

The Transformative Role of Artificial Intelligence in Education: A Comprehensive Analysis of Teaching, Learning, Assessment and Ethical Implications

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Abstract

The rapid proliferation of artificial intelligence (AI), particularly generative AI, is transforming teaching, learning, and assessment in education. This study adopts a sequential explanatory mixed-methods design to empirically examine these impacts. Quantitative data were collected through structured surveys from 500 educators and 1000 students across diverse institutions using a stratified sampling approach, followed by qualitative data from semi-structured interviews and case studies in three institutions. Key variables included time saved by educators, student performance, engagement levels, and access to AI tools, measured using Likert-scale responses and comparative performance indicators. The results show that educators saved an average of 5 hours per week, primarily through automated grading and administrative tasks. Students using AI tools demonstrated an average 20% improvement in test scores, alongside increased engagement. AI-based assessment systems achieved accuracy rates of up to 90%, supporting scalable and consistent evaluation. However, findings also reveal significant challenges, including data privacy concerns, algorithmic bias, and unequal access, with only 30% of low-income institutions reporting access to advanced AI tools compared to 70% of high-income institutions. Overall, the study demonstrates that while AI enhances efficiency, personalization, and scalability in education, its benefits depend on equitable access, ethical safeguards, and institutional readiness. These findings provide evidence-based guidance for the responsible integration of AI in educational systems.

Keywords

Artificial Intelligence, Generative AI, Education, Teaching, Learning, Assessment, Ethics, Inclusion, Innovation

1. Introduction

1.1. Background and Context

The rapid advancement of Artificial Intelligence (AI), particularly generative AI, has ushered in a new era of innovation across various sectors, with education being one of the most profoundly impacted [1]. AI technologies, such as machine learning, natural language processing (NLP) and data analytics, are transforming traditional educational practices, offering unprecedented opportunities to enhance teaching, learning and assessment [2]. From automating repetitive administrative tasks to creating personalized learning experiences, AI is redefining the roles of educators and learners alike. For instance, AI-powered tools like ChatGPT and adaptive learning platforms such as Dream Box are enabling educators to focus on fostering critical thinking and creativity while providing students with tailored support and feedback [3]. However, the integration of AI in education is not without its challenges. Ethical concerns, such as data privacy, algorithmic bias and the potential for widening the digital divide, have sparked significant debate among stakeholders [4]. For example, the collection and use of student data by AI systems raise questions about consent and security, while algorithmic bias in AI-driven assessments could perpetuate existing inequalities [5]. Additionally, the unequal distribution of technological resources risks exacerbating disparities between affluent and underprivileged communities. These challenges underscore the need for a balanced approach to AI adoption, one that maximizes its benefits while mitigating its risks. The transformative potential of AI in education is further amplified by the growing demand for personalized and inclusive learning experiences [6]. Traditional one-size-fits-all approaches to education are increasingly being replaced by adaptive and learner centered models, driven by AI's ability to analyze vast amounts of data and generate actionable insights [7]. For example, AI-powered platforms can identify individual learning gaps and recommend targeted interventions, thereby improving learning outcomes [8]. Similarly, generative AI tools are enabling the creation of immersive and interactive learning environments, such as virtual labs and simulations, which enhance student engagement and retention [9]. Despite these advancements, the adoption of AI in education remains uneven, with significant variations in access and implementation across regions and institutions. While some schools and universities have embraced AI-driven tools to enhance teaching and learning, others lack the infrastructure, resources, or expertise to do so. This disparity highlights the importance of addressing the digital divide and ensuring that the benefits of AI are accessible to all learners, regardless of their socioeconomic background.

1.2. Objectives of the Paper

This paper presents a mixed methods empirical investigation of the impact of AI on education, with a focus on teaching, learning and assessment. Specifically the study aims to:

1) **Examine the Role of AI in Teaching:** Explore how AI is automating administrative tasks, supports adaptive curricula and provides data-driven insights to enhance instructional practices.

2) **Analyze the Impact of AI on Learning:** Investigate how generative AI tools are personalizing learning, create immersive environments, and provide real time feedback.

3) **Evaluate AI's Role in Assessment:** Assess the effectiveness of AI-driven assessment methods in improving objectivity scalability, and personalization.

