

The impact of the use of artificial intelligence in the education sector

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Abstract

The aim of this study was to review the studies carried out on Artificial Intelligence and education. Various databases were searched for keywords artificial intelligence, education, vocational education, and education systems. These studies were shortlisted as per the year of publication. Studies talk about the pervasiveness of Artificial Intelligence today and its impact on education and teaching methods and learning systems. Many studies have talked about AI applications which aid in improving learning outcomes. Some studies have also highlighted the need to adjust vocational education training around the idea that AI would be phasing out many jobs in the coming decades.

Keywords: Artificial intelligence, impact, education, sector, review, trends

Introduction

With rapid advancements in Artificial Intelligence, and the growing pervasiveness of the same, the field of education has not remained untouched. Artificial intelligence is having a deep impact on education which is bound to continue in the decades to come.

Students and children, growing up in the age of artificial intelligence, have different expectations of Artificial Intelligence systems, which go a long way to improve educational outcomes. According to Williams, Park, Oh, & Breazeal (2019), children growing up in the era of artificial intelligence (AI) will have fundamentally different relationships with smart technologies than other. New AI-enabled interfaces that support interaction through gesture, touch, and speech allow younger and younger children to access digital content and services.

According to Chassignola, Khoroshavin, Klimova, & Bilyatdinova (2018), the educational landscape has also begun to change alongside developments in artificial intelligence. An increasing number of educational programs incorporate digital culture into the curriculum across the world. For example, in France, even primary schools provide some courses about internet technologies, while high school students must pass an exam proving their computer skills. Moreover, many educational facilities have Learning Management Systems (LMS) installed such as Moodle (Chassignola, Khoroshavin, Klimova, & Bilyatdinova, 2018).

Methodology

In this paper, we will review some of the research studies which have been carried out on the subject of Artificial Intelligence (AI) and education. Towards this end, specific search terms were used in Google Scholar search engine, such as “artificial intelligence” + “education”, “artificial intelligence” + “vocational education”, and “education systems”. The results of these searches were shortlisted as per the year of publication. For the purpose of this study, only studies published after 2000 were used, in order to review the studies on artificial intelligence and education.

Results and Discussion

According to Lufeng (2018), Artificial intelligence is an important innovation in the rapid development of modern Internet. In the 21st century, human beings have been continuously researching and exploring Internet information technology. All kinds of application forms of Internet informatization begin to appear in our life.

The use of AI in the day-to-day life across the world is increasing exponentially. For example, AI scientists are currently building on new approaches in machine learning, computer modelling, and probability statistics to improve financial decision making, and are using decision theory and neuroscience to drive the development of more effective medical diagnostics (Luckin, Holmes, Griffiths, & Forcier, 2016).

According to Tuomi (2018), one of the key roles of modern educational system is that it creates competences that allow people to participate in the economic sphere of life. Education, in this interpretation, is a key driver of economic productivity and competitiveness, and educational policies are framed in the context of economic growth. Therefore, it is imperative to inquire how AI will transform work and employment in context of educational policies (Tuomi, 2018). According to the study by Verma (2018), artificial intelligence is playing an increasing role in the research of educational technology, management sciences and operational research areas. According to Lufeng (2018), AI and education have a mutual relationship; it is primarily revealed in the following aspects:

- (a) First, the future of education development is contained in artificial intelligence and its development. According to Lufeng (2018), “the development of education from academic education to knowledge education is an inevitable trend”.
- (b) Secondly, AI’s continuous development is fostered through modern education and knowledge system. In recent years, the development of AI has been accompanied by the emerging concepts of Internet information technology. The AI’s foundation is computer program and basic data structures and its nature is human rational cognition. Lufeng says that computer science is a necessary link in the process of development of modern Internet technology intelligence. Hence, AI and education are complementary to each other, and they promote each other alongside improving the technological progress (Lufeng, 2018).

According to Luckin, Holmes, Griffiths, & Forcier, (2016), the application of artificial intelligence to education has been the subject of academic research for more than 30 years. The field examines learning in traditional classrooms and also, in workplaces, in order to support formal education as well as lifelong learning. “It brings together AI, which is itself interdisciplinary, and the learning sciences (education, psychology, neuroscience, linguistics, sociology, and anthropology) to promote the development of adaptive learning environments and other AIEd tools that are flexible, inclusive, personalised, engaging, and effective” (Luckin, Holmes, Griffiths, & Forcier, 2016).

