

From Access to Algorithms: A Critical Review of Gender Bias in Artificial Intelligence–Driven Education and Its Implications for Educational Equity (2020–2026)

Submitted by –
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Abstract

The rapid integration of Artificial Intelligence (AI) into educational systems has transformed teaching, learning, assessment, and educational decision-making across diverse contexts. While AI-driven educational technologies promise personalized learning experiences and enhanced educational outcomes, growing concerns have emerged regarding the reproduction and amplification of gender inequalities through algorithmic systems. This review critically examines contemporary literature published between 2020 and 2026 to explore the nature, manifestations, and implications of gender bias within AI-enabled educational environments. Drawing upon secondary data from peer-reviewed journal articles, policy reports, and international educational frameworks, the review synthesizes evidence across four key domains: access and participation, algorithmic bias, educational outcomes, and governance mechanisms. The findings suggest that gender disparities persist not only in access to AI-supported educational tools but also in the design, deployment, and evaluation of algorithmic systems that influence learning pathways and academic opportunities. Existing datasets, machine learning models, and recommendation systems frequently reflect societal biases, potentially reinforcing gender stereotypes and unequal educational experiences. The review further highlights emerging policy initiatives aimed at promoting ethical and gender-responsive AI in education while identifying significant gaps in current research and implementation practices. By proposing a conceptual framework linking algorithmic processes to educational equity outcomes, this study contributes to ongoing discussions on inclusive digital transformation and offers recommendations for researchers, educators, policymakers, and technology developers seeking to foster gender-just educational futures.

Keywords: Artificial Intelligence, Gender Bias, Educational Equity, Algorithmic Decision-Making, AI in Education, Gender and Education, Digital Inclusion, Educational Technology.

1. Introduction

The twenty-first century has witnessed an unprecedented expansion of Artificial Intelligence (AI) technologies across educational systems worldwide. From adaptive learning platforms and intelligent tutoring systems to automated assessment tools and predictive analytics, AI-driven technologies are increasingly shaping educational experiences and

institutional decision-making processes. Governments, educational institutions, and technology companies have embraced AI as a means of improving learning outcomes, increasing efficiency, and supporting personalized educational pathways (Holmes et al., 2022; UNESCO, 2021). The growing reliance on data-driven educational technologies has positioned AI as a central component of contemporary educational transformation.

Despite these promising developments, concerns have emerged regarding the equity implications of AI adoption in educational contexts. Scholars have argued that algorithmic systems are not inherently neutral; rather, they often reflect the social, cultural, and institutional biases embedded within the data used to develop them (O'Neil, 2016; Noble, 2018). Consequently, AI technologies may unintentionally reproduce existing inequalities and create new forms of exclusion. Among these concerns, gender bias has become an increasingly significant area of scholarly inquiry, particularly as educational technologies play a greater role in shaping students' learning opportunities, academic trajectories, and future career aspirations (UNESCO, 2024).

Gender inequality in education has traditionally been examined through indicators such as access, enrollment, retention, and achievement. While substantial progress has been achieved in expanding educational opportunities for girls and women in many parts of the world, contemporary forms of inequality are increasingly embedded within digital infrastructures and algorithmic systems (Unterhalter, 2019; UNESCO, 2023). AI-driven educational technologies have introduced new challenges related to representation, participation, visibility, and decision-making. For instance, recommendation algorithms may reinforce gendered subject preferences, predictive analytics may replicate historical disparities, and AI-powered learning systems may be trained on datasets that inadequately represent diverse gender experiences (West et al., 2019; UNESCO, 2024).

Recent global developments have intensified the relevance of this issue. The COVID-19 pandemic accelerated digitalization across educational sectors, increasing dependence on technology-mediated learning environments (United Nations, 2020). Simultaneously, advances in generative AI and machine learning have expanded the influence of algorithmic systems in educational planning, assessment, and student support services (Kasneci et al., 2023). These transformations have raised critical questions regarding whether AI serves as a tool for educational inclusion or as a mechanism through which existing gender inequalities are reproduced in new forms.

