Artificial Intelligence in Higher Education: Literature Review

L'intelligence artificielle dans l'enseignement supérieur : Revue de la littérature

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Abstract

Artificial intelligence is a rapidly evolving technology in higher education. It is being integrated into the sector through a wide range of applications, each of which has a significant impact on the educational process. This impact can be both positive and negative.

On the one hand, artificial intelligence offers opportunities for personalizing learning and teaching, improving administrative services, and supporting mental health. However, its integration into higher education institutions raises challenges and ethical issues that threaten students' privacy.

This literature review aims to explore the different applications of artificial intelligence, as an innovative technology, in the academic field while highlighting its advantages and disadvantages as well as the challenges and issues it raises. It also addresses the guidelines for an ethical integration of artificial intelligence in higher education, highlighting the fundamental principles to ensure a responsible and respectful adoption of human values.

Keywords: artificial intelligence, higher education, personalized learning, chatbots

Résumé

L'intelligence artificielle est une technologie en pleine évolution dans l'enseignement supérieur. Elle est intégrée dans ce secteur à travers un large éventail d'applications, ayant chacune un impact significatif sur le processus éducatif. Cet impact peut être aussi bien positif que négatif.

D'une part, l'intelligence artificielle offre des opportunités de personnalisation de l'apprentissage et de l'enseignement, de l'amélioration des services administratifs et de soutien à la santé mentale. Toutefois, son intégration dans les établissements de l'enseignement supérieur soulève plusieurs défis et enjeux éthiques mettant la vie privée des étudiants en jeu.

Cette revue de la littérature vise à explorer les différentes applications de l'intelligence artificielle, en tant que technologie innovante, dans le domaine universitaire tout en mettant en lumière ses avantages, ses inconvénients ainsi que les défis et les enjeux qu'elle soulève. Elle aborde également les lignes directrices pour une intégration éthique de l'intelligence artificielle dans l'enseignement supérieur, en soulignant les principes fondamentaux pour garantir une adoption responsable et respectueuse des valeurs humaines.

Mots clés : Intelligence artificielle, enseignement supérieur, apprentissage personnalisé, chatbots

Introduction

Artificial intelligence (AI) is a growing technology that is redefining the contours of many industries, including higher education (1). It has a transformative potential in this sector, addressing the modern challenges that academic institutions face. Conventional teaching methods adopted are now insufficient or unsuitable for the growing needs of students and teachers, paving the way for AI as an innovative solution (2). AI, through platforms where it is integrated, offers personalized recommendations and solutions, adapting learning to the different styles and rhythms of students, while also automating administrative tasks. However, its integration within universities poses significant challenges that require careful planning and raises ethical concerns, particularly regarding human rights and equity (1).

This literature review aims to analyze the impact of AI on university education. This involves exploring all its facets, including applications, advantages, disadvantages, challenges, and issues.

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ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION

Challenges faced by the traditional university system, such as crowded classes, lack of personalized attention for learners as well as differences in learning paces and styles have given rise to the need to complement, enrich, or sometimes replace conventional teaching methods with innovative AI-driven tools and approaches (3).

Two major factors, which are the release of OpenAI®'s ChatGPT® and the increase in virtual learning following the COVID-19 pandemic, are primarily driving the global expansion of AI in higher education (4).

Definition of AI in Higher Education

In the academic context, AI is referred to as "computer systems capable of performing human-like processes, such as learning, adapting, synthesizing, self-correcting, and using data to accomplish complex processing tasks."(5).

Applications of artificial intelligence in higher education

AI's applications in education aim to personalize learning by adapting the educational environment to the specific needs of learners, taking into account their knowledge, learning style, emotional state, and interests (6).

Intelligent tutoring systems: Intelligent tutoring systems leverage AI algorithms to simulate human tutors, optimizing learning through personalized support (7). These systems can monitor students' progress, provide feedback and recommendations, suggest educational materials, and select suitable exercises or tasks to promote their learning (8).

Notable examples of intelligent tutoring systems include ALEKS®, AutoTutor®, MATHia®, and MetaTutor® (9).

Adaptive learning systems: Adaptive learning systems are AI-powered systems that combine multiple elements to deliver a personalized learning experience. They model learners by creating individual profiles based on data such as assessment scores and learning preferences (10). Alta®(https://www.knewton.com/why-alta) is an adaptive learning solution offered by Knewton (11).