According to Luckin, Holmes, Griffiths, & Forcier (2016), the algorithms and models that comprise Artificial Intelligence (AI) in Education form the basis of an essentially human endeavour. AI in education offers the likelihood of learning that is more personalised, customized, flexible, all-encompassing, and appealing. It can offer teachers and learners “the tools that allow us to respond not only to what is being learnt, but also to how it is being learnt, and how the student feels” (Luckin, Holmes, Griffiths, & Forcier, 2016). It can aid learners in

developing the knowledge and skills which are required by employers, and it can aid teachers in creating more sophisticated learning environments than would be possible otherwise. For example, AI in education which can aid collaborative learning, which is a herculean task for one teacher to do alone. It is done by making sure that the correct group is formed for the task-at-hand, or by providing targeted support at just the right time (Luckin, Holmes, Griffiths, & Forcier, 2016).

There are three key models at the heart of AI in education:

- (a) the pedagogical model – This model requires that the AI system knows about the effective approaches to teaching.
- (b) the domain model – This model requires that the AI system knows more about subject being learned.
- (c) the learner model – This model requires that the AI system knows about the student (Luckin, Holmes, Griffiths, & Forcier, 2016).

Adaptive Educational Systems

Various Artificial Intelligence (AI) techniques have been used in adaptive educational systems such as Fuzzy Logic (FL), Decision tree, Bayesian networks, Neural Networks, Genetic algorithms, and Hidden Markov Models (Almohammadi, Hagra, Alghazzawi, & Aldabbagh, 2017).

According to Almohammadi, Hagra, Alghazzawi, & Aldabbagh (2017), there are several methods in which AI approaches are used in adaptive educational systems. For example, in some systems, the primary focus is to scrutinize and evaluate student characteristics to generate profiles of students with the aim of assessing their overall level of knowledge, which could be used as a foundation for prescribed software pedagogy. “AI approaches are also used to facilitate the diagnostic process completion so that course content can be adjusted to cater to the needs of every student, and some of them are used to learn from the student behaviours to adjust the prescribed software pedagogy” (Almohammadi, Hagra, Alghazzawi, & Aldabbagh, 2017).

Intelligent Tutoring System

According to Luckin, Holmes, Griffiths, & Forcier (2016), Intelligent Tutoring System (ITS) “use AI techniques to simulate one-to-one human tutoring, delivering learning activities best matched to a learner’s cognitive needs and providing targeted and timely feedback, all without an individual teacher having to be present”. A few of the ITS give control of learning to the learner in order to help the students foster self-regulation skills. Other tutoring systems use pedagogical strategies to support learning so that the learner is appropriately challenged and reinforced (Luckin, Holmes, Griffiths, & Forcier, 2016).

Recently, many of the ITS use machine learning techniques, self-training algorithms based on large data sets, and neural networks, to allow them to make suitable decisions about what learning content to provide to the learner (Luckin, Holmes, Griffiths, & Forcier, 2016).

According to Luckin, Holmes, Griffiths, & Forcier (2016), modern day model-based adaptive systems can be far more flexible as they aid the rationale for each decision taken by the system to be made obvious and understandable by humans. This makes them applicable to classroom teaching. Over the previous decade, numerous adaptive tutors have been able to support the individualization of learning with the help of the increasingly sophisticated learner, pedagogy, and domain models (Luckin, Holmes, Griffiths, & Forcier, 2016).

For example, the iTalk2Learn system¹⁶ which is designed to help young students learn about fractions. It uses a learner model that includes information about the learner's mathematics knowledge, their cognitive needs, their affective (emotional) state, along with the feedback they had received and their responses to that feedback (Luckin, Holmes, Griffiths, & Forcier, 2016).

According to Luckin, Holmes, Griffiths, & Forcier (2016), model-based adaptive tutors can include a range of AI in education tools that:

- “Model learners’ cognitive and affective states
- Use dialogue to engage the student in Socratic learning experiences, that is learning experiences that involve enquiry and discussion, questioning and answering
- Include open learner models to promote reflection and self-awareness
- Adopt meta-cognitive scaffolding (for example, by providing dynamic help or using a narrative framework) to increase learner motivation and engagement
- Use social simulation models – for example, to enable language learning students to engage more successfully with speakers of their target language by understanding cultural and social norms” (Luckin, Holmes, Griffiths, & Forcier, 2016).

Collaborative Learning

According to Luckin, Holmes, Griffiths, & Forcier (2016), long-term research has identified that any kind of collaboration (between a pair of students undertaking a project together or a community of students participating in an online course) can facilitate better learning outcomes than simply learning alone.