International organizations have increasingly recognized the importance of addressing these concerns. UNESCO, UNICEF, the Organisation for Economic Co-operation and Development (OECD), and other global agencies have emphasized the need for ethical, transparent, and inclusive AI governance frameworks that promote equity and social justice (OECD, 2021; UNESCO, 2021). Nevertheless, existing research remains fragmented across disciplines, with studies often focusing on isolated technological applications or specific educational contexts. A comprehensive synthesis of current evidence is therefore necessary to understand the broader implications of gender bias in AI-driven education and to identify pathways toward more equitable educational futures.

This review addresses this gap by critically examining scholarly and policy literature published between 2020 and 2026. Specifically, the study seeks to: (a) examine how gender bias manifests within AI-enabled educational technologies; (b) analyze the implications of algorithmic systems for educational equity and inclusion; (c) identify emerging policy and governance responses; and (d) propose future directions for gender-responsive AI implementation in education. By synthesizing contemporary evidence and developing a conceptual understanding of the relationship between AI systems

and gender equity, the review contributes to ongoing debates surrounding technology, education, and social justice in an increasingly digital world.

2. Methodology

This study used a critical review to pull together recent work on gender bias in Artificial Intelligence driven education and what it means for educational equity. A review made sense because the field is moving fast and covers a wide mix of technologies, policy efforts, and research settings. The goal was to map key themes, flag emerging concerns, and point to where things might go next for gender equity in AI enabled learning environments. We looked for literature published between 2020 and 2026 in major databases like Scopus, Web of Science, ERIC, and Google Scholar. Searches combined terms such as “Artificial Intelligence,” “AI in Education,” “Gender Bias,” “Educational Equity,” “Algorithmic Bias,” “Gender and Technology,” and “Generative AI in Education.” To add broader policy context, we also reviewed reports and documents from international organizations including UNESCO, OECD, UNICEF, and the World Bank (OECD, 2021; UNESCO, 2021).

We included peer reviewed journal articles, scholarly books, conference papers, and institutional reports that directly addressed AI applications in education and their links to gender, equity, inclusion, or algorithmic fairness. We left out studies that focused only on technical aspects of AI with no clear educational relevance. We also excluded work published before 2020 and sources that did not meet basic standards of methodological rigor. After screening, we read and grouped the selected literature by recurring themes. Four areas kept coming up: the growing use of AI across education systems, how gender bias shows up in AI enabled educational tools, what that means for equity and inclusion, and the policy responses and strategies being proposed for more gender responsive AI in education. Using thematic synthesis, we tried to build a clear picture of how algorithmic systems can shape gendered educational experiences and outcomes, and where there is room for more equitable approaches. By taking a critical and thematic approach, the review goes beyond summarizing studies. It looks at the structural and social implications of bringing AI into education. That perspective helps clarify how technological innovation intersects with equity and contributes to the wider conversation about building inclusive and ethical educational futures (OECD, 2021; UNESCO, 2021).

3. Gender and AI in Contemporary Education

Artificial Intelligence has become one of the most transformative forces in contemporary education. It is reshaping how teaching happens, how students learn, how assessments are designed, and how institutions make decisions. Across the world, schools and universities are turning to AI driven technologies to personalize learning, streamline administrative work, and boost student engagement. This shift mirrors wider trends toward digital transformation and data informed educational governance (Holmes et al., 2022; UNESCO, 2023). Personalized learning stands out as a key application. AI powered platforms can track learner data, detect individual patterns, and adjust content to match a student’s needs and pace. Intelligent tutoring systems, adaptive learning software, and recommendation engines all aim to tailor instruction in ways that improve

outcomes and efficiency (Zawacki-Richter et al., 2019). These tools have gained traction because they promise to meet diverse learner needs and make individualized instruction more feasible at scale.