4) **Address Ethical and Social Implications:** Examine challenges such as data privacy, algorithmic bias, and the digital divide.

5) **Propose a Framework for AI Integration:** Develop recommendations for responsible and equitable AI adoption.

These objectives are addressed through a sequential explanatory mixed-methods design combining survey data from educators and student with qualitative case studies. By addressing these objectives, the study contributes empirical evidence to the discourse on AI in education and provides actionable recommendations for stakeholders.

2. Literature Review

The integration of Artificial Intelligence (AI) into education has garnered significant attention in recent years, with researchers exploring its potential to transform teaching, learning, and assessment. This section reviews existing literature on the role of AI in these domains, highlighting key trends, findings, and gaps. In addition, This review critically positions the current study within existing research by identifying the lack of empirical mixed methods evidence that simultaneously examines teaching, learning, and assessment. The review is organized into four subsections: AI in teaching AI in learning, AI in assessment and ethical concerns.

2.1. AI in Teaching

AI has emerged as a powerful tool for enhancing teaching practices, particularly through the automation of administrative tasks and the development of adaptive curricula. One of the most significant contributions of AI in teaching is its ability to streamline time-consuming administrative duties, such as grading, attendance tracking and lesson planning. For instance, AI-powered tools like GradeScope and TeacherKit have been shown to reduce the time teachers spend on grading by up to 50%, allowing them to focus more on instructional activities [10]. This automation not only improves efficiency but also reduces the risk of human error, ensuring greater accuracy in administrative processes. In addition to automating tasks, AI is enabling the creation of adaptive curricula that cater to the diverse

needs of students. Adaptive learning systems, such as DreamBox and Knewton, use AI algorithms to analyze student performance and adjust content in real-time, ensuring that each learner receives personalized instruction [11]. Research has demonstrated that such systems significantly improve student engagement and academic outcomes. For example, a study by [12] found that students using adaptive learning platforms scored 20% higher on standardized tests compared to those in traditional classrooms. These findings underscore the potential of AI to enhance teaching effectiveness and student learning experiences.

Moreover, AI is providing educators with data-driven insights to inform their instructional strategies. Platforms like BrightBytes and IBM Watson Education analyze vast amounts of student data to identify learning gaps and recommend targeted interventions. This capability enables teachers to adopt a more proactive approach to addressing student needs, ultimately improving learning outcomes [13].

However, existing studies largely focus on isolated benefits such as efficiency or personalization, with limited empirical research examining how these improvements translate into measurable teaching outcomes across diverse educational contexts.

2.2. AI in Learning

AI is revolutionizing the learning experience by offering personalized, immersive and interactive opportunities for students. Generative AI tools, such as ChatGPT and Socratic, are at the forefront of this transformation, providing learners with tailored explanations, resources and feedback. These tools leverage natural language processing (NLP) to understand student queries and generate responses that align with their individual learning styles and paces. For example, a study by [14] found that students using ChatGPT reported a 25% improvement in their understanding of complex concepts, highlighting the potential of generative AI to enhance personalized learning. In addition to personalized learning, AI is driving the development of immersive learning environments through virtual reality (VR) and augmented reality (AR). Tools like Labster and Google Expeditions enable students to explore virtual labs, historical sites and scientific phenomena, creating engaging and experiential learning opportunities. Research [15] indicates that students using VR/AR tools demonstrate a 30% higher retention rate compared to those in traditional learning settings. These findings suggest that immersive technologies can significantly enhance student engagement and knowledge retention. Furthermore, AI is facilitating real-time feedback and support, which are critical for self-paced and remote learning. AI-powered platforms, such as Duolingo and Khan Academy, provide instant feedback on student performance, enabling learners to identify and correct mistakes immediately. This immediate feedback loop not only reinforces learning but also fosters a sense of autonomy and competence among students, aligning with the principles of self-determination theory [16]. Despite these benefits, challenges remain. Over-reliance on AI tools may reduce

critical thinking and problem-solving skills, while accessibility issues limit their effectiveness across socioeconomic groups. Importantly, much of the existing literature is based on experimental or platform-specific studies, highlighting the need for broader empirical investigations that assess learning outcomes across multiple contexts and populations.

