# Review of the Application of Artificial Intelligence in Education

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With the development of artificial intelligence technology, more and more artificial intelligence products are being applied to the education industry. Many countries in the world have also formulated relevant policies to promote the application of artificial intelligence technology in education. This paper briefly discusses the history of the development of artificial intelligence technology and its application in the field of education including teaching and learning innovations, effective teaching and learning approaches and smart campus life styles. This research analyzes the changes brought by artificial intelligence to education from different application aspects. It is suggested that, in order to better promote the application of artificial intelligence in education, there are three important aspects that must be considered at: the technical level; the model level and the practical level.

**Key words:** *Artificial Intelligence, Education, Educational Application, Teaching, Learning, Information and Communication Technology.*

**Introduction**

In 2019, the International Conference on Artificial Intelligence and Education was held in Beijing (Xu, 2019). The artificial intelligence field experts from all around the world gathered at the event to have a discussion and brainstorming session regarding the topic. It is a fact that Artificial Intelligence has now been implemented in various industries, stimulating transformation in social development and economic growth, leading to changes in mankind's productivity, lifestyle and even learning styles. Recently, UNESCO officially released the "Beijing Consensus - Artificial Intelligence and Education", suggesting that all countries should formulate corresponding policies and explore the effective strategies and practices the implementation of artificial intelligence to promote educational innovation (Huang, 2019). Education has high potential to advocate the development of human society with the in-depth

integration of artificial intelligence. The United States, Singapore, India are identified as the leading countries who have successfully launched new education reform strategies for the future and relevant policies and regulations are constantly formulated to design a blueprint for the smart education development in their countries (Parker, 2018).

The United States National Strategic Plan for Research and Development of Artificial Intelligence and the National Strategic Plan for Machine Intelligence, released in 2016 and 2018 respectively, expressly states that it will provide policy and financial support needed for the technology of artificial intelligence in education (Seng & Choo, 2008). The fourth Masterplan for ICT in Education which was launched in Singapore proposes to establish the smart learning environment in order to support a personalized and independent learning for students, with the objective to cultivate the responsible digital learners for the future (Horowitz, Allen, Kania, & Scharre, 2018). In 2018, India introduced the National Strategy for Artificial Intelligence, which listed education as one of the five essential areas for the implementation of artificial intelligence technology. In China, the government pays high attention to the integration and development of artificial intelligence and education, and vigorously promotes information informed education (Yan, 2019).

Digital teaching resources are widely accessible in all levels of education, the continuous enhancement of smart learning and teaching and management approaches have made significant progress in education modernization (Lei, 2018). At present, many countries in the world are very concerned about the application of artificial intelligence in education, particularly, how to make it beneficial to all communities (Zhu & Yang, 2012). The application of artificial intelligence at the educational level will continue to expand. In keeping with the passage of time, the development trend of artificial intelligence in education is inevitable and more artificial intelligence technologies will be applied in education in the future (Pan, 2018).

**The History of Artificial Intelligence Development**

Artificial intelligence technology has long history which is actively and constantly changing and growing. Artificial intelligence is an interdisciplinary subject involving informatics, logic, cognition, thinking, systems science and biology (Hon, 2019). It has been in knowledge processing, pattern recognition, machine learning, natural language processing, game theory, automatic, automated programming, expert systems, knowledge bases, intelligent robots, and other fields have achieved practical results (Jackson, 2019).

Artificial intelligence has undergone a long process of development and has a history of more than 70 years. The development process of artificial intelligence can be divided into several stages, in 1943an artificial neuron model was proposed, opening the era of artificial neural

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network research (Kandpal & Mehta. 2019). In 1956, the Dartmouth Conference was held, and the concept of artificial intelligence was proposed, which marked the birth of artificial intelligence (Luo, Meng & Cai, 2018). During this period, the trend of artificial intelligence research among international academicians increased and knowledge exchange was frequent. In the 1960s, as the main genre of Connectionism and Symbolism entered a depression, due to insufficient hardware capabilities, algorithmic defects, etc., artificial intelligence technology fell into a downturn (Boden, 2018). In the 1970s, the Back-propagation algorithm began to be studied, computer performance and computing power gradually improved and in general, the research and application of the expert system was moving forward with difficulty and artificial intelligence gradually began to make breakthroughs (Chakravarthy, 2019). In the 1980s, Back-propagation neural networks were widely recognized and algorithms based on artificial neural networks were advancing by leaps and bounds (Hinton & Salakhutdinov, 2006).