The rise of generative AI has pushed this role even further. Large language models are now being used for content creation, academic support, feedback, and direct student assistance. Learners can get immediate answers and customized guidance, which can increase accessibility and engagement (Kasneci et al., 2023). The speed of adoption has also prompted educators and policymakers to rethink long held practices around teaching, assessment, and how knowledge is produced. The COVID 19 pandemic accelerated much of this change. When schools closed and learning moved online, institutions leaned heavily on digital platforms to keep instruction going. That period underscored the value of AI supported systems for educational resilience and innovation (United Nations, 2020; UNESCO, 2023). Yet the expansion of AI in education also raises concerns about fairness, inclusion, and equity. Scholars have pointed out that educational technologies are not value neutral. When built on biased datasets or rolled out without strong ethical safeguards, they can reproduce existing social inequalities (Noble, 2018; O'Neil, 2016). Because AI systems learn from historical data, they can absorb and repeat patterns of discrimination and exclusion. That leads to critical questions: whose experiences are captured in educational datasets, whose needs guide algorithmic design, and who actually benefits from these innovations? These issues are especially pressing when viewed through a gender lens. AI is often framed as objective and impartial, but research shows that algorithmic systems can reinforce gender stereotypes and unequal opportunities if biases in data and design go unchecked (West et al., 2019; UNESCO, 2024). As AI plays a larger role in shaping educational pathways, understanding its relationship with gender equity has become a priority for researchers, educators, and policymakers. There is a clear tension here. AI offers real potential for personalization, access, and innovation. At the same time, it risks deepening existing inequalities if representation, fairness, and inclusivity are ignored. That tension is the starting point for examining how gender bias appears in AI driven educational systems and what it means for educational equity.

4. Manifestations of Gender Bias in AI-Driven Education

4.1 Bias in Training Data

The effectiveness of AI systems largely depends on the quality and representativeness of the data used to train them. However, educational datasets often reflect historical and societal inequalities, which may subsequently become embedded within algorithmic systems. Since machine learning models learn from existing patterns, they can reproduce gender disparities present in past educational records, participation trends, and achievement data (O'Neil, 2016; UNESCO, 2024).

Research has shown that women and girls remain underrepresented in many technology-related datasets, particularly those associated with STEM education and digital skills development (West et al., 2019). When such datasets serve as the foundation for educational AI systems, algorithms may unintentionally perpetuate existing gender imbalances. Consequently, AI-generated recommendations and predictions may favor historically dominant groups while overlooking the experiences and needs of female learners.

4.2 Algorithmic Stereotyping and Recommendation Systems

AI-driven recommendation systems are increasingly used to guide learning pathways, suggest educational resources, and support academic decision-making. Although these systems are designed to enhance personalization, they may inadvertently reinforce gender stereotypes when recommendations are based on historical behavioral patterns rather than individual potential (UNESCO, 2021).

For example, if historical data indicate that male students are more likely to enroll in engineering or computer science courses, recommendation algorithms may continue to direct male students toward STEM-related opportunities while suggesting alternative pathways to female students. Such practices can contribute to the persistence of gender segregation across academic disciplines and future occupations (UNESCO, 2024).

Algorithmic stereotyping is particularly problematic because it often operates invisibly. Students and educators may perceive AI-generated recommendations as objective and data-driven, without recognizing the potential influence of biased assumptions embedded within the system. This creates a risk that technology may legitimize existing inequalities under the appearance of neutrality (Noble, 2018).

4.3 Gender Representation in Generative AI

The emergence of generative AI technologies has introduced new concerns regarding gender representation within educational environments. Large language models and AI-powered content generation tools are increasingly used to provide explanations, examples, feedback, and learning support. However, studies have demonstrated that these systems can reproduce stereotypical associations between gender and professional roles, abilities, and social characteristics (Kasneci et al., 2023; UNESCO, 2024).

For instance, AI-generated educational content may disproportionately associate men with leadership, science, and technology while portraying women in caregiving or supportive roles. Such representations may subtly influence learners' perceptions of gender roles and career possibilities. Repeated exposure to stereotypical outputs can reinforce existing social norms and limit aspirations among underrepresented groups.

Furthermore, generative AI systems frequently rely on large-scale internet data, which may contain biased or discriminatory content. As a result, educational applications of generative AI require continuous monitoring to ensure that instructional materials promote inclusivity and equitable representation.