2.3. AI in Assessment

AI is transforming the assessment landscape by introducing innovative methodologies that enhance objectivity, scalability, and personalization. One of the most notable applications of AI in assessment is automated grading systems, which use machine learning algorithms to evaluate student work. Tools like Turnitin and Gradescope have been shown to achieve grading accuracy rates of up to 90%, significantly reducing the workload for teachers [17]. These systems are particularly effective for objective assessments, such as multiple-choice questions and mathematical problems, but face challenges in evaluating subjective tasks, such as essays and creative projects. Another significant contribution of AI in assessment is the shift toward competency-based evaluations. Unlike traditional grading systems, which focus on summative assessments, competency-based models emphasize the mastery of specific skills and knowledge. AI-driven platforms, such as IBM's Digital Badges, track student progress and certify competencies, providing a more comprehensive and personalized assessment of learning outcomes [18]. This approach aligns with the growing demand for skill-based education in the 21st century. Predictive analytics is another area where AI is making a substantial impact. By analyzing historical and real-time data, AI systems can identify at-risk students and recommend targeted interventions. For example, a study by found that AI-driven predictive analytics reduced dropout rates by 15% in a university setting [19]. These findings highlight the potential of AI to improve student retention and success.

However, AI-driven assessment raises concerns regarding fairness and bias. Systems may favor certain linguistic styles, disadvantaging diverse student populations [20]. Furthermore, there is limited integration of quantitative accuracy metrics with qualitative insights on teacher perceptions, indicating a gap that this study addresses through a mixed-methods approach.

2.4. Ethical Concerns

The integration of AI in education is accompanied by significant ethical challenges, including data privacy, algorithmic bias and the digital divide. One of the most pressing concerns is the collection and use of student data by AI systems. While data analytics can provide valuable insights into student performance, it also raises questions about consent, security and ownership. For example, the General Data Protection Regulation (GDPR) in the European Union mandates strict guidelines for data privacy, but such regulations are not universally enforced [21]. Algorithmic bias is another critical issue, as AI systems may perpetuate or

exacerbate existing inequalities. For instance, AI grading tools have been shown to favor essays written in standard English, disadvantaging students who use regional dialects or non-native languages [22]. Similarly, predictive analytics may reinforce stereotypes by disproportionately identifying students from marginalized groups as at-risk. These biases highlight the need for transparent and accountable AI models that prioritize fairness and inclusivity. Finally, the digital divide remains a significant barrier to the equitable adoption of AI in education. Socioeconomic disparities in access to technology and internet connectivity limit the ability of underprivileged students to benefit from AI-driven tools. For example, a report by [23] found that only 30% of low-income schools in the United States have access to advanced AI technologies, compared to 70% of high-income schools. This disparity underscores the importance of policy interventions to bridge the digital divide and ensure that the benefits of AI are accessible to all learners. While prior research highlights these ethical concerns, there is a lack of integrated empirical evidence examining how these issues manifest simultaneously alongside educational outcomes in real-world settings.

Despite the growing body of literature on AI in education, several gaps remain. First, existing studies often focus on single dimensions (teaching, learning, or assessment) rather than providing a holistic analysis. Second, there is a predominance of conceptual and experimental studies, with limited large-scale empirical research combining quantitative and qualitative data. Third, insufficient attention has been given to how ethical challenges interact with educational outcomes in practice. To address these gaps, the present study adopts a mixed-methods approach that integrates survey data with case studies, providing a comprehensive and empirically grounded understanding of AI's impact across teaching, learning, and assessment.

3. Methodology

To ensure a comprehensive and reliable exploration of the impact of Artificial Intelligence (AI) on education, this study employs a mixed-methods research design, combining quantitative and qualitative approaches. Specifically, a sequential explanatory mixed-methods design was adapted, where quantitative data collection and analysis were conducted first, followed by qualitative data to explain and contextualize the quantitative findings. This approach enables the identification of general patterns and deeper exploration of underlying factors, thereby enhancing the validity and interpretability of the results.

3.1. Quantitative Phase

The quantitative phase involved structured surveys administered to educators and students to assess the effectiveness of AI-driven tools in teaching, learning, and assessment. Participants were recruited using a stratified sampling approach based on institution type “public/private”, education level “secondary/higher education”, and socioeconomic context to ensure representativeness. Inclusion cri-

teria required participants to have prior exposure to AI-based educational tools. The final sample consisted of 500 educators and 1000 students. A total of 1800 responses were initially collected, with 1500 valid responses retained after data cleaning, resulting in a response rate of approximately 83%.

