Application and Prospect of Artificial Intelligence in Online Vocational Education

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Abstract. The rapid upgrading and changing of artificial intelligence technology accelerate the reconstruction of teaching modes, learning modes, and organization management modes of vocational education. Combined with the characteristics of modern vocational education, we should take advantage of the situation, face the problems, focus on the learning process of learners, help teachers develop more interesting and effective teaching activities, help learners to carry out learning more quickly and more targeted, and promote the deep integration of artificial intelligence and online vocational education.

Keywords: Artificial Intelligence · Vocational Education · Online Vocational Education

1 Introduction

In recent years, the rapid development of new technologies, such as artificial intelligence, blockchain, big data, and the Internet of Things have ushered in an intelligent era in human society. Artificial intelligence is widely considered as a new round of productivity revolution after the revolution of information technology. It is a strategic technology that leads the future of the world and changes the global landscape. Major developed countries take the development of artificial intelligence as a significant strategy in improving their national competitiveness and maintaining national security and make strategic plans for it. In 2017, China issued *Development Planning for a New Generation of Artificial Intelligence*, proposing to accelerate the new application of artificial intelligence in education, medical care, elderly care, and other urgent demands of people's livelihood and provide personalized, diversified, and high-quality services for the public. The deep integration of artificial intelligence and education has gradually become the focus for policy-makers and educators.

EDUCAUSE, the world's largest professional organization of higher education informatization, published *Horizon Report: Teaching and Learning Edition* on March 2, 2020. According to the report, the application of artificial intelligence is an important trend in the development of higher education and teaching technology. Besides, artificial intelligence and machine learning will improve the efficiency of learning and management.

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The Ministry of Education and other eight departments in China issued *Action Plan for Improving the Quality and Excellence of Vocational Education (2020–2023)* on October 4, 2020, which proposed to carry out the construction of informatization of vocational education 2.0 (the second phase) to upgrade the construction. It also required to coordinate the construction of an integrated intelligent platform of teaching, management, and service, promote the in-depth integration of information technology and intelligent technology into the whole process of management on campus, make decisions and manage in a more targeted and scientific way, and advance "Internet plus" and "Intelligence plus" education to reform and innovate education and teaching.

It can be concluded from the aforementioned that the integration of artificial intelligence into vocational education is a major trend in developing and improving the quality of vocational education. Online vocational education is a crucial form that integrates information technology, artificial intelligence, and other technologies to further teaching and learning and improves the capability of learners. This propels people to think over how to utilize artificial intelligence to promote the innovation of e-learning in online vocational education, so as to improve learners' capability of job performance through better learning.

2 Research Status of Application of Artificial Intelligence in Online Vocational Education

2.1 Research Status of Application of Artificial Intelligence in Education

Education is a social practice that cultivates people, which includes the subjects of education, the objects of education, the contents of education, and the forms of education. The influence and research of artificial intelligence in education focus on the following aspects:

2.1.1 Teaching

The development of artificial intelligence challenges the transformation of teachers' capabilities and continuous improvement in the future. Chen et al. explored the technological path of upgrading intelligent teaching systems and reshaping the learning process by bringing in artificial intelligence [1]. According to *China AI Development Report 2018*, the application of artificial intelligence in teaching helps teachers make their teaching more efficient and interesting. In the future, teaching will be a job completed by human-machine cooperation. Teachers will focus on the side that is more closely related to students' life with the support of intelligent technology [2]. This generates news requirements including the capabilities of students' psychological analysis, data analysis, and quick learning for teachers. They need to improve their professional capabilities and realize the sustainable development of ability and quality.

2.1.2 Learning

The research of artificial intelligence focuses on learning analytical technology and self-adaptive learning. Learning analytical technology emphasizes the monitoring of the

learning process. It uses artificial intelligence to analyze learning data, predict the risk of failure, and offer timely feedback to learners. Self-adaptive learning utilizes intelligent technology to adapt learning based on monitoring and design personalized learning paths according to students' individual needs, abilities, and emotional preferences. Jiang et al. emphasize the value of self-adaptive learning in promoting learners' metacognition and stimulating learners' intrinsic learning motivation. They also insist that self-adaptive learning technologies should be incorporated into the personalized design of MOOC, the construction of an online learning space that is accessible to all, and the development of intelligent education in the future [3].