The rapid improvement of computer hardware capabilities, coupled with the development of the Internet, reduces the computational cost of artificial intelligence which subsequently enters a stage of steady development. In 2006, Deep Learning was proposed, and artificial intelligence once again achieved breakthrough development (Deng & Yu, 2014). In the first decade of the 21st century, the development of Mobile Internet brought more application scenarios to artificial intelligence. In 2012, Deep Learning algorithms achieved breakthroughs in the field of voice and visual recognition (Zhou, Zhao, Wang & Liu, 2018). In 2016, AlphaGo defeated the World Go champion and sparked thinking about how artificial intelligence could change human society (Brunner, 2019).

**The Application Aspects of Artificial Intelligence in Education**

With the development of artificial intelligence technology, modern education will be combined with more technologies, such as speech semantic recognition, image recognition, Augmented Reality / Virtual Reality, machine learning, brain neuroscience, quantum computing, blockchain and so on. These technologies are collectively referred to as intelligent technologies and are consistently and rapidly integrated with the education industry. The intelligent upgrade of the education industry is in full swing. At present, more and more artificial intelligence education products have been applied to school education. (Yan, 2017). The typical scenarios of artificial intelligence education applications include intelligent tutor-assisted personalized teaching and learning, intelligent assistants such as educational robots, children's partners at home, intelligent assessment, mining and intelligent analysis of educational data, learning analysis and learning, digital portraits, and etcetera. Literature studies show that artificial intelligence technology in education has been used in at least 10 aspects: the (i) automatic grading system, (ii) interval reminder, (iii) teacher's feedback, (iv) virtual teachers, (v) personalized learning, (vi) adaptive learning, (vii)

augmented reality / virtual reality, (viii) accurate reading, (ix) intelligent campus and (x) distance learning.

***The Automatic Grading System*:** The automatic grading system is an artificial intelligence-based professional computer program that simulates the behavior of a teacher to assign grades to student tasks in an educational setting. It assesses student knowledge, the program analyzes their answers, provides feedback and develops personalized training programs. Many artificial intelligence education apps are using this program. Through the test of learning, the system automatically provides the learner evaluation score. This method can help teachers to better understand the learning situation of their students, and students, on the other hand, are made more aware of their level of learning achievement and knowledge mastery. One of the examples of the automatic grading system used in education app is Wolfie, an Israeli music education application (Shang, 2019). This app focuses more on classroom teaching, providing teaching and evaluation tools for teachers and students, and using modern advanced technology to change all aspects of music education, from teaching to learning to practice. The automatic grading system in Wolfie helps music educators guide students to correct the mistakes in the exercises, and provide teachers and students with a completely different way of music education and learning interaction.

***Interval Reminder*:** When someone is about to forget his/her knowledge, revising the knowledge is an effective technical solution that reinforces understanding and memory through timed repetitive reminders. The Polish inventor Peter Wozniak proposed an educational app based on the effects of the interval (Nazemi, Breyer, Burkhardt, Stab & Kohlhammer, 2014). This app tracks what people have learned and when. Using artificial intelligence, the app can determine when someone is most likely to forget something and suggest for him/her to modify it. Just a few reminder revisions will ensure that the information is now stored in a human's brain for years.

Teacher feedback is the student assessment of the teacher, a feedback method that has existed in education for some time. Despite the shift from paper to online surveys, little to no progress has been made in the feedback area (Holstein, McLaren & Aleven, 2019). Since student evaluation of teaching is often the most valuable source of information, it obviously needs to be elevated. Modern technologies, such as artificial intelligence-driven conversation robots, machine learning and natural language processing, provide exciting opportunities to improve the quality of feedback (Peters, 2019). Chat robot, for example, can collect opinions through a conversational interface like a real interviewer and only needs a small amount of work by others. The conversation can be adjusted based on student answers and personality.

