Constructing a Model of Intelligent Learning Space for Vocational Education in the Age of Intelligence

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Abstract. Vocational education is the key to achieving a strong country with skilled personnel and has become the central position for high-level professional personnel training in the new international context. However, traditional vocational education learning spaces lack the construction of learning contexts, digital transformation is still in its primary stage, and practical training skills are not solid enough. Additionally, school-enterprise cooperation is not deep enough. The widespread application of emerging technologies such as 5G, cloud computing, and artificial intelligence in the social field is reshaping the world of work and generating complex and diversified occupational labor forms. Social changes have made *Internet* + and *Smart* + the new driving force and focus of vocational education reform in the new era. The construction of learner-centered, human-machine collaboration and virtual-real integration of vocational education intelligent learning space breaks the boundaries of time and space, extends the boundaries of schools, accelerates the integration of industrial elements, upgrades technological platforms and optimizes educational resources, and becomes an important strategic deployment for the reform and development of vocational education in the intelligent era, helping to cultivate complex, innovative, high-quality technical and technical talents with unique ingenuity.

Keywords: intelligent technology · vocational education · human-machine collaboration · virtual-reality integration · learning space

1 Introduction

In the era of intelligence, the new wave of technological and industrial revolution emphasizes the iterative abilities of talents in manufacturing processes and service skills, highlighting the leading role of skilled professionals. Particularly, the rapidly changing international landscape, the scale of high-end domestic manufacturing, and the layout of industrial chains have become key factors in competing for the commanding heights of global economic strategy. Vocational colleges have implemented the "Digital Campus Specifications for Vocational Colleges and Universities" and taken the initiative to undertake tasks such as being the benchmark schools for informatization, establishing demonstration virtual imitation real training bases, creating professional teaching

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resource libraries, and constructing high-quality online open courses. It has driven educational institutions to use information technology to update education concepts, change education models, reconstruct learning spaces, and carry out profound classroom revolutions [1]. In July 2021, the Ministry of Education and ten other departments issued the *5G Application Sailing Action Plan (2021–2023)*, which defines the key application areas of *5G + Smart Education*. The plan also proposes to increase the promotion of 5G in smart classrooms, holographic teaching, campus security, education management, comprehensive student evaluation, and other scenarios [2]. The COVID-19 pandemic continues to spread worldwide, posing serious challenges to the development of vocational education. In 2021, the Global Education Monitoring Report released by UNESCO pointed out that more than 80% of technical training courses focused on practical teaching, making vocational education and training greatly affected by the epidemic.

Moreover, the risk of job losses and turnover brought about by the epidemic has also led to a decrease in companies' willingness to accept students for internships, resulting in fewer internship opportunities. The epidemic has accelerated the distance learning process in vocational schools, leading to a significant increase in online courses and online training related to vocational education and a substantial increase in investment in information technology for distance learning [3]. As a place where teaching and practice occur, the learning space builds a learner-centered, human-machine collaboration and an intelligent learning space for vocational education that integrates virtual reality. The intelligent learning space breaks down the boundaries of time and space, expands the boundaries of schools, accelerates the integration of industrial elements, upgrades technology platforms, and optimizes educational resources. It has become an important strategic deployment for the reform and development of vocational education in the intelligent age. It helps cultivate complex, innovative, application-oriented, high-quality technical skills, producing skilled professionals with unique craftsmanship.

2 Overview of Learning Space

The learning space encompasses the entire spectrum of learning, from real to virtual, and can be divided into physical and virtual areas. Physical learning spaces in vocational colleges include formal learning places such as classrooms, laboratories, multimedia rooms, engineering integration learning places, on-campus and off-campus training bases, and informal learning places such as corridors, study rooms, and sports venues. Formal and informal learning are gradually merging. Virtual learning spaces include various learning management systems, learning resource platforms, and online communities [4]. In recent years, there has been an upsurge in research and practice on learning spaces at home and abroad. The North Carolina State, University SCALE-UP project promoted deep education and active collaborative learning. It has transformed the traditional classroom in several stages, resulting in a learning space that includes circular desks, easy access to appropriate laboratory equipment through the surrounding closet, and groups of two to three people with laptops, screens for displaying and sharing information, and handheld whiteboards [5]. Australia's Retrofitting University Learning Spaces project supported active learning, collaborative learning, and peer teaching by retrofitting existing spaces. The project focused on the transformation of both formal and informal learning spaces.

