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Role and impact of artificial intelligence in higher education: A comprehensive study

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Abstract
Artificial intelligence (AI) is technology that enables computers and machines to simulate human intelligence and problem-solving capabilities. Artificial Intelligence has been used commendably in numerous areas like Marketing, Healthcare, agriculture, education, banking, entertainment, Industries etc. Due to a lot of advancements in computing and information processing technologies, Artificial Intelligence has extensive applications in education sector. AI has valuable implications for learners, educators, policy-makers and other stakeholders in the education field. This article reviews the role of AI in education and explores the impact of AI on education by analyzing its effects on teaching, learning, assessments, administration, and future careers. AI is transforming learning as well as teaching process to a great extent. AI has the potential to revolutionize education by personalizing teaching methods to suit individual student needs, providing prompt feedback, and automating administrative tasks. It can also assist in grading and assessment, freeing educators to focus on developing curriculum and providing quality instruction. As in the future the requirement of technically trained human resources is undoubtedly going to increase, many researchers' emphasis on the effectiveness of AI in helping graduates to develop requiring skills for their future careers. Although AI is transforming education system in so many constructive manners but There are several challenges as well, like privacy issues, technical feasibility, accessibility, regulatory concerns, ethical issues, infrastructural issues etc. Even though dealing with all the challenges, AI is playing a significant role in transforming the education sector according to future needs.

Keywords: Artificial intelligence, education, learning, teaching, administration

Introduction

The term artificial intelligence was first coined by John McCarthy in 1956, during the Dartmouth Conference, Although, modern AI have come into existence in 1936 when Alan Turing designed the first algorithm-using machine that demonstrates intelligence like human beings such as learning, logical reasoning and problem-solving etc. [1]. Artificial intelligence is a field of technology, research and innovations that have culminated in computers, machines, and other artifacts having human-like intelligence characterized by cognitive abilities, learning, adaptability, and decision-making capabilities [2].

In various definition of AI researchers describe similar elements or characteristics of AI. AI has been defined as a theoretical framework guiding the development and use of computer systems with the capabilities of human beings, more particularly, intelligence and the ability to perform tasks that require human intelligence, including visual perception, speech recognition, decision-making, and translation between languages [3]. Pokrivcakova, description of AI is mainly orientated to the education sector, he observed that AI is as a results of many decades of research and development bringing together data scientists, product designers, system designers, statisticians, psychologists, education experts linguists, cognitive scientists, and many others to develop education systems with some level of intelligence and ability to perform different functions, including to help teachers and support learners to develop their knowledge and flexible skills for a constantly changing world [4]. Similarly, Wartman *et al*., defined artificial intelligence as the ability of computers and machines to mimic human cognition and actions [5]. These definitions and descriptions of AI encompasses that Intelligence or machine ability to demonstrate some level of intelligence and perform a wide range of functions and capabilities that require human-like abilities, comes out as a key characteristic of AI [6].

Now days, the use of Artificial Intelligence has increased the capabilities of various organizations by helping them improve their productivity, business strategies, administrative work, revealing the consumers preferences. So, Artificial intelligence (AI) has been a topic of growing interest and research in numerous fields, including education. A lot of changes have implemented in the way in which education can be delivered and received. Many researchers suggest that AI has a positive impact on the learning experience by facilitating the acquisition of new knowledge and skills. It has potential to provide a better professional environment for learners, instructors and administrators. As an assessment tool AI can be used in grading assignments, paper and exams. It also guides students to choose different content paths, and personalize learning according to their strengths and weaknesses.

Numerous researches and advancement in artificial intelligence technology, has helps tutors to execute their duties more efficiently and effectively. These technological innovations have also significantly improved administration, management and other sectors of the academia. Incorporation of artificial intelligence in education sector has had an extensive impact, including personalized and global learning, smarter content availability, improved effectiveness and efficiency in teaching and administration [7]. New approaches of application of AI in education sector emerge due to new researches and innovations. The increasing applications of AI in education require interdisciplinary approaches, while most AI research is

carried out only in science and technology fields [8, 9]. Many researchers and educators have consistently emphasized on the lack of educational perspectives in AI research [10, 12].

The main objective of this study is to analyses the impact of AI on various aspects of education, like teaching and learning, assessment and grading, administration and future careers etc. This study provides insights into the potential of AI to transform education system, challenges in implication and its contribution to the development of overall education sector.