Collaborative learning is effective because it motivates participants to “articulate and justify their thinking, to reflect on other explanations, to resolve differences through constructive dialogue, and to build shared knowledge and meaning” (Luckin, Holmes, Griffiths, & Forcier, 2016). According to Luckin, Holmes, Griffiths, & Forcier (2016), collaborative learning can also improve motivation. If students care about the group they are in, they become more involved with the task and hence, achieve better learning outcomes. “Research also suggests that collaboration between learners does not happen spontaneously” (Luckin, Holmes, Griffiths, & Forcier, 2016). For example, group members might not have the social interaction skills required to collaborate effectively. This can be especially difficult in relation to online collaborations, where participants rarely meet in person. This is where AI in education can contribute (Luckin, Holmes, Griffiths, & Forcier, 2016).

According to Luckin, Holmes, Griffiths, & Forcier (2016), several approaches have been investigated and these include:

- (a) Adaptive group formation - This approach uses AI techniques and knowledge about individual participants, most often represented in learner models, to form a group which is the most aptly suited for a particular collaborative task. Here, the aim may be to design a group of students who are all at a similar cognitive level and have similar interests. Hence, the participants bring different but complementary knowledge and skills (Luckin, Holmes, Griffiths, & Forcier, 2016).
- (b) Expert facilitation – According to Luckin, Holmes, Griffiths, & Forcier (2016), here models of effective collaboration – known as ‘collaboration patterns’ – are used to provide interactive support to the collaborating students. These patterns are either provided by the system authors or mined from previous collaborations. For example, AI

techniques such as machine learning or Markov modelling have been used to identify effective collaborative problem-solving strategies. Then, these are used to train systems to recognise when students are facing problems understanding the concepts that they are sharing with each other, or to provide targeted support of the right form at the right time. They can also show students (and their teachers) how well an individual is contributing to group works (Luckin, Holmes, Griffiths, & Forcier, 2016).

- (c) Intelligent Virtual agents - A third approach involves intelligent virtual agents which are introduced into the collaborative process (Luckin, Holmes, Griffiths, & Forcier, 2016). These AI agents might mediate online student interaction, or simply contribute to the dialogues, by acting as:
- An expert participant (a coach or a tutor)
 - A virtual peer (an artificial student at a similar cognitive level to the learner, but one who is capable of introducing novel ideas)
 - Someone the participants might themselves teach – for example, the artificial student might hold deliberate misconceptions, or provide alternative points of view to stimulate productive argument or reflection
- (d) Intelligent moderation - With large student numbers working in multiple collaborative groups, it can be impossible for one person to handle the large volume of data that the participants are generating in their discussions. Intelligent moderation utilizes AI techniques such as machine learning and shallow text processing to analyse and summarise the discussions in order to equip a human tutor to guide the students towards productive collaboration (Luckin, Holmes, Griffiths, & Forcier, 2016). For example, the system might provide alerts to human tutors to inform them of significant events (such as students going off topic or repeating misconceptions) that may require their intervention or support.

Expert System Applied to Education

According to Lufeng (2018), the Expert System is one of the oldest (most mature) and most researched field in AI application research. It can be described as a type of intelligent computer program system with a lot of knowledge and experience in a specific field. Lufeng (2018) says that “as a program system, it is characterized by the ability to make inferences and prejudgments based on past events and experiences, and to reveal the results of reasoning reasonably”.

Various problems in the field can be resolved using the expert system. According to Lufeng (2018), “due to its strong data storage and analysis and calculation ability, it can improve the fact that human brain has individual differences in forgetting and logical correlation, and form reasonable inference and discrimination based on previous facts and experience”.

Expert systems consist of databases, inference engines, interpretation agencies, and knowledge acquisition agencies such as why the system presents this problem to the user, and how the computer reaches its final conclusion (Lufeng, 2018). Domain experts or knowledge engineers comprehend knowledge acquisition in expert system through specialized software tools or programming, and constantly augment and perfect knowledge in knowledge base. By storing the knowledge and experience of experts in the field in advance, a large database with rich content can be formed. Lufeng (2018) says that users can interact with the expert system “in advance through the human-computer interaction interface”. “Through this interactive process, users' learning will leave out the process of selecting useful information in the redundant library data

and expert experience, and directly enter the implementation pre-judgment process based on expert experience” (Lufeng, 2018). It greatly improves the efficiency of learning.

