

Artificial Intelligence in Education Bridging or Widening the Digital Divide in Developing Countries

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Abstract: Artificial intelligence (AI) is rapidly transforming education through personalized learning, intelligent tutoring, automated assessment, generative content creation, learning analytics, academic research support, and educational administration. Although these technologies offer significant opportunities for improving educational quality and accessibility, their implications for developing countries remain complex. Educational systems in low- and middle-income countries frequently operate under constraints that include inadequate digital infrastructure, unreliable connectivity, limited financial resources, insufficient teacher preparation, linguistic diversity, and unequal access to technology. Consequently, AI has the potential both to reduce longstanding educational inequalities and to create a new layer of digital exclusion. This article provides an integrative review of the influence of AI on education in developing countries, with particular attention to teaching, learning, assessment, higher education, administration, inclusion, and educational equity. It synthesizes recent academic literature and international policy reports, with particular emphasis on developments associated with generative AI since 2022. The review identifies personalized learning, expanded access to educational expertise, teacher support, multilingual assistance, administrative efficiency, and improved accessibility as important opportunities. However, connectivity inequalities, affordability, algorithmic bias, inadequate AI literacy, academic integrity concerns, privacy risks, cultural and linguistic underrepresentation, and excessive dependence on automated systems present substantial challenges. To explain these competing effects, the article proposes an Inclusive AI in Education Framework in which infrastructure, affordability, human capacity, localization, governance, and pedagogical integration determine whether AI contributes to greater educational inclusion or reinforces existing inequalities. The paper argues that the educational value of AI in developing countries will ultimately depend less on the availability of sophisticated technologies than on the institutional and societal capacity to deploy them equitably, responsibly, and in accordance with local educational priorities.

Keywords: artificial intelligence, education, developing countries, generative AI, digital divide, educational inequality, Global South, higher education, AI literacy, ChatGPT.

1. Introduction

Artificial intelligence has moved rapidly from a specialized area of computer science to a technology capable of influencing almost every major sector of society. Education is among the fields experiencing particularly rapid change. AI technologies are increasingly used to personalize learning, automate feedback, generate

instructional materials, predict student performance, support academic research, provide conversational tutoring, assist teachers, and automate administrative processes (Chen et al., 2020; Hwang et al., 2020; Zawacki-Richter et al., 2019). The emergence of generative AI has accelerated this transformation. Systems based on large language models can generate text, explanations, computer code, assessments, images, instructional activities, and interactive responses to student questions. Unlike many earlier AI systems that operated primarily in specialized institutional environments, generative AI tools can be accessed directly by individual teachers and students using ordinary computers and mobile devices. Consequently, AI-supported education is shifting from institutionally controlled specialized systems toward widely available general-purpose technologies (Kasneci et al., 2023; Tlili et al., 2023). The potential educational benefits are considerable. AI may provide individualized instruction where teachers have limited time, assist learners who cannot easily access specialized instructors, reduce routine academic workloads, improve accessibility for students with disabilities, support multilingual education, and enable educational institutions to analyze data more effectively. Reviews of AI in education have identified applications across learning, teaching, assessment, and educational administration (Chiu et al., 2023; Zawacki-Richter et al., 2019). However, these opportunities do not occur within an equal global environment. The infrastructure, resources, digital competencies, institutional capabilities, regulatory environments, and languages required to benefit from AI are distributed unevenly. Developing countries frequently face shortages of qualified teachers, educational materials, technological infrastructure, and financial resources. These same conditions create a strong motivation to use AI while simultaneously limiting the ability to adopt it effectively. The global digital divide illustrates this contradiction. Despite substantial expansion of digital connectivity, approximately 2.2 billion people remained offline in 2025, most of them in low- and middle-income countries. Internet use reached approximately 94% of the population in high-income economies but only 23% in low-income economies. Important inequalities also persist between urban and rural communities and between socioeconomic groups (International Telecommunication Union [ITU], 2025). These differences matter because meaningful participation in AI-supported education requires considerably more than nominal Internet coverage. Reliable connections, appropriate devices, affordable data, digital skills, language support, and institutional capacity are also necessary. AI may therefore produce two fundamentally different educational trajectories. In the first, AI democratizes knowledge by offering low-cost access to tutors, translation, educational resources, and expert assistance, thereby reducing some disadvantages historically experienced by learners in resource-constrained environments. In the second, economically advantaged institutions and learners obtain better AI systems, infrastructure, training, and support while disadvantaged learners remain limited to weak connectivity and inferior access. AI would then transform the existing digital divide into an AI divide.