Ai Impact on Higher Education

The study ascertained that AI has extensively been adopted and used in education, particularly by education institutions, in different forms. AI initially took the form of computer and computer related technologies, transitioning to web-based and online intelligent education systems, and ultimately with the use of embedded computer systems, together with other technologies, the use of humanoid robots and web-based chatbots to perform instructors' duties and functions independently or with instructors. Using these platforms, instructors have been able to perform different administrative functions, such as reviewing and grading students' assignments more effectively and efficiently, and achieve higher quality in their teaching activities. On the other hand, because the systems leverage machine learning and adaptability, curriculum and content has been customized and personalized in line with students' needs, which has fostered uptake and retention, thereby improving learners experience and overall quality of learning [2].

With respect to AI-related learning network, Squeeze Net, Mobile Net, and Shuffle net are well developed for mobile phones [13]. The technical development of AI in mobile devices takes mobile education to the higher level, which provides convenience by helping student in less time and achieves interactive and personalized learning. For instance, virtual reality facilitates the learning process beyond the learning space to create a global classroom m since AI can connect students to the virtual classroom. In addition, AI-based chatbots provide a personalized online learning, and also turn instructor into chat conversations. This technology can assess the students' level of understanding.

Similarly, the web-based and online education, as enumerated in different studies, has transitioned from simply availing materials online or on the web for students to simply download, study, and do assignments to just pass, to include intelligent and adaptive web-based systems that learn instructor and learner behavior to adjust accordingly, to enrich the educational experience [14, 16, 18, 19].

Making similar observations and arguments, Sharma *et al*. observed that AI in education has taken the form of adaptive learning systems, intelligent tutoring systems, and other systems that improve the quality of administrative processes, instructions, and learning [6, 13]. Other important findings, from a further scouring of the different sources, is that the application of AI in education, from the analysis, presents an opportunity to break the physical barriers posed by national and internationally borders because learning materials are now domiciled on the Internet and the World Wide Web. Learning online or use of web-based learning platforms means that the material is accessible from anywhere in the world, and leveraging other aspects of AI, such as language translation tools, make it possible for students, to learn best within the context of their individual abilities.

Researchers have voiced concerns about the absence of educational theories and models, as found in AI-enabled e-learning research published in the past two decades [16]. It is also worth noting that AIEd innovations remain at the early, experimental stage, and there are few collaborations with educational institutions in related interventions such as AI enabled adaptive systems [17]. As a result, there has been a critical gap between what AIEd technologies could do and how they are actually implemented in authentic educational settings [18].

This study seeks to assess how the use of AI, in its different forms, in education, has impacted or affected different aspects of education. More particularly, the study will seek to assess how AI has affected teaching, learning, and administration and management areas of education. This section of the report provides an overview and brief discussion of the results of the study from a review of various articles that have assessed the nature and impact of artificial intelligence in the education sector.

1. Learning

Learning, which is an integral part of education, is another aspect of education that is within the scope of the study. From an evaluation and analysis of the different articles included in the study, different ways in which AI has been adopted and implemented or leveraged in fostering students' learning were identified. An important way in which AI has been applied in improving students' learning is the customization and personalization of curriculum and content in line with the learners needs, abilities, and capabilities [15]. Other approaches give learners a more pleasant and involving or experiential learning experience, therefore improving the learners' uptake and retention of information, the foundation of learning [19]. From another perspective, AI in education has also eliminated some barriers to access to learning opportunities, such as national and international borders, enabling global access to learning through online and web-based platforms [13, 15]. From the articles, different platforms and applications were identified. Some platforms will foster the customization and personalization of content and in so doing foster the uptake and retention of information, which improves the learning experience of the learner. For example, an application such as K newton makes real-time recommendations for students premised on deciphered learning style as adduced by the technology using machine learning algorithms, and subsequently customizes course materials or content to the learners' needs [11]. Other platforms with similar capabilities include Cerego, Immersive reader, and CALL, which together with other platforms, have the potential to improving the learning experience of learners at all levels of the education system, from early childhood education to university undergraduate and graduate level [11, 14]. Pokrivcakova also observed that the integration of AI and use of chatbots also improve the learning experiences of students because they leverage machine learning algorithm and deliver content customized to students learning needs and capabilities [14]. Mikropoulos also highlights the same concept, observing that virtual reality and simulation fosters students improved learning experiences [15]. Other uses of AI in fostering the students' learning experience are the use of AIWBES. AIWBES is more adaptive and generates content that is based on the learner's needs [18]. The same capabilities of AI in web-based education are highlighted and discussed by Peredo *et al*., who observed that IWBE or intelligent and adaptive

web-based systems, particularly multi-agent systems (MAS) have a learner component, with the learner integrated as a social agent, in which the system focuses on understanding learner behavior and adjusting accordingly by generating content relevant to the learners' needs [19]. Evidently, AI integration or adoption and use in education has been focused in improving the learners' experiences, as well as having a major impact on other aspect of the education process.