In terms of practice, the development of the learning space in this project drew on the research results in the field of architectural design and transformed the learning space from the perspective of space planning [6]. In the Future Classroom project of East China Normal University, the project team aimed to achieve innovative learning in a new technology environment. They developed several learning space cases regarding spatial layout and technology application based on studying factors influencing classroom transformation [7]. Zhejiang University's *Zhiyun* Classroom supported two-way interactive distance learning, solved the problem of insufficient capacity of large-scale classroom selection, and realized the teaching effect of *seeing the screen as a meeting* [8]. Vocational education, as important as general education, focuses on ability-oriented education oriented toward the working world. In the era of intelligence, due to industrial transformation and upgrading, vocational education requires a learning space that integrates human-machine collaboration and virtual reality. The learning space of vocational education is the primary place where learners acquire knowledge, practice skills, and cultivate talent. It should not only support the learning of learners' knowledge and technical skills but also support the cultivation of learners' communication, cooperation, critical thinking, and innovation skills necessary to face the work world and adapt to the requirements of career development in the intelligence era.

3 The Dilemma Faced by Traditional Vocational Education Learning Space

This study adopts the questionnaire survey method and distributes questionnaires to higher vocational colleges and secondary vocational colleges in the R Province through the questionnaire star platform. The R province is a major economic province in the country's north. It accelerates the construction of a national vocational education innovation and development highland. A total of 30 questionnaires were collected, and 28 valid questionnaires could be used for data analysis. The effective recovery rate reached 93.3%. The questionnaire includes basic information, campus information construction, information management, digital resource construction, and professional information development. This study analyzed the questionnaires submitted by 30 higher vocational colleges and secondary vocational colleges. It found that the digital transformation of vocational education is at the initial stage. The traditional vocational education learning space lacks the construction of learning situations, the traditional vocational education skills training needs to be more solid, and school-enterprise cooperation needs to be deeper.

3.1 Digital Transformation of Vocational Education is at the Initial Stage

On the one hand, there needs to be more understanding of the digital transformation of vocational education. Managers of many vocational education schools believe that the application of informatization in vocational education is simply replacing the existing traditional teaching equipment with informatized teaching equipment, and the modern concept of informatization needs to be applied in education. On the other hand, related resources are scarce. According to the survey data of vocational schools, the proportion of vocational schools with full coverage of campus networks accounts for 40%, and the balance of the full range of wireless networks accounts for only 14%, as shown in Table 1. The average number of smart classrooms built in vocational schools is 22.6%, and the average number of majors covered by smart classrooms is 32.3%, as shown in Table 2. The average value of virtual simulation training rooms in vocational schools is 15.36%, and the average number of virtual simulation training centers/bases in vocational schools is only 10.65%, as shown in Table 3. Insufficient hardware equipment and replacing the existing teaching equipment with informatized modern teaching equipment require a large amount of capital expenditure, which vocational schools in many regions of China can hardly afford with their economic strength alone. Compared with general education, the educational allocation for vocational education is relatively small, which makes the replacement of information-based teaching equipment in vocational schools very difficult, and the replacement process is also very slow [9]. The lack of advanced hardware equipment support makes it difficult for big data, artificial intelligence, VR/XR, and other intelligent technologies to empower vocational education and leads to a lack of teaching resources and uneven distribution of resources.

Table 1. Construction of Campus Network and Wireless Network in Vocational Schools.

