A snapshot of the evolving landscape of artificial intelligence in education

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Abstract

The rapid advancement of artificial intelligence (AI) has led to remarkable breakthroughs in various sectors, such as healthcare, finance, and transportation. One particularly transformative area where AI has the potential to redefine our experience is education. Incorporating AI into educational settings can help to enhance student learning and support educators for example, to develop more personalised and efficient lesson plans. This contribution explores the various ways in which AI can support education, the potential obstacles it may present, and the possible future landscapes of AI as a component of education systems.

Keywords

Education, Competencies, Curricular, AI

1. Introduction

Education must keep pace with the rapid development of technologies and the constant access to vast amounts of new knowledge and information [1]. Improving 21st century skills is becoming increasingly urgent, especially to close the gap of the growing mismatch between students' actual competencies and the needs of the labour market [2].

However, educators often struggle to adapt their pedagogy to the complexity of modern societies [3]; and policies tend to lag behind due to the speed of technological advances [4].

In education, the discussion focused on how technology is affecting the relationship and effectiveness in the process of teaching and learning, particularly as artificial intelligence (AI) is increasingly used in educational systems [5]. Despite the impact of AI on our daily lives, most people do not fully understand AI and the decisions made by machine algorithms, or the role that humans play in the interaction with AI [6].

A statement from UNESCO's International Commission on the Future of Education [7] identifies key directions for change, including:

- Promote equity and shared prosperity in education systems by promoting inclusivity and reducing competition.
- Encouraging curricula that emphasis connections over categories by adopting interdisciplinary, intercultural, and ecological approaches within and beyond formal education.
- Support teachers to create transformative education by investing in teaching practices that promote cooperation and solidarity.
- Use digital technology to enhance connectedness to one another and to the world as a force for social solidarity, involving stakeholders in problem solving and solution development.
- Ensure that new technological paradigms are aligned with democratic values and inclusive, participatory practices to serve an interconnected human and planetary future.

These statements underline both: the great potential and the great risk of the use of AI in

education. The much-needed conversation about AI literacy has significant ethical implications and should address issues such as using AI to empower and enhance teaching and learning, assessing, and managing the educational process [8]. Pedagogical practices are affected in different ways by AI, this emphasizes the need of transversal human skills (creativity, complex problem solving, critical thinking, and collaboration) for supporting one's ability to communicate and collaborate with AI tools in life, learning, and work [9].

2. Areas of AI in education

As the technological landscape rapidly evolves, so do the demands on education, requiring a new set of skills for teachers and students. In particular, the development of digital literacy with a focus on AI and data literacy is needed to be aware of the potential and limitations of these technologies [10]. Education for AI includes broader teacher and learner competencies to provide the necessary knowledge and attitudes to engage with AI in a confident, critical, and safe way, without necessarily requiring a specific background in mathematics or programming [11]. Education with AI focuses on how AI can enhance the teaching and learning process. This domain requires knowledge of how the methods and technologies used can best work together in a defined context to enhance the teaching and learning of specific content [12] and can be briefly described as the process of differentiation [13] or personalisation [14] of teaching and learning. Education about AI focuses on the fundamentals of AI and requires knowledge of processes like programming or machine learning as a key to preparing students for the labour market and is often discussed as a topic in a renewed curriculum [10].

2.1. Education for AI

Education for AI should include an introduction to AI, such as the definition and history of AI, as well as the importance and applications of AI in different fields. This should include providing basic knowledge about AI and its applications in everyday life, including basic principles of machine learning and deep learning, as well as common AI applications such as virtual assistants, recommendation engines and self-driving vehicles [15]. The content should also explore the characteristics of different data types, data formats, and data sources. It should also consider issues such as privacy and ethics in data collection, storage, and bias and fairness in the use of AI algorithms [16], as AI literacy and digital citizenship, as it should include examples of responsible use of AI and data-driven technologies. Education for AI should raise awareness and recognition of potential biases and limitations of AI systems, as it should discuss the reliability and quality of AI-generated content, such as deep fakes or fake news [17]. It could be beneficial to introduce students to exploratory data analysis methods, including descriptive statistics, data distributions, data visualisation techniques and tools such as bar charts, pie charts and scatter plots, as well as making data-driven decisions based on analysis and visualisation. Education for AI should equip learners with AI literacy and digital citizenship skills to enable responsible use of AI and critical evaluation of AI-generated content. By integrating practical data analysis methods and real-world examples, students can better understand and navigate the increasingly AI-driven world [18].