AI-aided education includes intelligent education, innovative virtual learning, and data analysis and prediction. Note that AI-enable education is playing a more important role as learning requirements promotes [20]. Intelligent education systems provide timely and personalized instruction and feedback for both instructors and learners. They are designed to improve learning value and efficiency by multiple computing technologies, especially machine learning related technologies [18], which are closely related to statistics model and cognitive learning theory.

Various techniques are incorporated into AI system for learning analysis, recommendation, knowledge understanding and acquirement, based on machine learning, data mining and knowledge model [21].

2. Teaching

In particular, for student assessment, image recognition and prediction of machine learning can be used to grade student assignments and exams, with faster and more reliable results than human being. More specific application of AI in education, as evidenced form the different articles reviewed takes different forms. Chassignol *et al*. highlighted the extensive application of AI in different areas, including content development, teaching methods, student assessment, and communication between teacher and students [11]. For example, according to the study by Chassignol *et al*. AI has been extensively applied in curriculum development and content personalization, teaching and pedagogical methods, assessment, and communication exchanges between teachers and students. Chassignol *et al*. provide examples of different platforms and applications of AI, such as Interactive learning environments (ILEs), which are used to manage performance and provide feedback and exchanges between teachers and students; Intelligent tutoring systems, such as ACTIVE Math, MATHia, Why2Atlas, Comet, and Viper which have been used at different levels of the education system to by educators or instructors for different subjects at different levels of education, as well as extensive use in learning assessment to track performance and improve the available pedagogical tools [3, 11]. Similar applications are evident in other studies.

From the analysis of the articles identified and included in the analysis, one of the key areas that have seen an influx of AI systems, is teaching or instructions. AI has facilitated the creation and deployment of systems that are evidently very powerful pedagogical tools. These tools have fostered improved instructional quality. Different platforms and applications of AI as an instructional tool are discussed and highlighted in the various articles evaluated. Timms discusses various applications of AI as a pedagogical tool or instructional platforms; simulation-based instructions, which include using different technologies, such as virtual reality to demonstrate or show students concepts or practically demonstrate materials, giving students an experiential or practical learning experience [22]. The same concept or the application of virtual reality elements as an element of AI in education is discussed in other studies. For example, Mikropoulos and Natsis highlight the use of virtual reality as well as including 3-D technology and highly interactive simulation as a pedagogical tool, which helps students have a better understanding of demonstrated concepts [19, 15]. Similarly, Wartman and Combs highlight the use of AI, in the form of virtual reality and simulation in medical education, which takes medical students through practical aspects of their education, such as operations and understanding human anatomy, among other subjects [5]. Other studies have also highlighted the integration of AI into machines or robots and creation of powerful instructional tools and improvement of the quality of the applied pedagogical strategies. Indeed, Timms highlights that another key form of application of AI in education as an instruction tool is the integration of AI in education principles in robots, the development and use of robots as teacher assistants and colleagues, cobots, which can be used to undertake basic and even advanced teaching tasks, such as teaching students to read and pronounce words [22, 7]. Indeed, Sharma *et al*. observed that the integration or the use of AI in education, more particularly, integration with other technologies and use as instructional tools, has resulted in the development and use of better teaching tools [6, 13]. On the other hand, Pokrivcakova also highlights the integration of AI into computer programs, and the development and use of chatbots, or online computer-based robots with conversational and dialogue abilities to answer routine student queries, and in some instances, disseminate instructional materials [4, 14]. AI equips the humanoid or other robots with cognitive and decision-making abilities, as well as dialogue and conversation abilities, and subsequently, enable their use as instructional and pedagogical tools. Further, from the analysis of the articles, other ways of the application of AI in education were identified. For example, intelligent tutoring systems in different forms are discussed in different studies. For example, Rus *et al*. observe that intelligent tutoring systems or IT's equipped with conversational and dialogue abilities, as well integrated with animated conversational agents, in the form of chatbots or cobots, have fostered realization of effectiveness in teaching [20, 12]. The same concepts are also highlighted in the AI applications in education discussed by Pokrivcakova Computer-assisted language learning (CALL), which provides students or learners with customized instructions; as well as the writing and translation assistants in language learning [4, 14]. Other forms of application of AI in education, particularly, in instructions to perform teacher or instructor functions are also highlighted. Web-based education platforms integrating AI with instructor abilities are discussed by Kahraman *et al*. and Peredo *et al*. in their different publications. Kahraman *et al*. discuss the integration of AI in web-based education, more particularly, the use of AIWBES in teaching, and incorporating teacher-like functions, making the platform a powerful supportive pedagogical tool [14, 18]. Similarly, Peredo *et al*. discuss IWBE or intelligent and adaptive web-based systems, in which teachers are studied and presented as social agents in this system; the system then seeks to understand and support teachers in the discharge of their mandates, to provide instructions and directions to students, with an objective of ensuring that the technology, web-based education, used in education is efficient and systematic way to improve learner experience [15, 19]. AI has been integrated into different technologies and approaches