Gamification: Gamification, in its essence, is not an adaptive learning system. It simply integrates playful elements to enhance learner engagement and motivation. However, when
combined with AI, it gives rise to an adaptive learning system in the educational context (12). AI-powered gamification platforms provide intelligent feedback and assessment mechanisms. Instead of traditional grading, students receive real-time feedback on their performance in the game (12). An example of a popular application is Duolingo® (13).

Recommender systems : Recommender systems are sophisticated software tools that leverage AI techniques to provide a selection of relevant items that are perfectly aligned with an individual's specific interests. These systems analyze user behaviors and preferences to deliver personalized suggestions that improve the user experience and facilitate the discovery of new content (7).

Automated Essay Scoring: Automated Essay Scoring (AES) is a computer system that scores students' responses based on criteria such as grammar, style, and content and uses natural language processing and machine learning techniques to evaluate essays. A notable example of AES that uses natural language processing techniques is E-Rater®, proposed by Powers et al. to evaluate essays, with a focus on style and content (14).

Automatic Short Answer Grading: Automatic Short Answer Grading is another educational application of AI. Students submit short answers, which are evaluated by machine learning algorithms (15).

Automated Writing Assessment: Automated Writing Assessment (AWE), an AI-based tool, is beneficial for both teachers and students. It assesses the writing of academic learners and provides formative feedback that complements traditional assessment methods (16). An example of AWE software is Grammarly®, which corrects grammatical, spelling, and punctuation errors, while also offering synonym suggestions and detecting plagiarism. According to a study by Ghufron & Rosyida, Grammarly® helps reduce writing errors among students, improving the quality of their written work (16).

Plagiarism detection: In the scientific and academic field, plagiarism is considered a major academic and ethical violation, since it constitutes theft of intellectual property (17). Turnitin® software is an AI-driven tool specifically designed to verify the originality and authenticity of students' work. It is primarily intended for classroom use, allowing students to review their work before submitting it, while also providing teachers with a way to detect plagiarism in submissions. Turnitin® software searches databases and the internet while comparing students' work with millions of other works in its database (18).

Learning Management Systems: A Learning Management System (LMS) is a software designed to digitally manage various aspects of educational programs, such as managing, tracking, and reporting on the learning process. These platforms enable higher education institutions to provide an online learning environment that supports course delivery, student-teacher interaction, progress tracking, and performance assessment. The synergy between LMS and AI offers a significant transformational opportunity for education (19). Techniques such as natural language processing can help learning management systems by enabling deep search strategies to create content that reflects learners' actions. Students will then be able to use the virtual learning management system to access learning materials that are tailored to their learning style. This will promote greater learner engagement in using the program (20). Examples of learning management systems are Blackboard®, Moodle® (20).

Profiling and Prediction: Profiling and prediction are AI applications in higher education. They allow students to anticipate their learning outcomes, provide improved control over their educational journey, and help faculty identify and support at-risk students, which helps reduce the risk of academic failure (6). Some universities collaborate with companies like Civitas Learning® (https://www.civitaslearning.com) to predict student success rates

as well as those who may be at risk of failure or dropping out (21).

Educational chatbots: The conversational unit or AI-based chatbot is a program designed to imitate human conversation through text or voice interaction. It is used in various fields, including higher education, to convey information naturally. Modern chatbots, such as ChatGPT® and Google Bard®, are among the most sophisticated chatbots. Other chatbots, such as Ada® for tutoring, which answers questions and provides personalized feedback, or Replika®, which acts as a companion for students by listening to them, offer support services tailored to the needs of learners (22).

Cobots: Cobots represent an important application of AI in university education. They act as teaching assistants. Cobots can perform teaching tasks ranging from basic exercises, such as learning to read, to more complex activities. They can think, make decisions, and interact with students, thus providing a more personalized learning experience (23).

Humanoid Robots: Over the past decade, thanks to rapid advances in deep learning and generative artificial intelligence, humanoid robotics has seen remarkable progress, demonstrating exceptional performance in various fields and applications (24). AI gives humanoids and other robots cognitive, decision-making, and communication abilities, allowing them to become effective tools for teaching and learning. These robots, whether autonomous or in collaboration with teachers, succeed in accomplishing various educational tasks, including the transmission of educational content, while providing personalized support adapted to the needs of each learner (25).