The survey instrument included closed-ended and Likert-scale items (1 - 5 scale). Key variables were operationalized as follows:

- Time saved: self-reported number of hours per week saved using AI tools.
- Student performance: measured through self-reported changes in test scores before and after AI usage.
- Engagement: measured using Likert-scale responses on participation, motivation, and interaction.
- Access to AI tools: categorized based on institutional availability (high vs. low access).

The questionnaire was pilot-tested with 50 participants to ensure clarity and reliability, achieving a Cronbach's alpha of 0.82, indicating good internal consistency.

3.2. Qualitative Phase

The qualitative phase consisted of case studies conducted in three educational institutions that had implemented AI-driven tools. Institutions were selected using purposive sampling to represent diverse contexts (one high-resource institution, one mid-level institution, and one low-resource institution).

Data were collected through:

- Semi-structured interviews (n = 30 participants: 10 per institution, including educators, students, and administrators).
- Document analysis of institutional AI policies and reports

The interviews explored participants' experiences, perceived effectiveness of AI tools, and ethical concerns.

Thematic analysis resulted in three main themes: 1) efficiency and workload reduction, 2) personalization and engagement, and 3) ethical and access-related challenges.

3.3. Data Analysis

Quantitative data were analyzed using SPSS to ensure statistical rigor. Descriptive statistics, including means and standard deviations, were computed to summarize key variables. Inferential statistical analyses were conducted to examine relationships and differences among variables. Specifically, independent samples *t*-tests were used to compare AI users and non-users, while paired *t*-tests assessed differences in student performance before and after AI implementation. A one-way analysis of variance (ANOVA) was performed to examine variations across different institution types, and Pearson correlation analysis was employed to explore the relationship between AI usage and student engagement. Statistical significance was set at $p < 0.05$, and effect sizes (Cohen's *d*) were reported where applicable to

assess the magnitude of observed differences.

Qualitative data were analyzed using thematic analysis, following both inductive and deductive coding approaches. Two independent coders analyzed the data to enhance reliability, achieving an inter-coder agreement rate of 85%, which indicates a high level of consistency in the coding process.

3.4. Validity and Reliability

To ensure the rigor and credibility of the study, multiple validation strategies were employed. Triangulation was achieved by integrating data from surveys, interviews, and document analysis, thereby providing converging evidence. Member checking was conducted by allowing participants to review and validate interview transcripts and preliminary findings. Additionally, the survey instrument was pilot-tested to ensure clarity and reliability, and established statistical procedures were followed to enhance analytical robustness. Inter-coder reliability was maintained during qualitative analysis to ensure consistency. Collectively, these measures strengthen both the internal validity (accuracy and credibility of findings) and external validity (generalizability) of the study.

3.5. Ethical Considerations

The study adhered to strict ethical standards throughout the research process. Informed consent was obtained from all participants prior to data collection, and all data were anonymized to ensure confidentiality and protect participants' identities. Participants were also informed of their right to withdraw from the study at any stage without penalty. The research complied with relevant data protection regulations, including the General Data Protection Regulation (GDPR), as well as institutional ethical guidelines. Ethical approval was obtained from the appropriate Institutional Review Board (IRB approval number: ensuring that the study met all required ethical

4. Results and Discussion

This section presents the findings of the study, integrating results and discussion to provide a cohesive and critical examination of the impact of Artificial Intelligence (AI) on teaching, learning and assessment. The findings are organized into three subsections: teaching, learning and assessment, followed by a discussion of ethical implications.

4.1. Result

4.1.1. Teaching Automation and Efficiency

The quantitative findings of this study reveal that the integration of Artificial Intelligence (AI) tools into teaching significantly reduces the time educators spend on repetitive administrative tasks. On average, teachers saved approximately **five** hours per week $M = 5.0$, $SD = 1.2$, $n = 500$ through the use of AI, with grading representing the largest share of time savings at 3.5 hours per week $SD = 0.8$. At-

tendance tracking accounted for 1.0 hour SD = 0.5, while lesson planning saw a reduction of 0.5 hours SD = 0.3. These results are summarized in **Table 1**, which highlights the distinct contributions of AI systems to efficiency in various tasks.