2.2. Education with AI

Education with AI includes the use of digital educational tools, to support and enrich the learning experience as engaging alternatives for students to foster innovative teaching and learning methods that were generally unattainable before the development of such technology [19]. The successful integration of AI tools into lesson plans, needs a profound knowledge about how AI can be used to personalise learning, provide feedback, or enhance peer collaboration [12].

Personalised learning is a strategy that potentially could be facilitated and benefit most using technology [20]. Educational technologies have helped to overcome the challenges of personalisation in standardised education systems, which often relied on a one-size-fits-all approach, by managing personalised learning aspects and providing tailored learning activities [21]. Furthermore, digital educational tools have evolved to address students' self-regulated learning capabilities, empowering them to make effective choices that improve learning outcomes and efficiency and can detect when students are using inefficient strategies and provide recommendations to guide them towards more effective learning paths [22]. AI could be also

useful tool to connect students' learning experiences with their values and personal interests, resulting in higher course completion rates, increased work pace, reduced disengagement, and improved learning outcomes [23]. The use of simulations and games in the classroom, for example, enables teachers to illustrate complex systems to students, while allowing students to explore and interact with these systems independently. Combining immersive simulations or games with teacher-led explanations can help students bridge the gap between informal, practical understanding and formal, academic understanding [24]. It is crucial for teachers to be aware of ethical considerations such as bias, fairness and transparency of AI, while regularly evaluating the effectiveness of AI tools in the classroom to ensure that learning objectives are met, and the educational experience is enhanced [25].

2.3.   Education about AI

Understanding how AI applications work can be complex, as they often use multiple AI techniques that require highly technical knowledge [26]. The report 'K-12 AI curricula - A mapping of government-endorsed AI curricula' [7] identifies three key areas for education about AI:

Understanding the fundamentals of AI, including topics such as algorithms and programming, data literacy, and contextual problem solving. This covers skills such as managing the data cycle, from collection to analysis and reporting and data literacy, to understand the ethical and logistical challenges associated with the societal role of AI. Contextual problem solving, includes design thinking and project-based learning, to enable students to apply AI as a solution to business or societal challenges.

Understanding ethics and social impact, including topics such as the ethics of AI, the social or societal impact of AI, and applications of AI in fields other than ICT. These topics include skills such as understanding ethical concepts of AI such as transparency, fairness, accountability, and awareness of unethical or illegal applications of AI. Understanding the societal implications of AI enables the exploration of adaptations to regulatory frameworks, changes in the workforce and new governance mechanisms. This competence also includes awareness of the applications of AI beyond computing in areas

other than ICT, such as art, music, social studies, science, and health, so it is important to consider its impact in different areas.

Understanding, using, and developing AI includes topics such as understanding and using AI techniques and developing AI technologies. This covers skills such as developing theoretical knowledge of AI processes such as machine learning, deep learning, and neural networks, and using existing AI algorithms for specific tasks. AI technologies such as NLP and computer vision as human-oriented applications as a field of experimentation, research, and study. The development of AI technologies is a specialised field that requires expertise in programming, mathematics, statistics, and data science to address societal challenges and develop innovative services.