and used as a stand-alone instructional tool or to support instructors in the discharge of their teaching mandate.

AI education system generally consists of teaching contents, data and intelligent algorithm, which can be divided into two parts, i.e., system model (including learner model, teaching model, and knowledge model) and intelligent technologies [23]. Teaching model help to build data map is crucial for improving learning, which establishes structures and association rules for collected education data [24]. Model works as a core in AI system, with technologies providing power for the system.

3. Administration

In this section, a summary of the findings on the application of AI in education, with a particular focus on administrative functions is presented. One of the key areas in education, identified as likely to be impacted by AI, is the performance of different administrative tasks in the education process, such as students' assignments and papers reviews, grading, and providing feedback to students. According to Sharma *et al*. AI in education, particularly in distance and online education, where AI has enhanced efficiencies in institutional and administrative services [6, 13]. Indeed, specific programs, such as Knewton, ease the burden on instructors because they provide a platform for feedback to students premised on the interaction on the platforms. Similar positions are evident in other studies and publications, which discuss systems that make the administrative tasks easier. For example, Rus *et al*. posited that intelligent tutoring systems (ITSs) perform a wide range of functions, including grading and providing students with feedback on their work [20, 12]. Instructors, working with ITS achieve improved efficiencies in various administrative tasks, as well as their core responsibilities, providing guidance and instructions to help students excel in their studies. The findings and arguments by Mikropoulos and Natsis augment the arguments and findings in these studies; leveraging and using AI in education has fostered effectiveness and efficiency in the performance of administrative tasks, such as grading of students' assignments [19, 15]. Indeed, a scrutiny of the online learning environment today, shows programs that make it possible for instructors to perform various administrative tasks, such as Turn It in and give suggestive grading and check plagiarism on students' assignments. AI has improved efficiencies in the performance of different administrative tasks that instructors, would require a lot of time to perform in the absence of AI.

AI application in education, in its various forms and serving different functions, has had a major impact on the performance of administrative and management functions in education. It has enabled instructors or teachers to perform their administrative functions, such as grading and providing feedback to students more effectively. AIWBEs programs have incorporated functions that provide instructors with grading guides, which make it easier to grade students' work and provide feedback [14]. AI has made the performance of administrative tasks easier and improve teacher or instructor efficiency and effectiveness in providing instructions and guidance to students. Intelligent tutoring systems provide a wide range of functionalities that enable instructors to perform different administrative tasks, including grading and providing feedback [12]. Other programs, such as Grammarly, Ecree, Paper Rater, and Turn It in among others, which leverage AI also provide instructors with the functionalities to perform different administrative functions, including plagiarism checking, rating and grading, and providing students with feedback on improvement areas. AI, has significantly reduced the paperwork and workload on instructors, particularly in the performance of various administrative functions, thereby enabling them to focus on their core mandate, instruction, dissemination of content and materials in line with the curriculum in place at the institution or nationally [11, 13]. While this area of education was not a focus for many of the articles evaluated, in the articles it was covered, there was evidence of attainment of improvements in the administrative processes and tasks quality, as well as effectiveness and efficiency of the instructors or educators in the performance of various administrative tasks.

4. Carrer Opportunities

According to Wartman and Combs education is changing in tandem with changes in the employment or professional world, necessitating the incorporation of AI in instruction and learning. For example, there is heavy use of AI in the medical profession, which necessitates exposing students to AI through use of the technology in medical education to prepare them for the experiences in the real world [17]. The trend and arguments identified and presented by Wartman and Combs are echoed in other studies and publications, which demonstrate other applications of AI in education. AI will impact the future job market of required skillsets. It will replace many other studies that involve routine tasks and structures that are easy to automate instead of unstructured disciplines that require complex cognitive interference. AI or computer assessment is not limited to grading papers but can be the gateway to a future career.