***Virtual Teacher*:**  In recent years, based on the development of artificial intelligence technology, some entrepreneurs began to provide students with an online "virtual tutor" using

artificial intelligence to help children learn (Goel, & Polepeddi, 2016). At Georgia Institute of Technology, students were fascinated by a teacher assistant named Jill Watson, who quickly and accurately answered the student requests. However, the students did not know that Ms. Watson's true identity was actually a computer with an IBM-artificial intelligence system. There is also a company in London known as "Whizz Education" (Whizz Education, 2014), that is popular with its flagship product, "Maths Whizz," a software for online tutoring. The company has designed after-school study course that is consistent with the school schedule. Students can ask questions at any time during the learning process. The virtual teacher will answer the questions step by step for students and adjust the answer according to the feedback of the students until the student masters the knowledge learned. At the same time, the system also provides real-time reporting for parents, so that they can keep track of their child's learning progress and understand better whether they can keep up with the progress of the school or will have difficulties during the learning process and etcetera. The system allows parents to encourage and even reward their children through online interaction, in which parental supervision of children is also taken into account in the program.

***Personalized Learning***: Personalized learning refers to a variety of educational programs in which learning speed and teaching methods can be optimized based on each learner's needs (Bailey, 2019). The experience is tailored to learning preferences and the specific interests of different learners. This artificial intelligence educational program can adapt to the individual's learning rhythm and continue to provide more complex tasks to accelerate his/her learning process. Therefore, students who are fast or slow can continue to learn at their own pace. Holotescu designed and developed the MOOC (Massive Open Online Course) Buddy teaching robot to provide learners with targeted, personalized learning resources (Holotescu & Grosseck, 2018). Bayne has also developed intelligent teaching assistant Botty who can help teachers in the teaching process and make classroom teaching activities more efficient (Bozkurt, Kilgore & Crosslin, 2018). These educational programs would assist in many ways such as the automatic correction of work, online question answering and intelligent evaluation (Li, 2016).

***Adaptive Learning***: In adaptive learning, artificial intelligence is gradually used to collect and analyze student learning data and outline the learning styles and characteristics of each student, and then automatically adjust the teaching content, mode and rhythm, to best suit their needs (Wu, 2019). With the passage of time, the accumulation of data gradually increases, the more "smart" artificial intelligence will be, and the more accurate it will be in adapting to students' learning. In this way, a virtuous circle will be formed, so that students' learning efficiency will be higher and higher, the effect will be better and better, and their confidence will also be enhanced. Since its inception in 2011, a company known as "Smart Sparrow" in the United States and Australia has been working to develop adaptive teaching tools for schools and teachers (Farmer, Catalano & Halpern, 2019). Their products are the

platform that integrate curriculum design, online learning, real-time feedback, adaptive learning, big data analysis, online collaborative learning, and intelligent coaching. Teachers can use the tools and content library on the online platform to design courses, and each part of the teaching process can add elements of interaction with students, so that students can master the knowledge through completing some "tasks" in the course.

Through these interactions, the system can collect student learning data at any time, track the progress of students, and discover the bottlenecks and difficulties of student learning, thus giving real-time feedback and reinforcement. For younger children, some companies have added gamification to adaptive learning systems to make boring learning becomes more fun. The American company "DreamBox Learning" cuts in from the gamification of the elementary school mathematics curriculum and designs a platform for learning mathematics in games (Jani, Muszali, Nathan & Abdullah, 2018). This platform is based on the performance of students in the game and the platform of interaction and practice, gradually to promoting student mathematics learning. It adjusts the content and exercises according to the progress of the students, so that students can learn all the mathematics courses required by their grades without realizing it.

***Augmented Reality (AR) / Virtual Reality (VR)***:  Using augmented reality (AR) / virtual reality (VR) in education, the imagination space is immeasurable, and the benefits are obvious (Martin, Bohuslava & Igor, 2018). Classroom is no longer limited to small classrooms, whiteboards, and power points, but the entire universe. Many companies, including Internet giants Google and Facebook, have devoted themselves to researching how to apply AR/VR in education. In order to make the VR scene as realistic as possible, the company "Alchemy VR" chose to cooperate with a number of institutions such as Samsung, Google, Sony, BBC, the National Museum of Nature, and the Sydney Museum of Australia to produce VR educational content (Huttar & BrintzenhofeSzoc, 2019). The company's "Great Barrier Reef Tour" is a product of collaboration with the BBC documentary team, giving students from all over the world the opportunity to sneak into the blue waters of Australia to learn the ecological environment of coral reefs.