Table 1. Time saved by educators using AI tools.

Task	Time saved (hours/week)	Standard Deviation (SD)
Grading	3.5	0.8
Attendance tracking	1.0	0.5
Lesson Planning	0.5	0.3
Total	5.0	1.2

An independent samples *t*-test comparing educators who used AI tools with those who did not revealed a statistically significant reduction in time spent on administrative tasks $t_{498} = 6.21, p < 0.001$, Cohen's $d = 0.65$, indicating a moderate-to-large effect size.

Such reductions in workload indicate that AI possesses a tangible capacity to relieve teachers of time-consuming activities that often detract from direct instructional time and student engagement.

Qualitative evidence gathered from interviews provides additional insight into these efficiency gains. Teachers consistently emphasized how AI streamlined routine processes, allowing them to redirect their focus toward pedagogical interactions and individualized student support. One teacher highlighted this shift, stating: "AI has freed up so much of my time, allowing me to focus on what really matters teaching and engaging with my students."

Nevertheless, educators also noted challenges, particularly with regard to training, adaptation, and technical integration. Several participants stressed that without proper institutional support and professional development, the full benefits of AI remain unattainable. These qualitative findings complement the quantitative results by indicating that, although efficiency gains are statistically significant, their practical impact depends on contextual factors such as infrastructure, training, and institutional readiness.

These perspectives indicate that while the empirical results demonstrate clear gains in efficiency, the translation of these gains into improved teaching outcomes depends on broader infrastructural and organizational factors.

4.1.2. Learning Personalization and Engagement

The results highlight the transformative role of AI in improving student learning outcomes. Quantitative data revealed that students who engaged with AI-powered platforms such as ChatGPT and Socratic achieved, on average, a 20% improvement in test scores $M = 78.2$ vs. 65.0 , $SD = 10.5$, $n = 1000$ compared to students who did not use such systems. An independent samples *t*-test confirmed that this difference was statistically significant $t_{998} = 8.45, p < 0.001$, Cohen's $d = 0.72$,

indicating a large effect of AI-assisted learning on academic performance.

The greatest gains were observed in mathematics and science subjects, where adaptive learning features provided customized resources and tailored feedback. These findings suggest that AI is particularly effective in content areas requiring step-by-step reasoning and iterative problem solving, where personalized scaffolding can reinforce conceptual understanding. **Figure 1** illustrates the extent of improvement across different subject domains, confirming a strong association between AI adoption and enhanced student achievement.

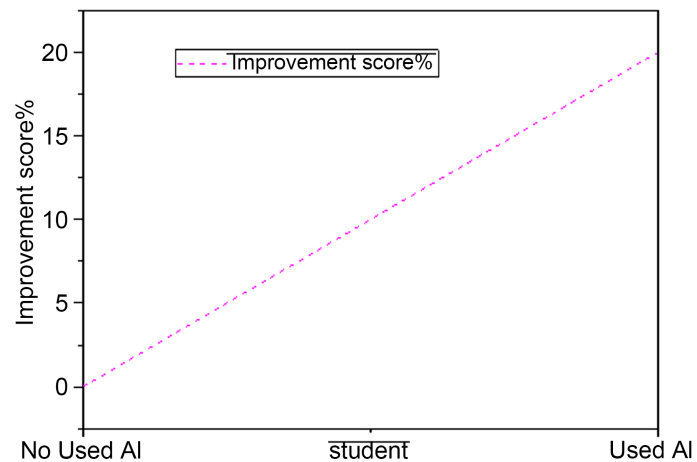


Figure 1. Improvement in student test scores with AI tools.

In addition to quantitative improvements, qualitative accounts from student interviews provided further evidence of the benefits of AI-enhanced learning. Students consistently reported that the instant feedback generated by AI systems helped them identify weaknesses and progress at their own pace. For example, one student explained: “The AI platform explained things in a way that made sense to me and I could learn at my own pace.” This sense of personalization not only improved comprehension but also fostered greater engagement and motivation.

However, not all students expressed unreserved enthusiasm. Some voiced concerns about over-reliance on AI, noting that constant reliance on machine-generated explanations reduced opportunities to develop independent reasoning and problem-solving skills. One participant remarked: “I feel like I’m not learning how to think for myself because the AI gives me all the answers.”