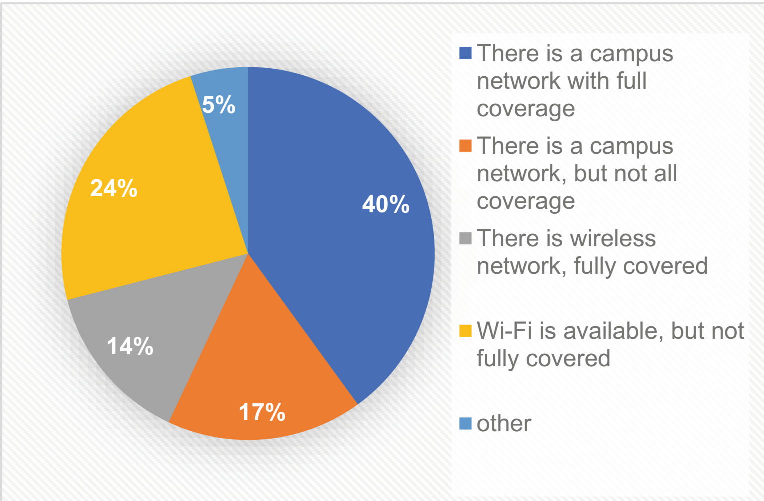


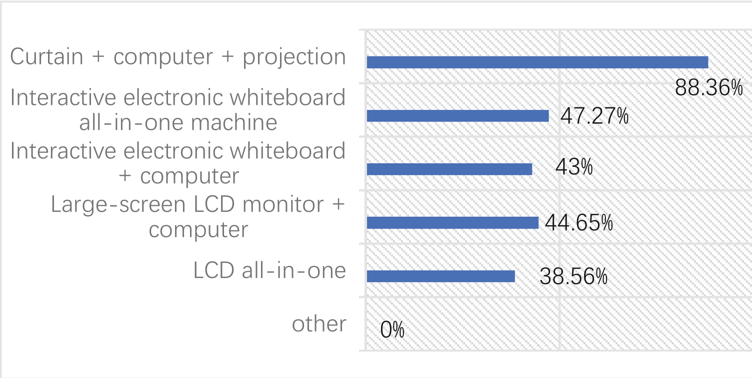
Table 2. Construction and Use of smart classrooms in Vocational Schools

The average number of smart classrooms	The average number of majors covered by smart classrooms	Professional Coverage Average
22.6%	32.3%	45.1%

Table 3. Number of virtual simulation training rooms/centers/bases in Vocational Schools

The average value of the virtual simulation training room	The average number of virtual simulation training centers/bases
15.36%	10.65%

Table 4. The Form of Multimedia Classrooms in Vocational Schools.



3.2 The Traditional Vocational Education Learning Space Lacks the Construction of Learning Situations

The biggest problem in vocational education is that learners lack the perception of hands-on practice in acquiring knowledge [10]. As shown in Table 4, the multimedia classroom form of curtain + computer + projection accounts for 88.36%. The construction of multimedia classrooms in vocational schools continues to use the ideas of multimedia classrooms in primary and secondary schools and universities and lacks support for integrating theory and practice, classroom environment, and work scenes [11]. Implicit knowledge and skills are required in many fields of work, such as professional attitudes, the cognition of professional values, and professional standards in the working world. If the learners do not have personal experience, they cannot be implanted in their hearts only through technology transfer.

3.3 Traditional Vocational Education Skills Training is Insufficient, and School-Enterprise Cooperation is not Deep Enough

There are *three high* (high cost, high risk, high pollution) and *four hard* (hard to go down, hard to move, hard to see out, hard to reproduce) problems in traditional vocational education teaching practice. Formal vocational education skills training needs to be more solid, and school-enterprise cooperation needs to be deeper. It makes knowledge and skills teaching and work training out of line. According to the survey data of vocational schools, 66% of vocational schools have established school-based digital resource libraries, but only 33% of vocational schools have full-time teachers responsible for developing digital resources, as shown in Table 5. As shown in Table 6. 12% of vocational schools have not used virtual simulation technology, and only 17% have applied it to virtual simulation experimental teaching. Most of the students' practical learning is through limited physical space or watching video courses online. Due to the uneven informatization capabilities of teachers and the lack of digital resources, there are few opportunities for in-depth practical learning with the help of virtual technologies such as XR. Students lack the conditions and opportunities to operate equipment and manufacture products in real-time offline or online, and it isn't easy to carry out practical exercises with realistic conditions [12].

Table 5. Construction of school-based digital resources in vocational schools.