This tension represents the central concern of the present article. The main research question is: Will artificial intelligence help reduce educational inequalities in developing countries, or will unequal access to AI create an additional layer of educational inequality?

2. Artificial Intelligence in Education

Artificial intelligence in education (AIED) encompasses technologies that perform tasks involving perception, prediction, language processing, reasoning, content generation, recommendation, or automated decision support in educational environments. Traditional AIED applications include intelligent tutoring systems, adaptive learning, automated assessment, learner profiling, recommendation systems, educational data mining, and predictive analytics (Chen et al., 2020; Zawacki-Richter et al., 2019). A systematic review by Zawacki-Richter et al. (2019) classified major AI applications in higher education into profiling and prediction, assessment and evaluation, adaptive systems and personalization, and intelligent tutoring systems. Subsequent research has broadened these categories as AI capabilities have become integrated into teaching, learning, assessment, and administration (Chiu et al., 2023). Generative AI represents a particularly important development because it enables users to interact with computational systems through natural language. Large language models can explain concepts, summarize texts, generate examples, translate content, answer questions, simulate conversations, produce computer code, and assist in writing. Such systems can therefore perform functions resembling tutors, writing assistants, teaching assistants, research assistants, and administrative assistants.

Kasneci et al. (2023) argue that large language models can support personalized learning, educational content creation, engagement, and feedback, but they also emphasize problems related to inaccurate information, bias, overreliance, and the need for strong AI literacy. Similarly, Tlili et al. (2023) identify substantial educational potential while cautioning against uncritical adoption of conversational AI.

3. Methodological Approach

This article adopts an integrative literature review approach. Unlike a narrowly focused systematic review designed to estimate a specific quantitative effect, an integrative review enables synthesis of empirical studies, systematic reviews, conceptual contributions, and major international policy documents in order to examine a rapidly developing interdisciplinary phenomenon. Literature relevant to AI and education was considered across major themes including artificial intelligence in education, generative AI, AI in higher education, personalized learning, intelligent tutoring systems, academic integrity, AI literacy, educational technology and the digital divide, educational equity, AI in developing countries, the Global South, AI ethics, governance, and teacher and student AI competencies. Particular emphasis was placed on literature published between 2019 and 2026, while earlier work was considered where conceptually necessary. Greater weight was given to literature published after 2022 because the public emergence of widely accessible generative AI substantially altered both the capabilities and accessibility of educational AI.

4. Applications of AI in Education

4.1 Personalized and Adaptive Learning

One of the most frequently cited advantages of AI is its capacity to support personalized learning. Traditional classroom instruction often requires teachers to deliver similar content to students who differ substantially in prior knowledge, learning speed, language proficiency, and individual needs. AI-supported platforms can potentially analyze learner interactions and adapt content difficulty, sequence of instruction, examples, exercises, feedback, pacing, and recommendations. AI therefore offers possibilities for moving from standardized instruction toward individualized learning pathways. Personalization may be especially valuable in developing countries where high student-to-teacher ratios make individual attention difficult. An AI-supported environment could enable students to receive supplementary explanations and exercises without requiring teachers to respond individually to every question. However, meaningful personalization requires reliable student data, appropriate algorithms, curriculum alignment, and teacher oversight. Personalization should therefore supplement rather than replace pedagogical judgment (Varsik & Vosberg, 2024).

4.2 Intelligent Tutoring and Academic Assistance

AI tutoring systems have long been developed to provide individualized guidance. Generative AI substantially extends this possibility because conversational systems can respond to open-ended questions in natural language. Students can ask an AI tutor to explain difficult concepts, provide examples, simplify explanations, generate practice questions, translate terminology, review solutions, provide hints, and recommend additional study. Research on educational chatbots suggests that such technologies can support learning, student engagement, and access to educational information, although effectiveness depends strongly on implementation quality (Kuhail et al., 2023; Labadze et al., 2023). For students in underserved regions, the implications may be significant because AI-supported learning resources can supplement limited access to specialist instruction. Nevertheless, an AI tutor is not automatically a reliable tutor. Large language models can generate plausible but incorrect responses. Students without sufficient subject knowledge may be unable to identify such errors. Human supervision and information-verification skills therefore remain essential (Kasneci et al., 2023).