Virtual Reality: Virtual Reality can be described as the set of hardware and software technologies aimed at creating an immersive illusion that gives the impression of being transported to another environment. Key elements of these technologies include immersion, a sense of presence, and interactivity. This immersion improves the perception of time and user engagement. Virtual Reality is considered a 21st-century learning aid, allowing students to better retain and apply the information learned by increasing concentration. It also develops learners' cognitive, psychomotor, and emotional skills (26).

For example, in medical education, AI-assisted Virtual Reality has been used to train neurosurgery residents on various procedures (27).

Augmented Reality: Augmented Reality enriches the user experience by superimposing virtual elements on real objects.

Currently, it is being integrated into various levels of education and across many disciplines, providing active and collaborative learning experiences. It can be used for various applications such as teaching 3D anatomy, where virtual bone structures are superimposed on reality via a head-mounted display (28).

Another example of Augmented Reality being used in university education, it allows students to explore and manipulate three-dimensional molecular models to better understand organic chemistry (27).

Opportunities and challenges of artificial intelligence in university education

AI in higher education is a double-edged sword, as while it offers notable benefits, it also has drawbacks and raises several challenges (1).

The opportunities

AI has the potential to constructively influence the education sector and improve the educational process, teaching strategies, administrative efficiency, and student outcomes. Understanding the revolutionary impact that AI can have on educational institutions and their stakeholders relies on exploring the benefits outlined below (29).

Figure 1 summarizes some advantages of AI tools in higher education (15).

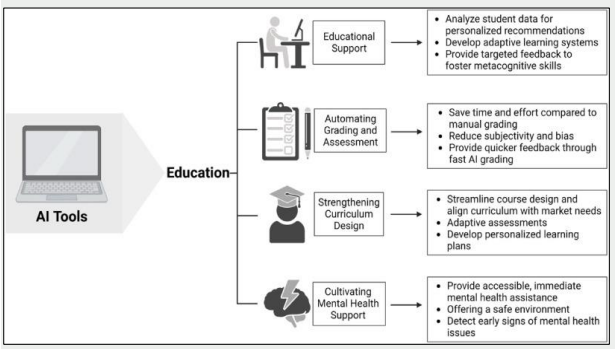

Figure 1. Opportunities of artificial intelligence in higher education

The student component

Continuous learning: AI-enabled platforms provide students with the opportunity for lifelong learning by allowing them to continue developing new skills even after their formal education ends (30).

Personalization of learning: Thanks to AI, traditional learning is evolving towards a more personalized, student-centered approach that adapts to their specific needs, allowing them to learn at their own pace (31).

Improved quality of learning: Personalizing learning improves student performance, which optimizes academic outcomes and strengthens skill acquisition (25).

Improved student engagement: By providing learning experiences that are both interactive and engaging, AI can increase student engagement and significantly increase their motivation to learn. For example, chatbots, which can interact with learners playfully and engagingly, make learning fun (31).

Access to advanced learning resources: AI can help expand access to advanced learning resources that are not available everywhere or are expensive (32).

Educational equity: AI helps reduce educational disparities, which is especially beneficial for regions with limited educational resources. The combination of AI and the internet allows students in remote areas to access top-notch teachers through online courses and facilitates

the exchange of educational resources (33).
Mental health support: AI models provide immediate and compassionate support and allow students to express their ideas in a safe environment. Additionally, by analyzing students' communication patterns, AI tools can detect early signs of stress, inform stakeholders about a student's mental health status, and lead to appropriate interventions (15). Furthermore, the use of AI in behavioral therapy allows for accessible, personalized, and effective mental health treatments, through tools such as chatbots, virtual reality, and machine learning algorithms. These approaches offer innovative ways to improve student well-being (34).
Improved collaborative processes: Virtual classrooms and AI-powered collaboration tools enable students to work together on projects, share ideas, and engage in constructive discussions, strengthening their critical thinking and teamwork skills (30).

The Teacher Component

Improving the quality of education: Studies have shown that the use of AI contributes to better achievement of educational objectives, not only improving quality but also increasing productivity in education (25).
Personalization of teaching: Through adaptive learning platforms, AI has successfully transformed the way educators teach from traditional standardized teaching to personalized teaching that responds to the pace of each learner (33).
Continuous professional development: AI can provide continuing professional development opportunities for teachers in a variety of ways. For example, AI systems can provide insights into a teacher's performance and highlight areas that require further development (35).
Minimizing workload: AI-powered automation of grading and assessment saves teachers time and effort compared to manual methods (15), allowing them to focus on the actual teaching and learning process (36).
Improving teaching performance: Teacher evaluation is essential to measure the quality of education, but it is complex. AI applications can help them by analyzing student comments, providing feedback to teachers, and suggesting improvements. AI uses text data to optimize teaching processes, improve performance monitoring, and develop relevant educational programs. It offers strategic insights to extract useful knowledge (37).