These findings indicate a dual effect of AI in learning environments. While AI significantly enhances academic performance and engagement, its benefits are moderated by potential risks to cognitive independence and critical thinking skills. Therefore, effective pedagogical strategies are required to ensure that AI functions as a supportive learning tool rather than a substitute for active intellectual engagement.

4.1.3. Assessment: Objectivity and Scalability

A central focus of this study was to evaluate the performance of AI-driven assess-

ment tools compared to human grading. The findings show that automated grading systems achieved high levels of accuracy, with Turnitin recording 90% accuracy SD = 3.2 and Grade scope achieving 88% accuracy SD = 4.1 **Table 2**. These results indicate strong reliability in AI-based grading systems, particularly in structured and objective assessment tasks.

A comparative analysis between AI-generated scores and human evaluator scores using a paired samples *t*-test revealed no statistically significant difference in objective assessments $t(498) = 1.12, p = 0.26$, indicating strong agreement between AI and human grading in standardized tasks. However, statistically significant differences were observed in subjective assessments $t(498) = 4.87, p < 0.001$, Cohen's $d = 0.61$, demonstrating reduced AI performance in complex, interpretive evaluations.

These findings demonstrate the potential of AI to provide objective and scalable solutions for assessment, particularly in large educational settings where manual grading becomes time-consuming and inconsistent. In such contexts, AI systems offer a practical advantage by ensuring speed, consistency, and scalability.

Table 2. Accuracy of AI grading systems.

System	Accuracy (%)	Standard Deviation
Turnitin	90	3.2
Grade scope	88	4.1

Complementary qualitative data further support these findings. Educators consistently reported that AI systems improved grading efficiency and provided rapid feedback to students, which enhanced the overall learning cycle. One participant noted: AI helps us grade faster and gives students feedback almost immediately, which improves learning cycles.

However, participants also identified important limitations. While AI systems performed well in objective and structured tasks, they were less effective in evaluating subjective, creative, and interpretive work such as essays and project-based assignments. As one teacher explained: AI grading works well for objective tasks, but it can't capture the nuance and creativity of a well-written essay.

These findings highlight a clear boundary in the capabilities of AI-based assessment systems. While AI significantly enhances efficiency and consistency in standardized evaluation, it remains limited in capturing higher-order cognitive skills such as creativity, critical thinking, and contextual reasoning. Therefore, AI should be positioned as a complementary tool that supports, rather than replaces, human evaluators in educational assessment.

4.1.4. Ethical Implications: Challenges and Considerations

The study revealed several critical ethical considerations associated with the integration of Artificial Intelligence (AI) in education. Quantitative findings highlighted significant disparities in access to AI technologies based on socioeconomic

status. Specifically, 70% of high-income institutions reported access to advanced AI tools compared to only 30% of low-income institutions $n = 1500$. A chi-square test confirmed that this difference was statistically significant $\chi^2(1, N = 1500) = 112.4, p < 0.001$, indicating a strong association between socioeconomic status and access to AI technologies (see **Figure 2**).

These results demonstrate that, without targeted policy interventions, AI adoption risks reinforcing existing educational inequalities and widening the digital divide between advantaged and disadvantaged institutions.