4.4 Gendered Impacts on Learning Opportunities

Gender bias in educational AI extends beyond technological design and affects learners' educational experiences and opportunities. Biased algorithms may influence access to educational resources, academic support services, and learning recommendations, thereby shaping students' educational trajectories (Holmes et al., 2022).

For female learners, particularly those from marginalized socioeconomic backgrounds, algorithmic biases may compound existing barriers to participation and achievement. In contexts where digital access and

technological literacy are already unequal, biased AI systems may further widen educational disparities rather than reduce them (UNESCO, 2023).

Moreover, AI-driven predictive systems used to identify student performance, retention risks, or academic potential may generate outcomes that disproportionately disadvantage certain groups if gender-related biases remain unaddressed. Such outcomes have significant implications because they may influence educational interventions, institutional decisions, and future opportunities available to learners.

Overall, evidence suggests that gender bias in AI-driven education operates through multiple pathways, including biased datasets, stereotypical recommendations, unequal representation, and differential educational outcomes. These manifestations highlight the need to critically examine not only the technological capabilities of AI but also its broader social and educational consequences. Understanding these implications is essential for ensuring that AI contributes to educational equity rather than reproducing existing inequalities.

5. Implications for Educational Equity

Gender bias in AI driven educational technologies has clear consequences for educational equity. Equity goes beyond giving everyone the same access to learning. It also involves fairness in participation, achievement, representation, and the opportunities that open up later in life. As AI plays a larger role in educational decision making, biased systems can shape students' experiences in ways that either support or undermine equitable outcomes (UNESCO, 2021).

One key issue is how bias affects student participation and engagement. AI powered platforms are meant to personalize learning and respond to different needs. But when algorithms rely on biased assumptions or replicate past patterns, some groups of learners may get less relevant recommendations, weaker academic support, or fewer chances to advance. That can lower motivation, confidence, and overall engagement with learning (Holmes et al., 2022).

Bias also matters for academic achievement and subject choice. Research continues to show that women and girls are underrepresented in STEM fields. If educational algorithms reinforce traditional gender patterns through course suggestions or learning pathways, they may unintentionally steer female students away from science, technology, engineering, and mathematics (UNESCO, 2024). In that way, AI systems risk maintaining existing gender gaps instead of opening up more inclusive participation.

Digital inclusion is another concern. AI has the potential to broaden access to quality education, but uneven access to devices, connectivity, digital skills, and AI enabled learning environments can disadvantage female learners in certain social and economic contexts (UNESCO, 2023). Gender bias therefore overlaps with wider issues of socioeconomic inequality, geography, and digital access, producing layered forms of educational disadvantage.

The effects do not stop at the classroom door. Educational experiences shape aspirations, career choices, and professional paths. Biased recommendations, stereotypical content, and unequal learning opportunities can

narrow what students believe is possible and which careers seem open to them. This is especially troubling in emerging technology sectors where women remain underrepresented (West et al., 2019).

Increased use of automated decision making also raises questions about fairness and accountability. Predictive analytics and AI based assessment tools now influence decisions about student support, performance evaluation, and planning. If these systems carry gender related biases, institutional decisions may reproduce inequalities while appearing objective and data driven (O'Neil, 2016). That points to the need for critical scrutiny of the ethical dimensions of educational AI, rather than assuming the technology is neutral.

Taken together, these points suggest that gender bias in AI driven education is not just a technical problem. It is tied to broader questions of social justice and educational equality. To ensure equitable outcomes, we need to look closely at how algorithms shape learning opportunities, influence choices, and distribute resources and support. Addressing these challenges is essential if AI is going to contribute to truly inclusive and equitable education for all learners.