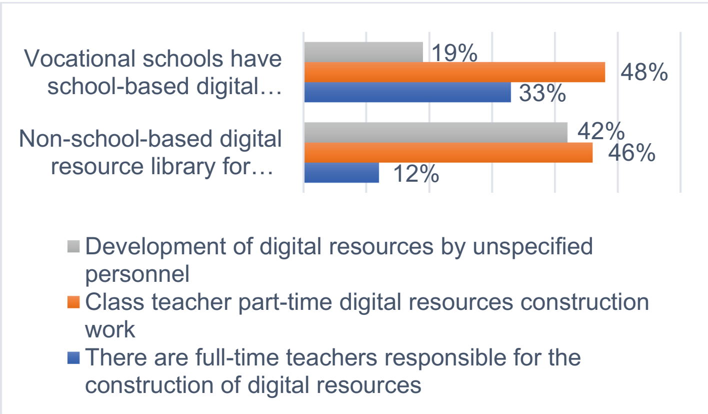
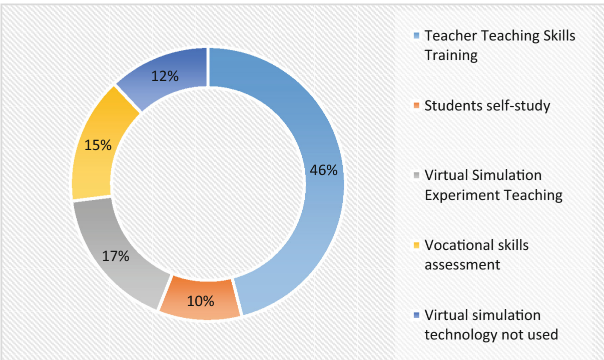


Table 6. The Main application areas of virtual simulation technology in vocational schools.



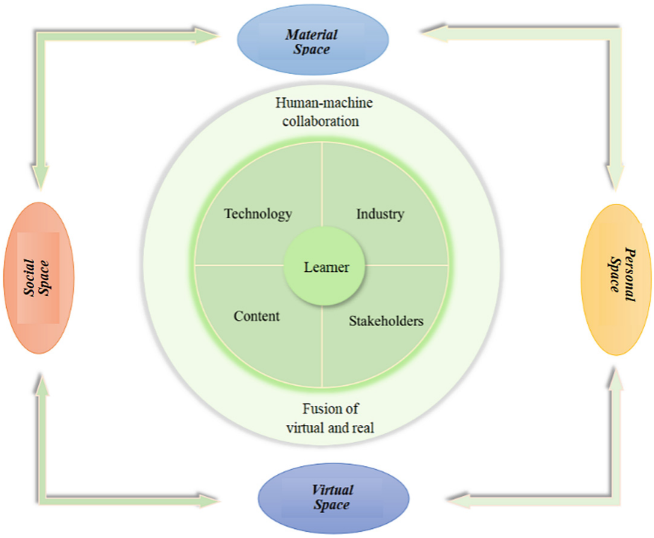


Fig. 1. Vocational education smart learning space model

4 Construction of Intelligent Learning Space for Vocational Education

4.1 Basis of Construction

From the data perspective, Yang Xianmin and others constructed a multimodal learning space fusion model divided into physical space and information space from the perspective of reality and virtuality and divided into social space and personal space from the perspective of society and individuals [13]. In the digital transformation era, Huo Lijuan constructed an IPST framework reflecting the characteristics of vocational education types from four dimensions of Industry-Pedagogy-Space-Technology [14]. Based on the above studies and studies at home and abroad, this paper proposes constructing an intelligent learning space model of vocational education centered on learners, man-machine collaboration, and virtual reality fusion, as shown in Fig. 1.

4.2 Smart Learning Space Model for Vocational Education

4.2.1 Material Space

The physical space of intelligent vocational education is a space that exists as a thing commonly known as a smart campus, smart classroom, smart learning resource library, smart training base, smart cloud classroom, and real-time recording and broadcasting system. As shown in Fig. 2, taking the smart classroom as an example, the space is usually equipped with smart devices such as digital pens, smart blackboards, various sensors, and educational robots, which can provide hardware support for individual learning, content rendering, intellisense and interactive collaboration [15]. The learning status of learners can be automatically sensed and recorded in real-time, and the learning