***Accurate Reading***: More than 75% of the reading learning intelligent teaching platform, Newsela is used by K-12 schools in the United States, which provides scholars with real-time assessment, synchronous vocabulary learning, integration variety of resources and learners (Opfer, Kaufman & Thompson, 2016). The reading content is divided into three broad categories: libraries, news, and text collections. Each category contains a large number of rich themes. In the library classification, it includes art and culture, science and mathematics, religion and philosophy, politics and economy, etcetera. The same content will be presented in different forms according to different readers, and the vocabulary will be adjusted according to the learner's reading level. These functions are all based on artificial intelligence

technology. Newsela has created a first-class education for primary education (Ding, 2017). The reading materials are combined with the content of the school curriculum, and provide five reading levels. The content of the entire catalogue is divided into 2~6 grades. Each article will have five Power Words, which is the new vocabulary that students will learn. After that, the test exercise is administered to enhance the learning effect (Leonardo, 2018). Teachers can track the progress of the students through real-time data collection, and adjust their teaching progress, methods, content, etc. in time.

*Intelligent Campus***:** With the help of leading artificial intelligence technology, intelligent campus aimed to improve teaching quality as well as campus management and services, to provide a more systematic and secure environment for students (Yan, 2018). At Deakin University in Victoria, Australia, the development of smart campus is in full swing. As a teacher's aide, the intelligence behind it comes from IBM's Watson supercomputer system. Once the project is completed, the Smart Campus will be able to answer all questions related to the student's campus life such as how to find the next lecture hall, how to apply for the next semester course, how to get homework, where to find a parking lot or how to contact a professor are all that artificial intelligence campus robots will be able to solve.

*Distance Learning***:** In 2014, Kose published the book title "Application of Artificial Intelligence in Distance Education", and believed that the application of artificial intelligence in distance education aims to study the use of computers to make up the gap between students and educators (Kose, 2014). In distance education, artificial intelligence technology should be used to support distance education, or different intelligent systems can be used to improve distance education (Kose, 2014).

**Suggestions for the Development of Better Artificial Intelligence in Education**

In order to better promote the application of artificial intelligence in education, there are three important aspects must be considered: at the technical level; model level and the practical level.

At the technical level:  Strengthen the supervision of information security and ethics

At present, the research on artificial intelligence technology is basically mature, and it is necessary to strengthen supervision on education information security and ethics in the future. On the one hand, artificial intelligence education inevitably touches student privacy data, personality preferences, ability levels and other issues in the application process. Once the data is leaked, students will suffer severe psychological blows, thus affecting the actual effect of education and teaching. Consequently the use of effective encryption techniques must be a priority to improve this risk. Potentially, artificial intelligence has two sides; if used

improperly, it will break the law or cause ethical problems, thus damaging the interests of all parties.

At the model level： Improve the relevant models of artificial intelligence education applications

At present, the research on the model of artificial intelligence application is still in its infancy, and its specific research ideas and contents need to be continuously improved, and combined with relevant theories to improve the existing model. The construction of the artificial intelligence education application model should pay more attention to the interdisciplinary research of its related education science and professional science. Researchers should make suggestions for the application of artificial intelligence education on the basis of following the law of educational development. The application of artificial intelligence education can only ensure that it will not be lost in the jungle of technology if it conforms to the laws of education development.

At the practical level： Expand the practice and application scope of artificial intelligence education.

At present, the application of artificial intelligence education is mainly based on the promotion of enterprise artificial intelligence education products. These products have limited coverage for teaching, learning, management, examination and other educational scenarios. At the same time, enterprise developers are keen on new product applications. At the same time, the comprehensive analysis and summary of typical cases of artificial intelligence education are neglected, which leads to the inability of artificial intelligence education to expand its practice due to lack of experience and relevant theory. In addition, the scope of application of artificial intelligence education is often set as a school, and its application range is relatively narrow. Therefore, research should pay more attention to the diversification of artificial intelligence education application scenarios and promote the full application of artificial intelligence education in higher education, vocational education, basic education and special education.

**Conclusion**

In summary, it is found that artificial intelligence technology has been used in many different aspects in education, from promoting education innovation, assisting the teaching and learning processes, and managing smart campus life to providing useful information to the stakeholders. In the context of 21st century, the use of artificial intelligence technology in education is undeniable. Artificial intelligence technology is very much needed in the future to ensure effective teaching and learning process among teachers and students and will be

indispensable for the betterment of the education system.

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