6. Emerging Policy Responses and Ethical Considerations

The growing use of Artificial Intelligence in education has prompted increasing attention from policymakers, international organizations, and researchers regarding the ethical implications of algorithmic decision-making. While AI offers opportunities to improve learning experiences and educational efficiency, concerns surrounding fairness, transparency, accountability, and gender equity have led to calls for stronger governance frameworks and ethical safeguards (UNESCO, 2021). One of the most significant global initiatives is UNESCO's *Recommendation on the Ethics of Artificial Intelligence* (2021), which emphasizes human rights, inclusiveness, diversity, and non-discrimination in AI development and deployment. The framework highlights the importance of ensuring that AI systems do not reinforce existing social inequalities and encourages member states to adopt policies that promote equitable access to AI technologies and protect vulnerable populations from algorithmic harm (UNESCO, 2021). Within educational settings, these principles underscore the need for AI systems that support rather than undermine gender equality.

Similarly, the Organisation for Economic Co-operation and Development (OECD) has developed principles for trustworthy AI, emphasizing transparency, accountability, human-centered values, and fairness (OECD, 2021). These principles encourage educational institutions and technology developers to assess the potential social consequences of AI systems before implementation. By prioritizing fairness and inclusivity, such frameworks aim to reduce the risk of discriminatory outcomes and promote responsible technological innovation. An important policy response involves the development of gender-responsive AI governance. Scholars argue that addressing algorithmic bias requires attention not only to technological design but also to the social and institutional contexts in which AI systems operate (West et al., 2019). Gender-responsive governance seeks to ensure that diverse perspectives are represented throughout the AI lifecycle, including data collection, system design, implementation, and evaluation. Such approaches can help identify potential biases early and support the development of more inclusive educational technologies.

Transparency has also emerged as a critical ethical consideration. Many AI systems function as “black boxes,” making it difficult for educators, students, and policymakers to understand how decisions and recommendations are generated. Limited transparency can hinder efforts to detect bias and challenge unfair outcomes. Consequently, researchers advocate for explainable AI systems that provide clear information regarding the factors influencing algorithmic decisions (Holmes et al., 2022). Greater transparency can enhance trust while enabling stakeholders to evaluate whether educational technologies operate fairly across different learner groups.

Another important strategy involves conducting regular bias audits and fairness assessments. Bias audits allow developers and educational institutions to examine whether AI systems produce unequal outcomes based on gender or other demographic characteristics. Continuous monitoring is particularly important because algorithmic systems may evolve over time as they process new data and adapt to changing educational environments (UNESCO, 2024). Regular evaluation can therefore help ensure that educational technologies remain aligned with principles of equity and inclusion.

Despite these developments, significant challenges remain. Many educational institutions lack the technical expertise and resources necessary to assess algorithmic fairness effectively. In addition, existing regulatory frameworks often struggle to keep pace with rapid technological advancements. As AI continues to transform educational practices, stronger collaboration among policymakers, educators, researchers, and technology developers will be essential for promoting ethical and equitable implementation.

Overall, emerging policy frameworks demonstrate growing recognition of the need to address gender bias and other forms of inequality within AI-driven education. However, ethical principles alone are insufficient unless they are translated into practical strategies that guide the design, deployment, and evaluation of educational technologies. The next step is therefore to consider how a gender-responsive approach to AI can be systematically integrated into educational systems to promote greater equity and inclusion.

7. Towards a Gender Responsive AI Framework in Education

The review makes clear that addressing gender bias in AI driven education is not just a matter of tweaking algorithms. Meaningful solutions need to look at the whole educational AI ecosystem, from how data are collected and systems are designed to how they are implemented and what outcomes they produce. A gender responsive approach should therefore build fairness, inclusivity, transparency, and accountability into every stage of the AI lifecycle. Drawing on the literature, we propose a conceptual framework for gender responsive AI in education. It has five connected parts: inclusive data, fair algorithms, transparent decision making, equitable learning experiences, and gender equitable outcomes.

First, inclusive data means creating datasets that genuinely reflect the diversity of learners. Because AI systems learn from historical data, there must be deliberate effort to address underrepresentation and to capture a range

of educational experiences and gender identities (UNESCO, 2024). More inclusive datasets reduce the chance that algorithmic systems will simply repeat past inequalities.

Second, fair algorithm design calls for bias detection and mitigation to be built into development from the start. Educational technology developers should routinely test algorithms for discriminatory effects and take corrective steps when problems appear. Fairness checks should be treated as a standard part of building educational AI, not an optional extra (West et al., 2019).