5. Influence of AI on Teaching

Teachers occupy a central position in determining whether AI improves educational quality. AI can assist teachers with lesson planning, generation of examples and exercises, preparation of instructional materials, differentiation of content, assessment design, rubric creation, preliminary feedback, translation,

summarization, administrative documentation, and analysis of student performance. Reducing routine tasks could enable teachers to devote more time to higher-value activities such as mentoring, classroom interaction, curriculum design, and individual student support. Farrokhnia et al. (2024) identify productivity and personalized support among important strengths of generative AI in education. AI may therefore change rather than eliminate the teaching profession. The conventional teacher-student relationship increasingly becomes a teacher-AI-student relationship. UNESCO's AI competency framework for teachers consequently identifies human-centered values, AI ethics, AI foundations, AI pedagogy, and AI-supported professional learning as major areas of teacher competence (Miao & Cukurova, 2024).

6. Influence of AI on Student Learning

AI can affect student learning through several mechanisms. It can increase access to explanations, encourage experimentation, provide rapid feedback, reduce linguistic barriers, and support self-directed learning. These capabilities make AI potentially valuable for students who would otherwise have limited access to tutoring. However, the same features can weaken learning when students delegate cognitive tasks rather than using AI to support them. The distinction between cognitive augmentation and cognitive substitution is therefore critical. Kasneci et al. (2023) emphasize that critical thinking, fact-checking, and understanding the limitations of language models are essential for responsible educational use. Grassini (2023) similarly observes that generative AI creates significant educational opportunities but requires substantial reconsideration of pedagogical practice. Educational institutions should consequently teach students not merely how to operate AI systems but how to question, verify, critique, and improve AI-generated outputs.

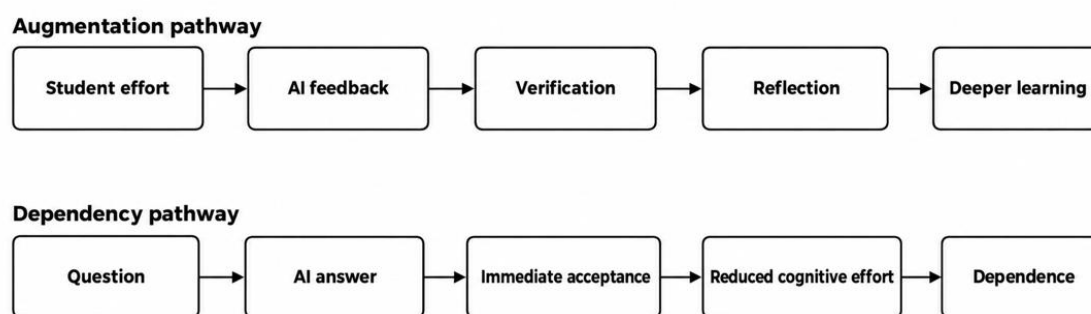


Figure 1. Two cognitive pathways of student AI use: augmentation versus dependency.

7. AI and Educational Access in Developing Countries

The potential of AI to improve educational access may be particularly significant in contexts characterized by resource scarcity. Many developing-country education systems face shortages involving specialist teachers, learning materials, laboratories, libraries, academic advisors, language resources, and educational support services. AI cannot eliminate the structural causes of these shortages, but it may reduce some consequences. Generative AI could allow a learner in a remote area to receive explanations of scientific concepts even when specialist tutoring is unavailable. AI-supported translation may enable students to access material originally produced in another language. Teachers may generate supplementary exercises where textbooks are limited. According to the ITU (2025), approximately 74% of the world's population used the Internet in 2025, but the rate was approximately 23% in low-income economies. The corresponding figure for Africa was approximately 36%. The difference between nominal network coverage and meaningful connectivity is equally important because bandwidth quality, device ownership, affordability, and digital competencies affect what users can actually accomplish online.