2.1.3 Teaching Resources and Environment

The application of artificial intelligence in education can help solve the problem of unevenness in the distribution of education resources and promote educational equality. For example, artificial intelligence self-adaptive tutors can offer extra one-to-one help to students to unlock their potential and increase the possibility of success. Ren et al. hold that educational informatization 2.0 (the second phase) has ushered in "a new era driven by the integration of innovation and intelligence" and proposed to construct a new educational landscape of "a networked, digitalized, personalized, and lifelong education system and a learning-oriented society where everyone can learn everywhere at any time". They believe that intelligent education is a new stage and new demand of educational informatization [4]. Wu et al. advocate for creating an ecosystem of "artificial intelligence plus education" and they mentioned four application forms, including intelligent campus, three-dimensional integrated teaching places, online learning, and education platforms based on data intelligence and intelligent education assistants [5].

2.1.4 Teaching Technologies

Yan et al. probed into the connotation and key technologies of artificial intelligence. They believe that the key technologies of educational artificial intelligence are mainly related to the representation of knowledge, machine learning and deep learning, natural language processing, intelligent agents, and affective computing, and the application and development trends of the key technologies are mainly in the fields of intelligent tutors and assistants, intelligent assessment, learning partners, data mining and learning analysis [6]. Yu et al. analyzed the application of machine learning in intelligent education. As the core of artificial intelligence, machine learning can automatically identify patterns, discover rules, and predict students' performance based on a large amount of data, so as to meet the demand for intelligent education and personalized learning [7]. These key technologies of "artificial intelligence plus education" will make the integration of artificial intelligence and education possible and provide technical support for the intelligent transformation of education.

In general, the education topics related to artificial intelligence focus on "teaching" and "learning", such as "personalized learning", "intelligent education", "big data", "machine learning" and other technologies related to artificial intelligence. Meanwhile, scholars believe that education can be replaced by artificial intelligence rationally. There are many theoretical discussions on the integration of artificial intelligence and education

but few reliable methodologies that can support them. Besides, few interdisciplinary studies between pedagogy and other disciplines have been done at present, so there is much to do to practice the integration of artificial intelligence and education.

2.2 Research Status of Application of Artificial Intelligence in Vocational Education

The rapid upgrading and changing of artificial intelligence technology accelerate the reconstruction of teaching modes, learning modes, and organization management modes of vocational education. Huang et al. claimed that "Artificial intelligence will promote the systematic transformation of value chains in industrial, service, and agricultural sectors, which will change the way of economic growth and the market of labor force [8]." Chen et al. believe that the goal of talent cultivation in vocational education should be upgraded to cultivating people of knowledge, skills, innovation and creativity based on the former two qualities that they pursued in the past. This inevitably requires teachers to be someone innovative and creative. As for vocational education, it is imperative to develop online courses, accelerate the mutual recognition of credits among vocational colleges and universities, and certify and accredit online open courses in vocational education to make teachers in vocational colleges and universities accessible to all as soon as possible. In this way, teachers' productivity can be totally liberated and they can become teachers who lead students, work inventively, learn persistently, and strive to be experts in the field (so-called teachers with four new qualities) in the era of intelligence [9].

Dong Wenjuan and Huang Yao think that vocational education in the era of artificial intelligence is still employment-oriented and cultivates intelligent workers in the new era; insists on the inheritance of technology and attaches importance to technical education; returns to the essence of education to serve the overall development of people; adheres to the ideas of humanity and promotes craftsmanship. They also put forward the way of internal structural reform from the perspectives of the construction of majors and curriculum, teachers' burden alleviation, and personalized learning, and the way of external structural reform from the perspectives of the construction of multiple learning situations and the optimization of organizational management [10].

At present, there are relatively few studies on the application of artificial intelligence in online vocational education, most of which are about military vocational education. China's military vocational education refers specifically to the organized and autonomous modern continuing education that people receive on the job, which is a lifelong education system that focuses on online learning and integrates diversified offline learning methods. Online learning of military vocational education mainly relies on a special platform built and shared by the entire military. It provides one-stop online education services and management through the platform and gathers high-quality online education resources from military and local organizations to provide services for all officers and soldiers, creating a learning atmosphere in the military and gaining popularity among officers and soldiers.