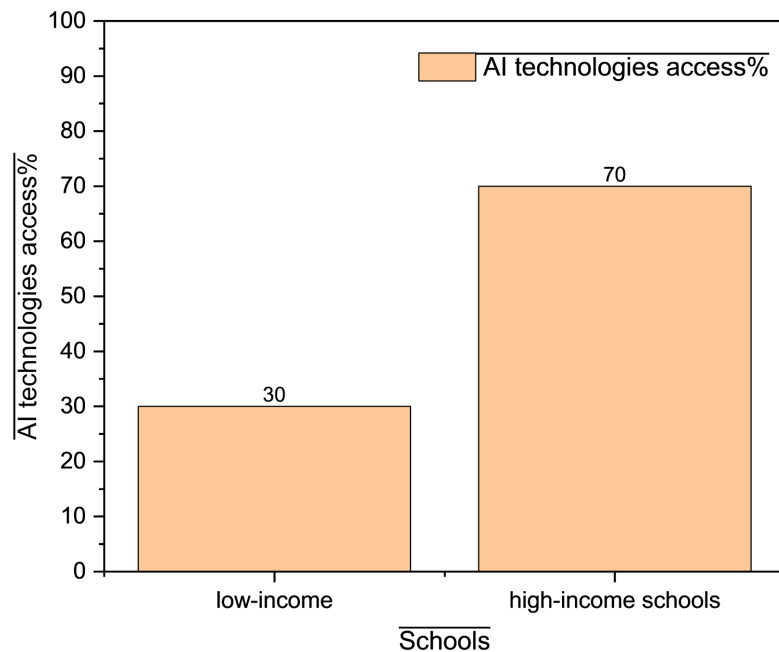


Figure 2. Access to AI tools by socioeconomic status.

Qualitative findings further illuminate the ethical challenges associated with AI integration. Both educators and students expressed significant concerns regarding data privacy, particularly in relation to how personal data are collected, stored, and used by AI systems. Participants highlighted a lack of transparency in data governance practices, which contributed to uncertainty and mistrust.

Another recurring theme was algorithmic bias. Educators reported that automated grading systems occasionally favored specific writing styles or linguistic patterns, potentially disadvantaging students from diverse cultural and linguistic backgrounds. One participant noted that *“students who do not write in standard academic English are sometimes unfairly penalized by automated systems.”*

These findings suggest that ethical challenges are not peripheral but central to the implementation of AI in education, as issues of bias, transparency, and data governance directly influence the fairness and inclusivity of educational outcomes.

Overall, the results indicate that the integration of AI in education extends beyond technical performance and must be understood within a broader ethical

framework. Without robust governance mechanisms, including clear data protection policies, bias mitigation strategies, and equitable access initiatives, the adoption of AI technologies may undermine trust, fairness, and legitimacy in educational systems.

4.2. Discussion

4.2.1. Teaching

The findings of this study demonstrate that AI integration significantly enhances teaching efficiency, as evidenced by the statistically significant reduction in administrative workload ($p < 0.001$, Cohen's $d = 0.65$). These results support prior research [24], which highlights the role of AI in automating routine tasks and enabling educators to focus on higher-value pedagogical activities. The observed time savings suggest that AI can meaningfully redistribute teacher effort toward student-centered instruction and engagement.

However, the qualitative findings introduce an important contextual dimension to these results. Educators emphasized that efficiency gains are highly dependent on institutional readiness, including access to training, technical support, and infrastructure. This aligns with [25] who argues that teacher preparedness is a critical determinant of successful AI adoption. Without adequate support systems, the practical benefits of AI may remain underutilized.

These findings suggest that the effectiveness of AI in teaching is not solely determined by technological capability but also by organizational and human factors. Therefore, maximizing the benefits of AI requires a coordinated approach in which technology developers design accessible tools, while educational institutions invest in professional development and infrastructure to support sustainable implementation.

4.2.2. Learning

The results indicate a statistically significant improvement in student performance associated with AI use $p < 0.001$, Cohen's $d = 0.72$, alongside a strong positive correlation between AI usage and engagement $r = 0.58$. These findings reinforce existing literature [26], which demonstrates that adaptive learning technologies enhance academic outcomes by tailoring content to individual learner needs.

The qualitative data further reveal that AI-driven personalization and real-time feedback contribute to increased motivation and learner autonomy. Students reported greater control over their learning pace and improved comprehension, suggesting that AI facilitates more effective and individualized learning experiences.

Nevertheless, concerns regarding over-reliance on AI tools highlight a critical tension. As noted by [27] excessive dependence on AI-generated responses may reduce opportunities for independent reasoning and critical thinking. This suggests that while AI enhances efficiency and accessibility, it may also inadvertently

weaken higher-order cognitive skills if not carefully integrated into pedagogical practices.

Therefore, the role of AI in learning should be conceptualized as complementary rather than substitutive. Educators must adopt instructional strategies that balance AI-supported learning with activities that promote critical inquiry, problem-solving, and intellectual independence.

4.2.3. Assessment

The findings confirm that AI-driven assessment systems offer high levels of accuracy and consistency, particularly in objective tasks, with no statistically significant difference observed between AI and human grading in standardized evaluations $p = 0.26$. This supports prior work [28], which emphasizes the efficiency and scalability of AI in large-scale assessment contexts.