Consequently, AI policies for developing countries should incorporate low-bandwidth, mobile-first, multilingual, and potentially offline-capable solutions rather than assuming infrastructure conditions typical of wealthy countries.

8. AI in Higher Education

Universities are among the institutions most visibly affected by generative AI. Students increasingly use AI for brainstorming, concept explanation, writing support, programming, translation, summarization, literature exploration, examination preparation, and research support. Academic staff can use similar systems to prepare teaching materials, design assessments, draft administrative communication, summarize information, and develop examples. Researchers may employ AI for idea development, language improvement, coding assistance, data-analysis support, literature organization, and manuscript preparation. However, research use raises important concerns involving fabricated references, data confidentiality, attribution, copyright, authorship, and research integrity. Baig and Yadegaridehkordi (2024), reviewing ChatGPT research in higher education, found increasingly diverse applications among students, academic staff, researchers, and nonacademic university personnel. Bhullar et al. (2024) similarly identified rapidly expanding scholarly interest while highlighting unresolved questions regarding responsible integration. A UNESCO survey published in 2025 involving 400 responses from UNESCO Chairs and UNITWIN Networks across 90 countries found that nearly two-thirds of participating higher education institutions either had AI guidance or were developing it (UNESCO, 2025). Universities in developing countries therefore face an important strategic decision between unrealistic prohibition and uncontrolled adoption.

9. AI in Educational Assessment

Assessment represents one of the areas most disrupted by generative AI. Traditional take-home assignments often assume that the submitted text reflects the student's independent production. Generative AI weakens this assumption because high-quality text can now be generated within seconds. This does not mean assessment should be abandoned. Instead, assessment design must evolve through strategies such as oral defense of submitted work, authentic case-based assignments, classroom assessment, progressive submission of drafts, project demonstrations, reflective components, personalized questions, peer discussion, practical tasks, assessment of reasoning processes, and explicit AI-use declarations. The educational objective should shift from trying to determine whether a student ever interacted with AI toward assessing whether the learner demonstrates required knowledge and competencies. Human accountability should remain central in consequential assessment.

10. AI in Educational Administration

Administrative applications may significantly influence educational systems. Potential uses include admission management, scheduling, student advising, dropout-risk identification, performance prediction, resource allocation, institutional reporting, quality assurance, help-desk automation, enrollment forecasting, and decision support. Zawacki-Richter et al. (2019) identified profiling and prediction as major areas of AI application in higher education. For resource-constrained educational systems, automation of repetitive administrative tasks may increase institutional efficiency. However, predictive systems can have serious consequences when decisions affect admissions, student progression, scholarships, or interventions. Such systems require transparency, validation, fairness monitoring, and human review.

11. Opportunities Presented by AI in Developing Countries

AI may offer developing-country education systems important opportunities in educational access, teaching support, personalized learning, tutoring, language support, assessment, accessibility, research, administration, decision-making, teacher development, and resource creation. The economic implications are also noteworthy because generative AI may lower the marginal cost of producing exercises, explanations, translations, and adapted instructional content.

However, lower production cost does not automatically imply equitable access. Commercial AI systems may provide substantially more capable models through paid subscriptions. This creates the possibility that affluent students and institutions receive more advanced AI assistance than disadvantaged populations.

Table 1. Major educational opportunities associated with AI in developing countries.

Educational dimension	Potential contribution of AI
Educational access	Extending learning assistance to underserved populations

Teaching	Supporting lesson preparation and reducing routine workload
Personalized learning	Adapting explanation, pace, and exercises
Tutoring	Providing on-demand academic assistance
Language	Translation and multilingual educational support
Assessment	Supporting feedback and formative assessment
Accessibility	Assisting learners with different educational needs
Research	Supporting literature organization, writing, and analysis
Administration	Automating repetitive institutional processes
Decision-making	Supporting educational analytics and planning
Teacher development	Providing professional learning resources
Resource creation	Generating localized examples and supplementary materials

12. The Digital Divide and the Emerging AI Divide

The digital divide is perhaps the most important structural limitation affecting AI-supported education. Contemporary digital inequality includes access to devices, reliability of connectivity, Internet speed, affordability, digital literacy, quality of services, ability to create rather than merely consume digital content, and capacity to benefit socially and economically from technology. AI introduces additional dimensions, including access to advanced models, ability to afford premium services, AI literacy, prompt and interaction skills, availability of local-language models, institutional integration, teacher expertise, computational infrastructure, governance capacity, and ability to verify AI-generated information. The ITU's 2025 connectivity evidence demonstrates the underlying structural challenge. Approximately 96% of those still offline live in low- and middle-income countries, and Internet services remain unaffordable in many such economies (ITU, 2025). Educational AI may therefore amplify advantages if those already benefiting from stronger schools, high-speed connectivity, newer devices, English-language proficiency, and trained teachers also gain superior AI access.