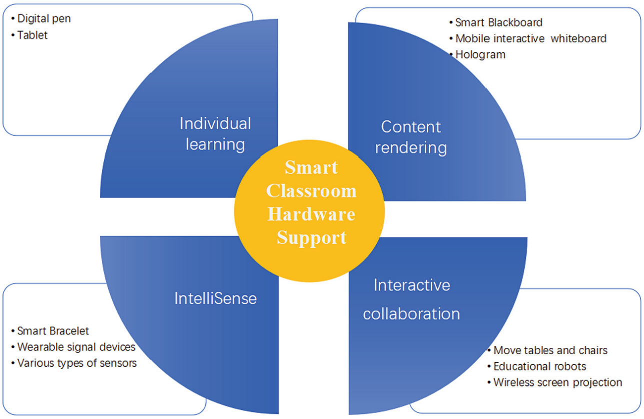


Fig. 2. Smart Classroom Hardware Support

Environment's temperature, humidity, and lighting are automatically adjusted. Learners can arbitrarily splice the tables according to different classroom learning styles. The con-nection of off-site space based on 5G+ remote broadcasting technology can not only realize the relationship between off-site classrooms but also connect classrooms with libraries, laboratories, actual work sites, fields, and other places where learning can be carried out. It makes students' vision break through the classroom walls and visualize the invisible and intangible things so they can learn in the situation. The special delivery classroom, synchronous classroom, dual-teacher classroom, and inter-school collabora-tive teaching deepen the cooperation between schools and enterprises in vocational ed-ucation. In the future, the connection of vocational education off-site space will greatly promote cross-class, cross-school, cross-regional, and even cross-country, joint school-enterprise teaching activities, and realize the integration and efficient sharing of high-quality educational resources, and narrow the education gap [10].

4.2.2 Virtual Space

The learning space empowered by intelligent technology can realize deep physical and mental integration through intelligent technology. Situational cognition theory emphasizes the interaction between students and social situations, the social network, and the activity system in which real behavior occurs. Due to the constructive, social, and situational characteristics of vocational education knowledge, the construction of learning situations in vocational education means that students have to face the real work process and tasks so that learners can learn meaningful knowledge and skills. For example, Augmented Reality (AR) is used in the course of "Computer Assembly and Maintenance" to show students the devices in the mainframe, which places the learners in an AR-created context and builds an experiential learning space where the learners are present to experience the process of assembling a computer. The construction of learning spaces under the empowerment of smart technologies requires the Use of the qualities of spatial places and the structure of the spirit of place to create an intimate and clear imagery relationship between learning spaces and learners, which in turn shapes multiple spatial imageries, empowers learners' subjective confidence, and enhances learners' inner sense of identity, belonging, and security in the space [16].

4.2.3 A Scenario-Based Learning Space that Integrates Virtuality and Reality

The key to scenario-based learning is the creation of scenarios and the design of activities in different scenarios. The core of embodied cognition theory is to emphasize the body's participation in the cognitive process and the embodied interaction between the body and the environment, so the process of mental formation should focus on being in the situation, body perception, and dynamic interaction [17]. The learning space that integrates virtual and real changes learners' identity from *real people* to *virtual and real people*. Learners can focus more on the learning activity itself. There are several types of virtual, real, and virtual-real scenes. In vocational education, real scenarios are classrooms, laboratories, internship factory workshops, enterprise jobs, etc. Wearable and sensing devices can create virtual scenes, and augmented reality technology and mobile devices can create scenes that integrate reality and virtuality. As shown in Fig. 3, combining vocational education training should be based on the characteristics of the work process and use the advantages of technology to create a virtual and real fusion, multimodal scenario-based vocational education training. To build vocational education science-reality integrated learning activities, designs physical model + simulation software, independent learning + intelligent assessment, virtual simulation teaching + real on-site teaching [18]. Different knowledge learning and skill training must be matched with varying learning scenarios. Multimodal scenario-based learning takes advantage of different scenarios. Various vocational education training activities are designed for classroom training, job training, and ubiquitous training. For example, classroom training uses a virtual simulation training system based on 3D real scenes, and job training aims at pain points of vocational education through digital twin workshops, 5G high-definition live broadcast to carry out learning activities on-site, and at the same time realize ubiquitous practical training with the help of venues and socially interactive learning spaces.

5 Elements of Intelligent Learning Space Model for Vocational Education

The learners of vocational education are not only vocational school students and general high school graduates but also non-traditional source groups such as retired military personnel, laid-off unemployed people, migrant workers, and new farmers. The vocational education learning space model is designed with learners as the center and contains four major elements: content, technology, stakeholders, and industry.