Tan Shaoying of Air Force Early Warning Academy probed into the positive effects of the use of big data on military vocational education, analyzed the practice of the US military in terms of learning opportunities, integration of training, teaching quality, and

curriculum, and proposed measures for the development of our military vocational education in the environment of big data, namely focusing on overall planning, establishing a big data center, changing the methods of teaching guidance, and organizing personalized career planning [11]. Wang Hongjun believes that the combination of powerful algorithms of artificial intelligence and the big data that is accumulated continuously will further strengthen the accurate matching of supply and demand in military vocational education, improve the relevance, accuracy, and effectiveness of the construction of courses resources, and improve the accuracy of courses learning, so as to strengthen officers' and soldiers' ability of job performance and let them become more professional and enhance the troops' ability of combat training and war preparation [12]. Zhao Bin of the 63823 Army of the PLA argues that the troops need to update the knowledge of soldiers and officers and improve their abilities through continuing education in the era of information, but the current mode that relies on colleges and universities to organize training can no longer meet the troops' diversified demands for talent training. Thus, it is urgent to build a brand new mode and give full play to the dynamic role of teaching institutions in the transition of teaching.

3 Features of Modern Vocational Education

Vocational education, as an important part of the education system, is a significant social practice of cultivating people's vocational knowledge, ability and quality. In the modern society where science and technology develop quickly and knowledge updates rapidly, it is extremely important to advocate lifelong education and on-the-job education, because the innovative and creative labor forms will require stronger working ability since artificial intelligence has replaced more and more jobs that used to be completed by human labors. Modern vocational education has been expanded from vocational school education that provides diplomas to vocational training without offering diplomas but covering wider scopes, such as offline vocational training and online vocational training. Corporate universities have been rising in the new era, which are not only training centers for employees, but strategic platforms that play an important role in advancing organizational reforms, spreading corporate culture, and promoting knowledge management. They are of great significance.

Modern vocational education is more inclusive. With the development of the Internet, big data, cloud computing, and especially artificial intelligence, the forms and contents of the four elements of education have been changing and innovating accordingly. The subjects of education have been extended from teachers and learners to common people, resources, and robots; and the objects of education have been extended to each individual in a lifelong learning society where everyone needs to develop through learning and innovation and improve his or her quality to a higher level. The contents of education are abundant and easy to access from books and massive resources on the Internet; and the interaction among people is faster and closer; the demand for learning is more and more diversified and urgent; the forms of education are no longer limited to school education. We have already embraced an era when everyone can learn everywhere.

The goal of modern vocational education is to cultivate high-quality, moral and talented workers with the capability of e-learning and innovation. The focus of education

shifts from traditional application skills to comprehensive qualities in the new era, and from imparting knowledge and skills to cultivating the capability of e-learning and lifelong learning. As for cognition, modern vocational education aims to help students to understand and apply knowledge and gradually learn to analyze, evaluate, and create instead of memorizing things at a lower level. As for learning modes and methods, artificial intelligence technology provides convenient means for better teaching, learning, managing, evaluating and testing, and supports massive online learning and personalized tutoring.

The developments of information technology and artificial intelligence technology make online vocational education an important channel for working people to improve themselves. They have a relatively mature plan for their development, and a clearer understanding of their shortcomings and needs for learning, so they can choose and receive personalized vocational education voluntarily according to their posts, interests and different psychological needs. Since their time is fragmented, they can take MOOC, micro-lectures, virtual online training courses according to their interests, needs, learning speed and methods, so as to learn in a more targeted and effective way, and reconstruct learning space.

Modern vocational education tends to shift from individual learning to organizational and group learning. Individual knowledge acquisition accumulates in groups, thus realizing the transformation of knowledge. In the era of artificial intelligence, with the continuous progress of science and technology and the deepening of the reform of talent cultivating modes and teaching methods in vocational education, new education and teaching systems such as intelligent learning and interactive learning, have emerged. Adults learning emphasizes the deeper understanding of the contents, enhancement of their abilities to solve practical problems and cultivation of their innovative thinking during the learning process. With the help of artificial intelligence technology, the atmosphere of online group learning and project-based learning can be created to stimulate collective wisdom in communication, discover scientific truth in questioning, and internalize the spirit of truth-seeking in learning.