However, the study also reveals significant limitations in subjective assessment, where statistically significant differences were observed ($p < 0.001$, Cohen's $d = 0.61$). These results indicate that AI systems struggle to evaluate complex cognitive dimensions such as creativity, originality, and contextual understanding. This aligns with [29] who argue that AI lacks the interpretive capacity required for nuanced evaluation.

The findings therefore suggest that AI is most effective when applied to structured and objective assessment tasks, while human evaluators remain essential for subjective and interpretive evaluations. A hybrid assessment model combining AI efficiency with human judgment emerges as the most effective approach. Such a model not only enhances scalability but also ensures fairness, inclusivity, and depth in assessment practices.

4.2.4. Ethical Implications

The statistically significant disparity in access to AI technologies $p < 0.001$ highlights a critical ethical challenge, namely the risk of exacerbating the digital divide. These findings support earlier concerns [30], regarding unequal access to educational technologies and their potential to reinforce existing inequalities. Without targeted policy interventions, AI adoption may disproportionately benefit already advantaged institutions, thereby widening educational disparities.

In addition to access issues, concerns related to data privacy and algorithmic bias emerged as central themes. Participants expressed uncertainty regarding how their data are collected and used, reflecting broader societal concerns about transparency and digital surveillance. Furthermore, evidence of bias in AI grading systems particularly in relation to linguistic and cultural differences raises important questions about fairness and inclusivity.

These findings suggest that ethical considerations must be integrated into the design and implementation of AI systems in education. Effective governance frameworks should include transparent data practices, bias mitigation strategies, and equitable access policies.

Ultimately, the ethical integration of AI in education extends beyond technical

considerations and requires a multidisciplinary approach involving educators, policymakers, developers, and communities. Ensuring that AI enhances equity rather than exacerbates inequality is essential for maintaining trust, legitimacy, and fairness in educational systems.

5. Conclusions

The findings of this study underscore the transformative potential of Artificial Intelligence (AI) in education, particularly in enhancing teaching efficiency, personalizing learning experiences, and improving assessment practices. By automating administrative tasks, AI enables educators to devote more time to higher-order instructional activities and individualized student support. Additionally, AI-driven learning tools, including adaptive platforms and real-time feedback systems, contribute to improved student engagement and academic performance. In the domain of assessment, AI offers scalable and consistent evaluation methods, particularly for objective tasks, while highlighting the continued importance of human judgment in more complex and interpretive evaluations.

Despite these benefits, the study also identifies critical challenges associated with AI integration. Issues related to data privacy, algorithmic bias, and unequal access to technology highlight the need for careful and responsible implementation. These challenges demonstrate that the successful adoption of AI in education depends not only on technological advancement but also on ethical governance, institutional readiness, and equitable resource distribution.

The mixed-methods design of this study strengthens the validity of the findings by combining statistically significant quantitative results with in-depth qualitative insights. This approach provides both generalizable evidence and contextual understanding, making the findings relevant across a range of educational settings, from primary education to higher education institutions.

In terms of practical implications, the study highlights the importance of a balanced and strategic approach to AI adoption. Policymakers and educational leaders must invest in teacher training, infrastructure, and policy frameworks that promote transparency, fairness, and inclusivity. Furthermore, interdisciplinary collaboration between educators, technologists, and policymakers is essential to ensure that AI technologies are effectively aligned with educational goals.

Future research should address several key areas. Longitudinal studies are needed to evaluate the long-term impact of AI on student learning outcomes and teaching practices. Additionally, further investigation into bias mitigation in AI systems and strategies to reduce the digital divide will be critical for ensuring equitable access. Expanding research across diverse educational contexts and AI tools will also enhance the generalizability of findings.

Authors' Contributions

In this study, BIGIRIMANA Gentil conceptualized the research, designed the methodology and conducted the primary data analysis. GASHURWE Alpha Lib-

ertas contributed to the literature review, data collection and validation of the results, as well as drafting and revising the manuscript. NDAYISHIMIYE Richard provided critical insights, supervised the project and reviewed the manuscript for intellectual content and coherence. All authors discussed the results, approved the final version of the manuscript and agreed to its submission.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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