Although all the values stated above about how AI is creeping into the career world, researchers criticise these aspects arguing that when it comes to soft skills such as empathy, communication, collaboration, innovation, critical thinking, problem solving, and leadership, AI is not as robust as human cognitive ability and reinforce their views by suggesting that higher institutions should provide soft and hard skills such as math, IT, and engineering while training students. Although computer-driven screening is believed to avoid biases in the traditional recruitment process, AI is not bias-free. That algorithm can favor candidates with time and money to continually re-tool their resumes. To end the conflict with a culminating result, it suggested that citizens of the new world order require new skills. These skills should include interpersonal skills such as adaptability, critical thinking, conflict resolution capabilities, and other cognitive skills.

5. Ethics and Policy Making-

The integration of Artificial Intelligence (AI) into higher education has brought transformative changes in teaching, learning, administration, and research. However, alongside its benefits, AI raises critical ethical concerns and necessitates robust policy frameworks to ensure its responsible and equitable use. Ethics and policy making play a central role in shaping how AI technologies are deployed in academic environments.

One of the primary ethical issues in AI-driven education is data privacy and security. AI systems often rely on large volumes of student data, including personal information, academic performance, and behavioral patterns. Without

proper safeguards, this data can be misused or exposed, leading to violations of student privacy. Institutions must ensure transparency in how data is collected, stored, and used. Another significant concern is algorithmic bias and fairness. AI systems can unintentionally reinforce existing inequalities if they are trained on biased datasets. For example, automated grading systems or admission tools may disadvantage certain groups of students. Ensuring fairness requires continuous monitoring, diverse data inputs, and ethical auditing of AI systems.

Academic integrity is also challenged by AI tools. While AI can support learning, it can also enable plagiarism or over-reliance on automated solutions, reducing critical thinking and originality among students. Educators must redefine assessment methods and encourage responsible AI usage. Additionally, there is the issue of human autonomy and decision-making. Overdependence on AI in academic advising or evaluation may reduce the role of human judgment. Maintaining a balance between AI assistance and human oversight is essential to preserve the educational values of mentorship and critical engagement.

Challenges

There are few challenges as well, like regulatory concerns, privacy issues, technical feasibility, accessibility, ethical issues and infrastructural issues. The privacy issues relate to the anonymous collection of data without the knowledge of the individual whose data is being captured, using such captured data for commercial purposes, keeping the data secure. Facial recognition technology is one of the common applications of AI, and with a high misuse potential. The Assessment methods which have been employed in the online education mode have potential to promote unfair means. Also, recording and storing a huge amount of data for a large number of examinees poses security issues, as well as infrastructural challenges. The investment required is huge, which many entities cannot simply afford.

Various firms in the private Education Technology (EdTech) sector have sprung up in the recent past, which use Artificial Intelligence enabled features on their platforms. The results which these platforms offer, however, are substandard and/ or doubtful many times. This calls for a regulatory mechanism in order to have accountability of these firms, and for the proper usage of the AI technology.

The presence of these challenges, however provides a scope for working towards them so that the benefits of Artificial Intelligence are available to all those involved in the Education. The work has to done by government, as well as the private sectors.

Conclusion

Implied therefore, and as adduced from the analysis, is that AI has majorly affected or had a major impact on the education sector in general, and in application in educational institutions. Teachers or instructors using AI or leveraging AI are able to achieve greater efficiency and effectiveness in the performance of different tasks, including completion of administrative tasks, such as reviewing, grading, and providing feedback to students on submitted assignments. In addition, working with AI or the different forms of AI, such as web-based and online intelligent systems, cobots, and chatbots, teachers are able to achieve improvements in instructional quality.

AI in education initially took the form of computers and computer-related systems, and later, the form of web-based and online education platform. Embedded systems have made it possible to use robots, in the form of cobots or humanoid robots as teacher colleagues or independent instructors, as well as chatbots to perform teacher or instructor-like functions. The use of these platforms and tools have enabled or improved teacher effectiveness and efficiency, resulting in richer or improved instructional quality. Similarly, AI has provided students with improved learning experiences because AI has enabled the customization and personalization of learning materials to the needs and capabilities of students. Overall, AI has had a major impact on education, particularly, on administration, instruction, and learning areas of the education sector or within the context of individual learning institutions.

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