4 Problems and Prospects of Online Vocational Education

4.1 Problems and Difficulties of Online Vocational Education

The problem of insufficiency of excellent teachers should be solved first to conduct online vocational education. We can utilize artificial intelligence technologies, especially intelligent teaching assistants with core functions such as intelligent tutoring, intelligent question answering, and intelligent homework to achieve the goal of teaching, tutoring, answering questions, and marking homework in a targeted way when there are not enough excellent teachers. In addition, on-the-job learners have heavy workloads and little spare time, only a little of which can be used for learning freely. In this case, artificial intelligence technologies, such as deep learning, intelligent content recommendation, and intelligent diagnosis can be used to help teachers teach in a targeted way and help learners make learning plans and get timely feedback to learn efficiently. Finally, we need to solve the problem of management in vocational education. To put it specifically, we find it difficult to comprehensively collect and grasp the data in the teaching process, and

discover the features of the learning of a specific group of people, and design effective teaching contents and apply teaching methods according to it to achieve the teaching goals of improving learners' ability of job performance, and ensure the authenticity and validity of the results of online learning and examinations of on-the-job learners. These problems can be solved with the help of artificial intelligence technologies such as big data, blockchain, face recognition and virtual reality. The application and practice of artificial intelligence in the field of online vocational education and the reform of teaching methods and talent cultivation modes will help in creating a new intelligent vocational education system, and in raising innovative and intelligent talents.

4.2 Prospects of Deep Integration of Artificial Intelligence and Online Vocational Education

Artificial intelligence technology can be used to strengthen the management of an integrated learning system of "before-learning planning assistance, while-learning intelligent management, and after-learning effect evaluation", so as to make learning channels clear to the students, learning process traceable, and learning effects testable. First, federated learning is introduced to carry out learning architecture design. Federated learning is essentially a distributed machine learning technique, or machine learning framework. The goal is to achieve common modeling and improve the effectiveness of AI models on the basis of ensuring data privacy and security and legal compliance. Based on the different data distribution among multiple participants, federated learning can be divided into three categories: horizontal federated learning, vertical federated learning, and migrated federated learning. The essence of horizontal federated learning is the federation of samples, which is applicable to the scenario where the participants have the same business model but reach different customers, i.e., when there are more overlapping features and fewer overlapping users. The essence of vertical federated learning is the federation of features, which is applicable to the scenario where there are more overlapping users and fewer overlapping features. Migrated federated learning, which is mainly applicable to scenarios where deep neural networks (DNN) are used as the base model, can be considered when there is little overlap in both features and samples among the participants. Meanwhile, federated learning boasts the characteristics of "multi-party participation, data immobility, and privacy protection", which can effectively solve the problem of data security. Based on the idea of federated learning, we studied the storage, management and use of online vocational education data, as shown in Fig. 1. The identity data, job data, and education data including the learners' and the educators' are stored separately by each data source unit; each teaching unit distributively stores the teaching contents and the learning process data of each learner; each data source learns the characteristics of the data on its own; and the parameters of the model training are encrypted and then transmitted.

Artificial intelligence technology can be used in the survey on learners' conditions. The technology can collect basic data of learners such as learners' working experience, needs of job performance, differences of quality and ability, and automatically complete before-learning planning, recommend courses to learners intelligently, and generate personalized teaching plans and individual learning plans for learners to choose and modify, enabling teachers to teach according to the features of students and allowing different

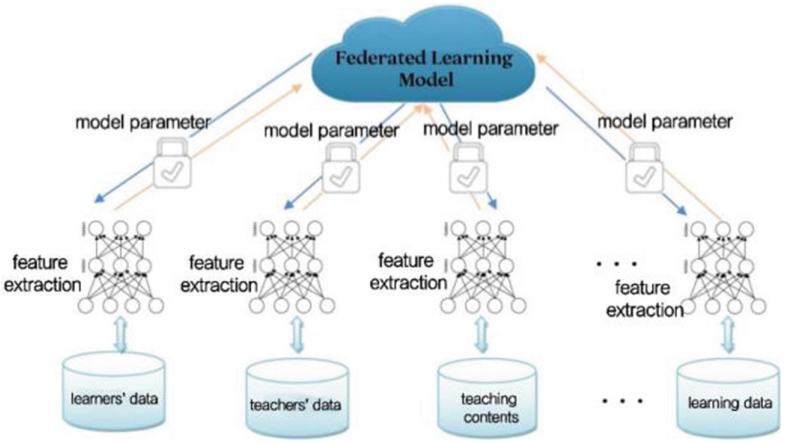

Fig. 1. The learning architecture design of online vocational education (Adapted from Zhou Chuanxin, Sun Yi, Wang Degang, Ge Huawei (2021). Research summary of federated learning. J. Chinese Journal of Network and Information Security, 5, 77–92.)