13. Infrastructure and Affordability

AI-supported education requires reliable electricity, broadband connectivity, mobile coverage, affordable data, suitable devices, institutional networks, cloud services, and technical support. The quality gap is substantial. ITU data indicate that 5G coverage reached approximately 84% of populations in high-income economies in 2025 compared with approximately 4% in low-income countries (ITU, 2025). These disparities affect the type of educational applications that can be used. Text-based AI interaction may function under relatively modest conditions, whereas real-time multimedia tutoring, advanced simulation, AI-generated video, and cloud-based laboratory applications require considerably greater capacity. A sustainable strategy should prioritize lightweight applications, low-data interfaces, mobile compatibility, downloadable resources, local caching, offline functions where possible, and open educational infrastructure. Affordability is equally important: a nominally available AI system is not genuinely accessible when recurring subscription or data costs exceed what students or institutions can sustainably afford.

14. Teacher Readiness and AI Literacy

Technology does not improve education independently of human capability. Teacher readiness is particularly significant because educators determine how AI is integrated into pedagogy. Teachers require more than basic technical skills; they must understand AI capabilities, limitations, ethical implications, bias, privacy, and pedagogical design. UNESCO's AI Competency Framework for Teachers identifies 15 competencies across five areas: human-centered mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning (Miao & Cukurova, 2024). Large-scale investment in AI tools without equivalent investment in human capability is therefore unlikely to produce sustainable educational improvement.

15. Student AI Literacy

Students also require structured AI competencies. The assumption that young people are naturally competent with technology is misleading. Frequent technology use does not necessarily imply the ability to evaluate algorithmic output, recognize hallucinated information, protect personal data, identify bias, or use AI ethically. UNESCO's AI Competency Framework for Students emphasizes a human-centered mindset, AI ethics, AI techniques and applications, and AI system design (Miao et al., 2024). Student AI literacy should include understanding how generative AI works at a basic level, recognizing that fluent answers can be inaccurate, verifying factual claims and references, protecting confidential information, understanding bias, respecting academic-integrity rules, and maintaining independent reasoning.

16. Language and Cultural Representation

Language may become one of the most consequential AI inequalities affecting developing countries. Large AI models depend on extensive training data. Languages with abundant high-quality digital content are generally better represented than languages with limited online resources. Performance may consequently vary substantially across languages, dialects, and cultural contexts. A student may technically have access to an AI tool while still receiving lower-quality educational support because the system performs poorly in the student's preferred language. Language inequality therefore creates a knowledge representation gap. The problem extends beyond translation because educational content must reflect local curricula, local history, cultural context, social norms, legal systems, examples familiar to learners, and locally appropriate pedagogies. Developing local datasets, language resources, evaluation benchmarks, and culturally adapted AI applications should therefore form part of national AI education strategies.

17. Academic Integrity

Generative AI has intensified longstanding concerns about academic integrity. Students can use AI systems to generate essays, assignment answers, programming solutions, laboratory reports, summaries, presentations, and research text. Farrokhnia et al. (2024) identify academic integrity as one of the major threats associated with ChatGPT in education. Dwivedi et al. (2023) similarly highlight concerns about credibility, authorship, bias, and misuse. A prohibition-only approach may be unsustainable because AI capabilities are becoming integrated into standard productivity software, search engines, writing applications, and programming tools. Institutions should therefore clarify which forms of AI use are permitted, when AI assistance must be disclosed, what constitutes academic misconduct, how AI-assisted coding should be treated, and what level of independent contribution students must demonstrate.