Third, transparent decision making stresses the need for explainable AI. Educators and students should be able to understand how recommendations, assessments, and predictions are made. Greater transparency supports accountability and makes it easier for stakeholders to spot sources of bias (Holmes et al., 2022).

Fourth, equitable learning experiences points to the responsibility of educational institutions to ensure AI supports all learners fairly. Teachers and administrators need training in ethical AI use and should be able to recognize and respond to algorithmic bias. Human oversight remains crucial so that technology does not become the sole driver of educational opportunities and outcomes.

Finally, gender equitable outcomes is the overall goal. Educational technologies should help narrow gaps in participation, achievement, representation, and career pathways, not widen them. That requires ongoing monitoring and evaluation to see whether AI systems are actually delivering on these aims in practice.

This framework suggests that gender equity should not be an afterthought added once the technology is built. It needs to guide the design, implementation, and evaluation of AI driven educational systems from the outset. When educational institutions and developers take a gender responsive approach, they are better placed to realize the benefits of AI while limiting the risks of algorithmic bias.

In the end, the future of AI in education will hinge on more than technical progress. It will depend on whether educational systems center fairness, inclusion, and social justice. Building these values into AI governance and practice is key to creating learning environments that empower all students regardless of gender.

8. Conclusion

Artificial Intelligence has emerged as a transformative force in contemporary education, offering unprecedented opportunities for personalized learning, enhanced accessibility, and improved educational decision-making. As educational institutions increasingly adopt AI-driven technologies, these systems have the potential to support more efficient and responsive learning environments. However, the findings of this review indicate that the benefits of AI are not distributed equally and that significant concerns remain regarding gender bias and educational equity.

The review demonstrates that gender bias can manifest throughout the AI lifecycle, from data collection and algorithm development to educational recommendations and learning outcomes. Biased datasets, stereotypical algorithmic assumptions, and unequal representation within AI systems may contribute to the reproduction of existing gender inequalities. Rather than functioning as neutral tools, AI technologies often reflect the social and historical contexts from which they emerge, making it essential to critically evaluate their impact on educational opportunities and experiences.

The analysis further highlights that the implications of gender bias extend beyond technological concerns and influence broader issues of educational participation, academic achievement, digital inclusion, and future career pathways. In particular, the potential reinforcement of gender stereotypes within AI-driven educational systems may limit opportunities for underrepresented groups and hinder efforts to achieve equitable educational outcomes. These findings suggest that educational equity must remain a central consideration in the design and implementation of AI technologies.

Encouragingly, international organizations and policymakers have begun to recognize the importance of ethical and inclusive AI governance. Frameworks developed by UNESCO and the OECD provide important foundations for promoting fairness, transparency, and accountability in educational AI. Nevertheless, translating these principles into practice remains a significant challenge. Educational institutions, technology developers, and policymakers must work collaboratively to ensure that AI systems are continuously evaluated and improved to minimize discriminatory outcomes.

To address these challenges, this review proposed a gender-responsive AI framework emphasizing inclusive data, fair algorithms, transparent decision-making, equitable learning experiences, and gender-equitable outcomes. The framework highlights the need to embed gender considerations throughout the AI lifecycle rather than treating equity as an afterthought. Such an approach can support the development of educational technologies that contribute to inclusion and social justice while maximizing the benefits of technological innovation.

Future research should continue examining the long-term effects of AI on gender equity across diverse educational contexts. Greater attention is needed to the experiences of learners from different cultural, socioeconomic, and geographic backgrounds, particularly within developing countries where digital inequalities remain significant. As AI becomes increasingly integrated into educational systems, ongoing research and policy engagement will be essential to ensure that technological advancement supports, rather than undermines, the goal of equitable education for all.

In conclusion, the future of AI in education will not be determined solely by technological capability but by the values that guide its development and application. Ensuring that AI promotes fairness, inclusion, and gender equity is essential for building educational systems that empower all learners and contribute to more just and sustainable societies.

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