Education about AI requires students and teachers to gain a comprehensive understanding of the fundamentals of AI, including algorithms, programming, data literacy and contextual problem solving. This will enable them to manage data cycles, apply AI to solve real-world challenges, and navigate the ethical and logistical complexities [27]. In addition, the ethical, social, and societal implications of AI in different domains should be grasp as the development of awareness of ethical concepts, legal frameworks and interdisciplinary applications. The understanding and use of AI techniques and the development of AI technologies require skills in theoretical knowledge, AI processes and specialised expertise in programming, mathematics, statistics, and data science [28].

2.4.   Other areas to consider

Following a non-exhaustive reflection on various fields of AI in Education, but nonetheless with an important impact on the system. For example, the use of AI for administrative functions in education. AI could have an important role to play in streamlining administrative functions within schools and universities, such as timetabling, staff scheduling, facilities management, finance, cybersecurity, safety, and security. By automating these tasks, AI can help optimise resource allocation and improve overall efficiency within educational institutions [29]. Teachers could be empowered by AI-driven tools supporting them by automating tasks such as grading assignments or monitoring attendance, allowing them to focus on more sophisticated

aspects of teaching [30]. AI can provide valuable insights into student performance, enabling targeted instruction and early intervention when needed. These tools have to potential improve the educational environment for both teachers and students [31]. For this scope also formative assessment systems, which have the potential to evaluate student learning and provide useful data to teachers and can be integrated to personalised learning platforms to minimise loss of instructional time while providing valuable feedback on student progress [3].

Nowadays the learning ecosystem is fragmented, there are multiple and different AI technologies operating independently of each other. This can lead not only to inefficiencies, but also to missed opportunities for collaboration and development. A scenario of an integrated learning experience, where AI technologies work together and communicate with teachers and school organization could be a tool to improve the landscape of the learning/teaching process in schools [32]. For this, it is imperative to ensure that all students benefit from AI advances in education, the digital divide and accessibility challenges must be addressed by investing in infrastructure development, promoting digital literacy. Designing AI tools with accessibility in mind can help bridge the gap and meet the needs of learners and close gaps not only for the diversity of aptitudes of learners but could also help overcome also ethnical and socioeconomic differences [33]. AI has the potential to promote inclusion and equity in education. However, developers must be mindful of equity and inclusion and design AI tools that are responsive to diverse learners, including those with disabilities and historically underserved populations. By focusing on these issues, AI can help create a more inclusive and effective educational experience for all students [34].

3. Conclusions

While there are certainly benefits to incorporating AI into education, it is important to also consider the risks and take steps to mitigate them. Algorithms essentially mirror the values of those who hold positions of power [35]. This means that when people create algorithms, they also create a set of data that reflects the biases embedded in society's history and systems, which ultimately translates into algorithmic bias. Despite the lack of explicit intention, gender and

racial biases can be observed in various AI-based platforms [36]. In the context of K-12 education, there are ethical concerns and challenges related to AI applications, including privacy, surveillance, autonomy, bias, and discrimination. Akgun and Greenhow [37] define four potential ethical and societal risks of AI applications in education:

Privacy: Exploitation of data via face recognition and recommender systems can compromise students' privacy.

Surveillance: Personalized learning systems and social networking sites can monitor students' activities.

Autonomy: Predictive systems can jeopardize students' autonomy and agency to govern their lives.

Bias and Discrimination: Automated scoring systems can perpetuate gender and racial biases and social discrimination.

In curriculum development, it is increasingly important to prioritise culturally relevant and responsive pedagogies. By focusing on students' knowledge, family backgrounds and cultural experiences, educators can create student-centred learning environments. Such environments allow students to express their own cultural and contextual experiences and to analyse, and disrupt existing power structure to foster social awareness [38].

Educating future generations to participate ethically in the development and use of AI will require more professional development for K-12 teachers, including both pre-service and in-service training [39]. Sustained professional learning can provide teachers with suggested curriculum resources and teaching strategies, while fostering a community of practice where they can share and critically reflect on their experiences with other educators. In addition, further research is needed to identify reflective teaching practices and students' meaning-making processes in relation to AI and ethics education.

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