Administration component

Improved performance of management platforms: AI has significantly improved the performance of management platforms. These platforms have been made more secure by adding facial authentication for exams and portal management and have been made more efficient for administrators by assigning AI-enabled routines to tasks such as course scheduling and staff data management (38).
Optimizing administrative tasks: AI optimizes university operations by automating repetitive administrative tasks, such as student admissions and enrollment management, thereby reducing workload and increasing efficiency. It also analyzes large data sets to improve student recruitment, retention, and financial aid allocation. This leads to greater operational efficiency, reduced administrative errors, and an improved student experience (39).
Empowering smart campuses: AI is revolutionizing education by enabling smart campuses, where technology is transforming teaching and management methods. Facial recognition, voice interaction, campus security, classroom performance tracking, and dormitory management are improved. These technologies enable analysis of student behaviors, providing teachers with tools to adjust their teaching methods and accurately check attendance (33).

Academic research component

Task automation: AI applications in education play a vital role in higher education by automating various tasks, including academic writing and literature review, which are laborious tasks. This automation helps to reduce the burden on researchers and frees up their valuable time (15).
Research optimization: AI tools, which are designed to provide valuable suggestions regarding grammar, style, and coherence of texts, contribute to the improvement of scientific and academic research. Whether for writing articles, theses, or other types of academic documents, theses help refine the quality of writing, thereby optimizing the results obtained by researchers and students (40).
Enhanced creativity and innovation: By actively engaging in interaction with advanced models, including ChaGPT®, researchers have the opportunity to explore concepts that have not yet been widely studied and to challenge preconceived ideas. This interactive and creative process leads not only to innovative research avenues but also to the development of advanced methodologies that can transform the way studies are conducted (41).
Better access to diverse knowledge: AI-driven platforms that are involved in the field of academic research have a vast database and information that allows them to provide researchers with a wealth of knowledge covering various fields and disciplines. Its ability to access relevant literature, synthesize key information, and offer diverse points of view makes it possible for researchers to benefit from an opening to a wealth of knowledge and a wide range of fields and disciplines (41).

The challenges

However, despite the vast opportunities that AI offers in higher education, it could also present several potential risks and challenges. Here are some disadvantages of using AI in education (29).
Potential biases: AI systems used by higher education institutions may be biased, especially if they are based on biased data. This can lead to unfair treatment of some students and reinforce existing inequalities (31).
Loss of human contact: The lack of human interaction in an AI-orchestrated educational environment could result in a lack of emotional connection, which is fundamental to student development. Additionally, human teachers help develop skills such as critical thinking, creativity, and social skills that AI cannot provide (42).

Technology dependency: Increasing reliance on technology, and particularly AI, can reduce human thinking capacity, making students and teachers more dependent on technology and less able to think critically. This dependency reduces the mental effort needed for tasks such as planning and organizing and can lead to a gradual loss of intellectual skills and engender laziness (43).
Misinformation: Some AI tools like ChatGPT® can provide explanations that are in various scientific contexts and produce citations and sources of articles that are often incorrect and random. This raises concerns about the reliability of the information it communicates, as it represents a real risk of misinformation, particularly in sensitive areas where accuracy is imposed (44).
Lack of academic integrity: AI-generated works and texts may not be differentiated from human-generated content, making plagiarism detection more difficult, thereby posing challenges for higher education institutions to maintain intellectual and academic integrity (45).
Loss of student autonomy: Over-reliance on AI in decision-making can have significant impacts on student autonomy. By relying too much on AI systems to guide their academic choices, students may find themselves losing their ability to make informed decisions about their education (29).
Infrastructure and training costs: To deploy AI technologies in universities, governments are responsible for putting in place adequate infrastructure and the technologies needed to effectively support AI-based teaching methods, especially in resource-constrained areas (46).
In addition to the infrastructure, they must also fund the necessary training programs to enable stakeholders to acquire the skills needed to use these technologies effectively and ensure equitable access (47).
Maintenance costs: Deploying an AI-based model requires frequent updates, bug fixes, and technical optimizations, which can be costly and time-consuming, especially when some institutions lack technical expertise. Data management, including cleaning, annotation, and quality control, is also essential but can be costly in some educational settings (48).
Resistance to change: The adoption of new technologies, including AI tools, can be hampered by resistance to change within the academic community. Faculty and administrators may be reluctant to integrate these technologies into established practices, favoring traditional teaching and learning methods (49).
Artificial intelligence Literacy: Individuals must acquire basic AI literacy, known as AI skills. In addition, it is important to consider ethical and legal considerations as well as biases in AI. It is also essential to recognize not only the benefits but also the risks associated with AI (50).