5.1 Reshape the Teaching Model in a Human-Machine Collaborative Learning Environment

In the learning environment of virtual-real integration, human-machine collaboration helps classroom teaching. Machine intelligence connects the classroom and real life with

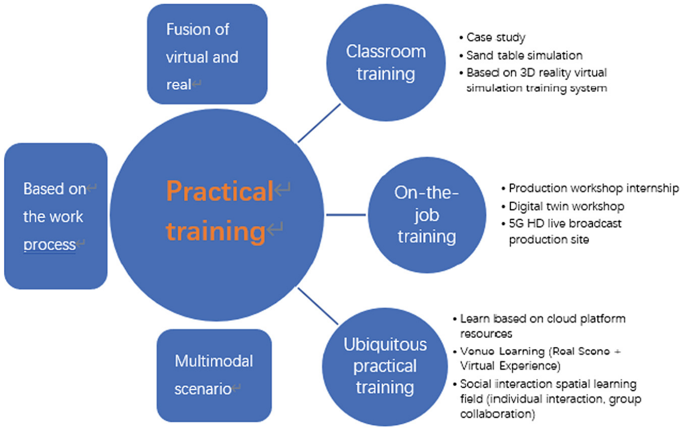


Fig. 3. Virtual and real integration training

big data and collects multiple data needed in this class with the help of various wearable devices, intelligent mobile terminals, and sensors. Machine intelligence analyzes the data with the support of a cloud platform, thoughtful analysis technology, and intelligent education machines and provides timely feedback to teachers and students, creating a more diverse learning environment for teachers and student [19].

Teaching design should focus on teaching objectives, educational content, and the learning situation, transform real projects of enterprises into teaching resources, and design and implement project teaching, case teaching, and work process-oriented education. Vocational schools implement new types of instruction, such as mixed teaching, integrated teaching of theory and practice, and modular teaching. At the same time, vocational schools explore the interaction and collaboration between on-campus and off-campus, online and offline spaces, and promote remote collaboration, real-time interaction, flipped classrooms, mobile learning, and other forms, and form a learning space that integrates theoretical knowledge and practical training, on-campus work simulation and off-campus workplace environment exercise [20]. Intelligent learning spaces allow educators to use technology to set up different teaching situations, implement different pedagogies, and build appropriate scaffolding to facilitate learners' learning. In the learning space, learners can actively understand problems, engage in thinking, construct knowledge, and receive social support through technology. Learners do not need to connect with other elements of the learning space directly but rather focus on the learning itself, which is accomplished through the intelligent learning space [21].

5.2 Intelligent Technology Expands Vocational Education Learning Space

With the rapid development of 5G/6G mobile communication technology, IoT, AR/XR, blockchain, and AI represent the in-depth application of new technology in education. As shown in Fig. 4, the reconstruction of learning space has entered the era of artificial intelligence [21]. Intelligent technology empowers the learning space and promotes the interaction between on-site learning spaces such as schools, enterprises, workshops, and

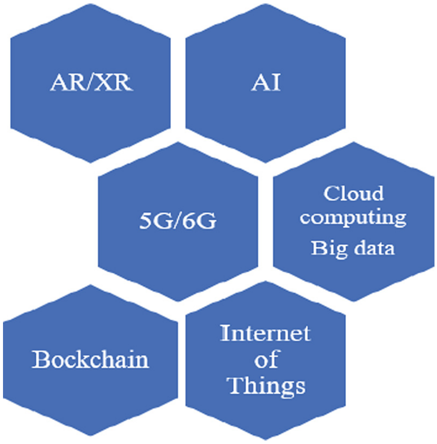


Fig. 4. Intelligent technology

virtual learning spaces supported by VR/AR to create a learning space that integrates virtual and real [14]. Intelligent technology activates the carrying capacity of space to support students' flexible learning behavior and the complex process of practical teaching in vocational education. From the spatial dimension, intelligent technology is profoundly promoting the further expansion of education from school space to social space. Due to the special attributes of vocational education, intelligent technology will further boost the growth of vocational education from the school field to all places that can produce knowledge and additionally eliminate the boundary between enterprises and schools so that multiple subjects, including enterprises and vocational colleges, can enter the intelligent ecosystem of vocational education and become direct actors [22], and realize cross-border integration of human-machine collaborative teaching in the age of intelligence.