According to Lufeng (2018), schools can help estimate the statistical distribution of students' learning content, learning efficiency and learning habit by introducing an intelligent teaching expert system, focusing teachers' previous teaching experience and wisdom and using virtual reality or human-computer interaction. At the same time, it can also be based on the effective teaching method to avoid the mistakes that students often make in the learning process and the mistakes that students enter into. In addition, the application of expert system to assist the completion of online teaching is also the key to the development of the combination of artificial intelligence and education. Traditional network teaching relies on Internet resources, which is characterized by large quantity and uneven quality levels in resource sources. Therefore, it is difficult for students to successfully concentrate on the learning process in order to improve learning efficiency (Lufeng, 2018).

According to Lufeng (2018), “after the application of expert system, by combining expert system for the operation of the network education system, students' cognitive situation, build a unified study of cognitive model, and generate a report of individual poor student take targeted guidance strategy and intelligent fault diagnosis, help students' better formation of adaptive learning, the network teaching resources further restricted the application of the terminal, to help students achieve intensification of learning”.

Vocational Education

According to Ma (2019), with the development of artificial intelligence, vocational education has unparalleled development opportunities. The author says that the influence of artificial intelligence on vocational education is deep and long-term.

Over the coming decade, AI is likely to replace millions of jobs, with most of them being positions for training of vocational education (Ma, 2019). The society and businesses will have higher requirements for the quality of personnel training in vocational education as the basic jobs are taken over by AI. Ma says that “the original vocational education talent training model will be difficult to adapt to the future industrial development needs”. Hence, in the future, vocational education must re-distribute the job characteristics of vocational education and rebuild occupations. The talent training mode of education reconstructs the knowledge structure and knowledge system of professional talents (Ma, 2019).

According to Ma (2019), while the development of AI is a threat to vocational employment, it also brings certain opportunities to vocational education itself. Due to continuous development of AI, education resources are increasingly being scientifically configured and integrated. Due to AI development, it is now possible to pay greater attention to the personalized learning of vocational students, by focusing on the higher value of vocational education such as the students' creativity, curiosity, multidisciplinary thinking ability, critical thinking and problem solving (Ma, 2019). The development of AI would be based on the analysis of students' advantages and disadvantages as well as personality characteristics. Students' study habits as well as behavioural habits could be corrected and teaching could be customized to students' aptitude.

Teachable Agent System and Local Language Proficiency

According to Ogan, Yarzebinski, De Roock, Dum Dumaya, Banawan & Rodrigo (2017), “personalized learning technologies offer an opportunity to bridge the gap between the official

medium of instruction and students' home language, while adapting to individual students' needs and preferences".

According to Ogan et al. (2017), whether acknowledged or implicit, the many AI in education (AIED) systems which use natural language have embedded design decisions related to the manner in which they engage in dialogic interactions with students, even when the domain content is math or physics.

Several such AIED systems are already working in this field. For example, working with an agent that spoke in African-American Vernacular English led to higher achievement in science reasoning for African-American students as compared to working with one that spoke in mainstream English (Finkelstein, Yarzebinski, Vaughn, Ogan, Cassell, 2013 – as cited in Ogan et al., 2017).

Similarly, Mohammed & Mohan (2015) allowed university students to select the amount of local Trinidad and Tobago dialect their system would use, and discovered that a majority of students preferred the dialect-enabled system and wanted to control the localization (Mohammed, & Mohan, 2015 – as cited in Ogan et al., 2017). These examples show that there are issues of student proficiency and student preference which underlie the success of a personalized approach to tutoring. In their study, Ogan et al. (2017) concluded that detecting and adjusting to local language could support learning gains in AIED systems. Their study highlights opportunities for language personalization in learning environments.

AI Applications in Education

The study by Zhao & Liu (2018) has compared the different AI applications in education across the world. They talk about Smart Sparrow, which is Australia's online adaptive education platform. They also mention Desire2Learn (D2L) which is a cloud education learning management platform in the US, along with Jill Watson, which is an online AI program based on the IBM Watson supercomputer. Zhao & Liu also mention Betty's Brain, which is an AI application in education.

Conclusion

To conclude, this paper reviewed studies which have been carried out on Artificial Intelligence and education. Studies have talked about the pervasiveness of Artificial Intelligence today and its impact on education and teaching methods and learning systems. Many studies have talked about AI applications which aid in improving learning outcomes. Some studies have also highlighted the need to adjust vocational education training around the idea that AI would be phasing out many jobs in the coming decades.

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