18. Critical Thinking and Cognitive Dependence

AI has an ambiguous relationship with critical thinking. Properly used, AI can stimulate critical thinking by enabling students to compare explanations, critique generated arguments, identify errors, test alternative interpretations, engage in simulated debate, receive immediate feedback, and explore unfamiliar perspectives. However, excessive reliance may reduce productive cognitive effort. Educational institutions should design activities encouraging an augmentation pathway in which AI interaction is followed by questioning, verification, reflection, and deeper learning rather than a dependency pathway in which instant output is accepted without critical engagement.

The goal should not necessarily be education without AI, but education that develops intellectual independence in the presence of AI.

19. Privacy, Ethics, and Data Governance

The integration of AI into education raises substantial ethical concerns involving privacy, data security, algorithmic bias, transparency, accountability, and human agency. Students and teachers may unknowingly provide AI platforms with personal information, student records, unpublished research, assessment materials, examination questions, or confidential institutional data. UNESCO's guidance for generative AI emphasizes data protection, human agency, age appropriateness, and institutional responsibility (Miao & Holmes, 2023). AI models may also reproduce biases contained in training data or underrepresent local

knowledge. When AI-supported decisions affect educational opportunities, responsibility must remain identifiable and consequential decisions should remain subject to human oversight.

20. AI, Accessibility, and Inclusion

AI may improve accessibility for students with disabilities through speech recognition, text-to-speech, speech-to-text, automated captioning, simplified explanations, translation, adaptive interfaces, and personalized presentation formats. This could enable greater educational participation. However, accessibility should not be assumed automatically. AI systems may fail to accommodate particular disabilities, interfaces may be poorly designed, and training datasets may underrepresent disabled populations. Varsik and Vosberg (2024) emphasize that AI can contribute to inclusion while simultaneously creating new risks involving access, bias, inadequate cultural responsiveness, and techno-ableism.

21. Artificial Intelligence and Educational Inequality

The central argument of this article is that AI can produce either an equalizing effect or an inequality-amplifying effect. Structural conditions such as infrastructure, affordability, device access, teacher competence, student AI literacy, language representation, institutional capability, and governance shape the quality of AI access. This, in turn, affects educational use in teaching, learning, assessment, research, and administration, ultimately influencing access, quality, achievement, efficiency, inclusion, and equity. Where structural conditions are strong and equitable, AI may increase educational opportunity. Where structural inequalities are severe, AI may reproduce or deepen existing educational inequality. The key policy question is therefore not simply whether education should use AI, but under what institutional and socioeconomic conditions AI improves education equitably.

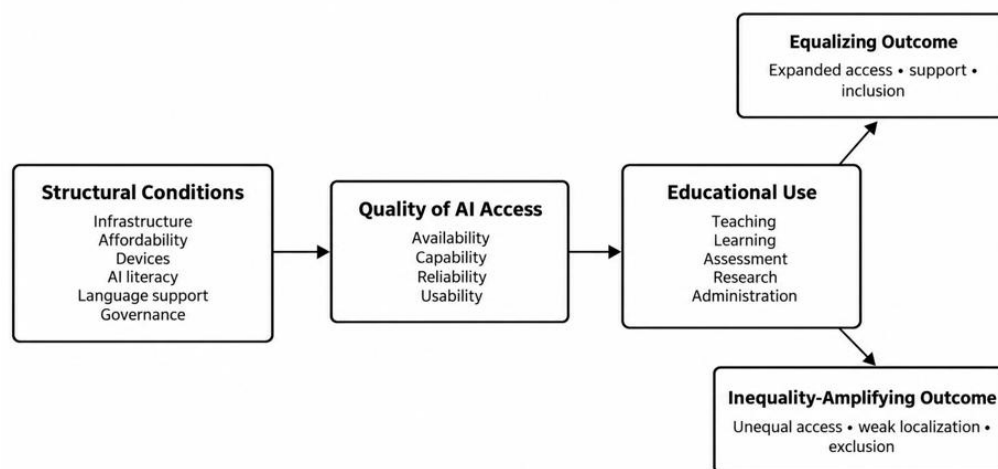


Figure 2. Conceptual pathway linking structural conditions, AI access, educational use, and equity outcomes.