students to learn on the basis of self-adaptation. The intelligent evaluation with real-time tracking and feedback for learners can optimize learning paths and teaching methods, while evaluating the level of learning ability and ability improvement in the field at different time periods before, during and after the learners' participation in online education courses; combining with the characteristics of learning psychology and external behavior performance of the educated objects through artificial intelligence technology, the evaluation can provide intelligent feedback to employers for the next step of the learners' further study and job alternating.

Classroom Management and Control Based on Intelligent Interaction Technology. Intelligent interaction technology includes intelligent voice interaction, graphic-assisted interaction, etc. The reasonable use of intelligent interactive technology can effectively manage online courses, timely understand students' doubts, control the teaching process, and thus improve the teaching quality. Classroom management and control based on intelligent interaction technology should include intelligent Q&A for classroom teaching, intelligent level setting for classroom teaching and online classroom discussion, etc. The technologies of image recognition and human-computer interaction and the robot-based learning assistants can be used in intelligent monitoring while learning. They can help teachers solve learners' problems accurately and intelligently online, relieving teachers of repetitive and massive work of grading and marking. They can also help learners construct a learning community to discuss and communicate with others, complete homework in groups, and practice together. Besides, big data technology can be applied to the real-time monitoring of learning and the intelligent evaluation of feedback. This can not only optimize learning paths and teaching methods and evaluate the improvement of learners' knowledge and ability in the field at different phases that before, during, and after taking online courses. With the help of artificial intelligence, the intelligent feedback of learners' learning psychology and features of actions will be

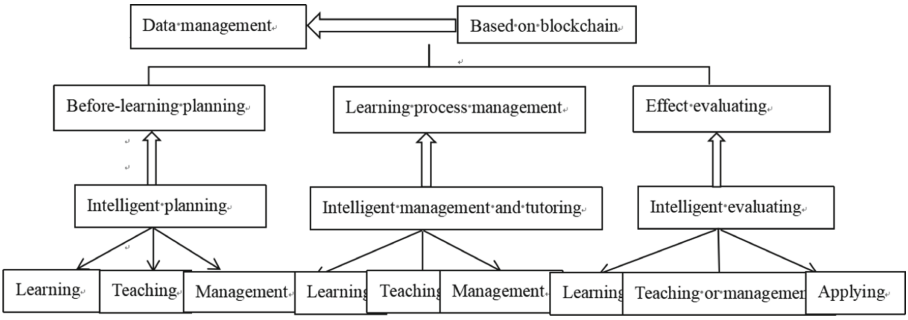

Fig. 2. Application of artificial intelligence in the online vocational education system (Photo credit: Original)

offered to employers, so that they can arrange further training courses for employees or change employees' jobs according to the feedback.

Blockchain technology provides a convenient method to accredit learning outcomes. Blockchain is a brand new way of data storage in essence. It can store and record all the data related to learning including the data of learners' condition and learners' growth profiles. We need to study how to realize a full record of learning trajectory and make data tamper-resistant with the help of blockchain technology, explore the methods to meet the demand for learning something and taking examinations online in person, making results traceable, realizing common recognition of outcomes, and improve the management efficiency (Fig. 2).

5 Conclusions

The rapid development of artificial intelligence has created various opportunities for the development of online vocational education. The integration of artificial intelligence into vocational education should follow the laws of education and learning, and better assist "teaching", "learning" and "management" to create a proper, interactive, and safe online learning environment that big data analysis can be used easily. The famous educator Gu Mingyuan often comments that "No interest, no learning", which is also true for online vocational education. The application of artificial intelligence in teaching and learning enables people to carry out demands analysis, sensitive information processing, intelligent use of personalized and customized teaching and learning, and benefit evaluation of AI applications, which can help teachers create more interesting and effective teaching activities, help learners study more quickly and in a more targeted way, and make learning more interactive, interesting, and practical, so that people can learn voluntarily and actively to improve the ability of job performance and acquire more knowledge.

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