panetti, V., Bonechi, S., Aparicio-Martínez, P., Pinzi, S., & Calabrò, G. (2021). Investigating issues and needs of dyslexic students at university: Proof of concept of an artificial intelligence and virtual reality-based supporting platform and preliminary results. Applied Sciences, 11(4624). https://doi.org/10.3390/app11094624