22. The Inclusive AI in Education Framework

Based on the literature reviewed, this article proposes an Inclusive AI in Education Framework for Developing Countries consisting of six interconnected pillars: infrastructure and access; human capacity; localization and cultural relevance; pedagogical integration; ethics and governance; and equity and sustainability. Infrastructure and access ensure reliable connectivity, electricity, devices, affordable data, and low-resource deployment options. Human capacity concerns the competencies of teachers, students, administrators, and policymakers. Localization and cultural relevance require support for local languages, curricula, culture, and knowledge. Pedagogical integration ensures that AI adoption responds to educational needs rather than technological novelty. Ethics and governance address privacy, security, bias,

accountability, transparency, academic integrity, and institutional responsibility. Equity and sustainability ensure that disadvantaged groups are not excluded and that long-term adoption is financially and institutionally viable.

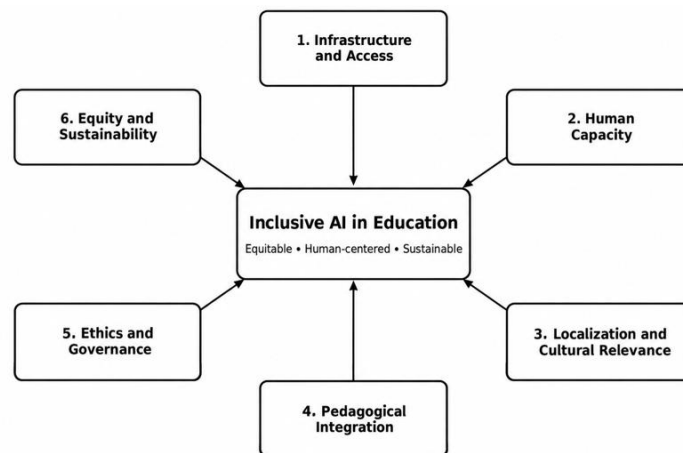


Figure 3. Proposed Inclusive AI in Education Framework for developing countries.

23. Discussion

The literature indicates that AI represents neither an inherently beneficial nor inherently harmful educational technology. Outcomes depend upon its interaction with pedagogical, institutional, economic, cultural, and technological conditions. Several tensions are particularly important. AI can democratize access to educational expertise while simultaneously concentrating advantage among learners with stronger connectivity and resources. Personalization may improve learning but requires data collection that creates privacy concerns. Automation can reduce workload but should not displace meaningful human interaction. AI can support cognition but may also encourage dependency. Finally, global AI systems provide extensive knowledge while often underrepresenting local languages and cultural contexts. Developing countries should therefore not remain merely consumers of externally developed AI systems. Building local datasets, evaluation capacity, language resources, institutional expertise, and research ecosystems is necessary for educational relevance and long-term technological autonomy.

24. Policy Recommendations

Governments should develop national AI-in-education strategies integrated with broader digital education policies. Priorities should include expanding reliable and affordable connectivity, reducing device inequalities, incorporating AI literacy into curricula, establishing privacy and AI governance requirements, supporting teacher professional development, encouraging local-language AI resources, supporting public educational AI infrastructure, establishing procurement and evaluation standards, and funding research on educational outcomes rather than adoption rates alone. Educational institutions should establish formal AI-use policies, define acceptable and unacceptable academic uses, train teachers and students, redesign assessment, establish privacy requirements, provide approved tools where possible, monitor educational impact, evaluate bias and accessibility, develop AI-literacy programs, and ensure important decisions remain subject to human oversight. Teachers should verify AI-generated materials, use AI to supplement rather than replace professional judgment, teach students how to evaluate AI output, design learning activities requiring reasoning, discuss acceptable AI use, protect confidential information, use locally relevant examples, and participate in institutional policy development. Students should be encouraged to treat AI as an intellectual tool rather than an answer-generation service by questioning outputs, verifying factual claims and citations, comparing alternative explanations, protecting personal data, acknowledging AI assistance where required, and maintaining responsibility for submitted work.

25. Implications for Future Research

Future research should examine AI and learning outcomes, rural-urban differences, socioeconomic inequality, gender and inclusion, teacher competencies, critical thinking, assessment models, low-resource languages, primary and secondary education, regional comparisons, and local AI ecosystems. More longitudinal and experimental evidence is particularly needed to determine when AI actually improves academic achievement and when it merely increases the speed or apparent quality of task completion. Comparative studies among Africa, the Arab region, South Asia, Southeast Asia, and Latin America could also reveal how infrastructure, culture, regulation, and institutional capacity influence outcomes.