Issues and Ethical Integration of Artificial Intelligence in Higher Education

Issues

The integration of AI in education raises important ethical and critical questions. As these technologies become more widespread in educational environments, it is essential to consider the ethical and practical considerations that arise (51).
Ethical considerations: The ethics of AI in education is a major issue that requires international collaboration (52). Neglecting ethical issues could lead to a lack of trust among educators, parents, and learners, hindering the effective application of AI (53).
Labor market disruption: AI application in higher education has the potential to reduce job opportunities for teachers (54).
Data security and privacy: The use of AI in education raises data privacy and security concerns. According to Khaled et al., personal data protection and security are major issues when using AI for educational assessments. The data collected can attract the interest of hackers, thus justifying strict regulations and adequate security measures (55).
Equity: Biases in AI algorithms that can perpetuate inequalities and compromise the fairness and effectiveness of AI-driven education systems (56).
Transparency: The opacity and inexplicability of generative AI models create challenges for students, who struggle to understand the reasons behind the results provided by these systems and correct their errors. For example, in educational AI applications, such as those used for teaching grammar, the complexity of the algorithms can prevent learners from understanding why a particular grammatical structure was generated (56).
Accountability: Integrating AI into university education raises questions of accountability. When teachers use AI systems, they share responsibility for the decisions made by these technologies (52).

Ethical integration of artificial intelligence in university education

To ensure that AI in education is implemented and used ethically, inclusively, and with a focus on positive learning outcomes for learners, a collaboration between policymakers, educators, and technology developers is needed to navigate these complex issues. This collaboration should focus both on the current application of AI and the development of clear and specific guidelines (53).
According to S. Ray and D. Ray (53), these guidelines (Table I) should serve as a framework to ensure that AI usage practices respect fundamental ethical principles.

Conclusion

To conclude, the integration of AI in the field of higher education is a revolutionary advancement that could profoundly reshape the educational landscape, replacing conventional teaching and learning methods with more intelligent and learner-centered approaches. This emerging technology offers a wide range of applications, ranging from personalized learning systems to interactive chatbots, offering innovative and powerful solutions to overcome the challenges of the conventional system. However, the adoption of AI by universities

may raise ethical challenges and issues related to student confidentiality and privacy, which requires the establishment of appropriate guidelines to ensure an ethical and inclusive integration of AI.

Table 1. Ethical integration of AI in university education

Challenges	Ethical principles
Data Privacy and Security	- Implement robust security measures. - Anonymize student data and comply with data protection laws. - Train stakeholders on the use of data.
Bias	- Select representative and diverse data sets. - Continuously check algorithms for bias. - Ensure transparency and algorithmic decision-making.
Transparency and explainability	- Build AI systems with transparency in mind so stakeholders can see the decision-making process. - Provide clear explanations for algorithmic results.
Informed consent	- Communicate the potential benefits and risks of AI applications to stakeholders. - Obtain informed and explicit consent before introducing AI technologies in an educational context.
Equity and Inclusivity	- Place inclusion at the center of the AI design process by considering the diverse needs of different student groups. - Regularly assess the impact of AI on different groups to ensure equitable outcomes.
Concerns about job loss	- Leveraging AI to support human teachers, not replace them. - Invest in professional development to optimize educators' use of AI.
Responsibility and accountability	- Establish accountability systems to define who is responsible at each stage of AI use. - Clearly define roles related to the use of AI. - Ensure that the final say in decision-making is retained by humans.
Digital skills and education	- Include courses on digital literacy and ethical AI. - Train teachers and ensure students understand the ethical implications of AI.
Continuous monitoring and evaluation	- Implement regular reviews, audits, and evaluations of AI systems to detect and address moral dilemmas before they become serious. - Foster an environment where progress is continuous.
Ethics	- Respect student privacy laws. - Obtain permissions and collect only the data necessary for educational purposes. - Provide explicit guidelines on data use and sharing.

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