26. Conclusion

Artificial intelligence is likely to become an increasingly important component of educational systems worldwide. Its capabilities in personalized learning, tutoring, content generation, language support, assessment, research, accessibility, analytics, and administration offer significant opportunities for developing countries. However, AI does not enter an educationally equal world. Large differences remain in Internet connectivity, affordability, device availability, digital skills, teacher preparation, institutional capacity, and language representation. These inequalities create the possibility that AI may disproportionately benefit already advantaged learners. If AI adoption is accompanied by investment in infrastructure, teacher and student competencies, local-language resources, ethical governance, inclusive policy, and pedagogical reform, it could become a powerful instrument for expanding educational opportunity. The educational consequences of AI will therefore be determined less by the sophistication of the algorithms themselves than by the social, institutional, and policy environments in which those algorithms are deployed. For developing countries, the goal should not simply be AI-enabled education. It should be inclusive, human-centered, locally relevant, and educationally meaningful AI-enabled education.

References

- Baig, M. I., & Yadegaridehkordi, E. (2024). ChatGPT in the higher education: A systematic literature review and research challenges. *International Journal of Educational Research*, 127, 102411. <https://doi.org/10.1016/j.ijer.2024.102411>
- Bhullar, P. S., Joshi, M., & Chugh, R. (2024). ChatGPT in higher education: A synthesis of the literature and a future research agenda. *Education and Information Technologies*, 29, 21501–21522. <https://doi.org/10.1007/s10639-024-12723-x>
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 4, 100118. <https://doi.org/10.1016/j.caeai.2022.100118>
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., Carter, L., ... Wright, R. (2023). 'So what if ChatGPT wrote it?' Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, 71, 102642. <https://doi.org/10.1016/j.ijinfomgt.2023.102642>
- Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2024). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, 61(3), 460–474. <https://doi.org/10.1080/14703297.2023.2195846>
- Grassini, S. (2023). Shaping the future of education: Exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences*, 13(7), 692. <https://doi.org/10.3390/educsci13070692>

- Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 1, 100001. <https://doi.org/10.1016/j.caeai.2020.100001>
- International Telecommunication Union. (2025). Facts and figures 2025. ITU.
- International Telecommunication Union. (2025). Global connectivity report 2025. ITU.
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., Stadler, M., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, 102274. <https://doi.org/10.1016/j.lindif.2023.102274>
- Kuhail, M. A., Alturki, N., Alramlawi, S., & Alhejori, K. (2023). Interacting with educational chatbots: A systematic review. *Education and Information Technologies*, 28, 973–1018. <https://doi.org/10.1007/s10639-022-11177-3>
- Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: Systematic literature review. *International Journal of Educational Technology in Higher Education*, 20, 56. <https://doi.org/10.1186/s41239-023-00426-1>
- Miao, F., & Cukurova, M. (2024). AI competency framework for teachers. UNESCO. <https://doi.org/10.54675/ZJTE2084>
- Miao, F., & Holmes, W. (2023). Guidance for generative AI in education and research. UNESCO.
- Miao, F., Shiohira, K., & Lao, N. (2024). AI competency framework for students. UNESCO.
- Organisation for Economic Co-operation and Development. (2024). Education policy outlook 2024: Reshaping teaching into a thriving profession from ABCs to AI. OECD Publishing. <https://doi.org/10.1787/dd5140e4-en>
- Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, 10, 15. <https://doi.org/10.1186/s40561-023-00237-x>
- UNESCO. (2021). AI and education: Guidance for policy-makers. United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2025). UNESCO survey: Two-thirds of higher education institutions have or are developing guidance on AI use. United Nations Educational, Scientific and Cultural Organization.
- Varsik, S., & Vosberg, L. (2024). The potential impact of artificial intelligence on equity and inclusion in education (OECD Artificial Intelligence Papers No. 23). OECD Publishing. <https://doi.org/10.1787/15df715b-en>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education—Where are the educators? *International Journal of Educational Technology in Higher Education*, 16, 39. <https://doi.org/10.1186/s41239-019-0171-0>