5.3 Stakeholders

In the context of industry-education integration and school-enterprise cooperation, in addition to the dual subjects of teaching and learning, stakeholders include school administrators, enterprises, and social public cultural institutions. Stakeholders can influence various elements of the learning space. Some public cultural institutions, such as libraries, museums, and science and technology museums, are also important places for liberal arts education, which expand the learning space. At the same time, the design of the learning space is often done with the participation of school administrators, teachers, students, and enterprises. In the age of intelligence, the technological embedding of learning space requires technology companies to provide the latest technology applications for the learning space [23]. In line with modern society, vocational education should move from *teaching* to *learning*, meaning that school-enterprise dual education should develop students' complex abilities by optimizing the existing practical project teaching and promoting students' lifelong learning. Learners can better adapt to the complex and changeable future world. The school-enterprise teams will work together to create embodied practical learning environments to promote the functional integration of learning and communication, teaching management, and research innovation in vocational education.

5.4 The Organic Connection Between the Production Process of Enterprises and the Teaching Process Reflects the Industrial Nature

In the era of artificial intelligence, integrating industry and education and the education model such as post-competition certificates bring profound changes to vocational education regarding learning mode, curriculum supply chain, talent training exchange, and school ecology. The school connects the industry chain with professional clusters, builds a modular curriculum based on vocational work process orientation, takes real work tasks or enterprise production as the carrier, integrates new technologies, new techniques, and new norms in the industrial field into the teaching content in time, and carries out classroom teaching with the teaching mode of integration of theory and practice, which greatly expands the connotation of learning space. The penetration of its school philosophy, school orientation, teacher selection, textbook use, resource development, and other elements with industry is the premise and basis for promoting the effective connection between the education chain and industry chain, talent chain, and innovation chain. The realization of the teaching mode is reflected in the seamless switching of multiple learning spaces, such as online and offline, on and off campus, which requires the teaching tasks to be jointly undertaken by school teachers and enterprise instructors to realize the transformation of physical scene resources simulation of enterprises and production training bases, the change of digital twin simulation resources of enterprises and the shift of production project tasks of enterprises [14]. The design of vocational education learning space should fully consider that the evaluation of learners' learning effects should be integrated into the standards of vocational jobs, the data analysis of learning behaviors of enterprise production scenes, and the authenticity and operability of the equipment, environment, materials, and projects supporting learning.

6 The Implementation Path of the Intelligent Learning Space Model of Vocational Education

6.1 Construct the Supply Chain of Vocational Education Courses

The elements of teaching content, teaching organization, teaching methods, and education technology are connected with industrial scenes, production processes, and industry standards to form a functional network structure. The key for vocational colleges to focus on constructing professional clusters is to improve the competitiveness of vocational education and the serviceability to promote regional economic development. Firstly, in the professional setting, according to the industrial chain or vocational job group that the professions face, several disciplines with the same or related expertise are regrouped, and on this basis, the core professions and their associated professions are determined to optimize the professional layout. Secondly, in curriculum construction, government administrators, industries, enterprises, curriculum experts, and experienced teachers are introduced for *collective deliberation* to effectively maintain the consistency of curriculum construction in the same professional group in terms of vocational positions, technical skill bases, courses arrangement, and implementation should emphasize systematization and hierarchy, and establish a talent training process chain of *task proficiency stage-job competency stage-career system stage* centered on skill acquisition. The talent training process chain integrates the production process of enterprises, and the teaching process of schools balances the participation power of both in different task stages and spirals the learning contents according to different task stage [24]. Professional theoretical courses reconstruct the teaching content with the work process-oriented project-based teaching concept, carry the real production tasks, production equipment, and production processes of enterprises and restore them virtually, present the new scenes, norms, and standards of the industry in time, and endow it with the historical mission of cultural inheritance of craftsmanship and professionalism, and promote fundamental changes in teaching content.

6.2 The National Vocational Education Smart Education Platform Realizes the Data Support of the Whole Process and Effectively Supports the Deep Learning of Learners

The learning space architecture based on intelligent technology integration and learning space teaching based on intelligent big data technology should become the direction and trend of vocational education learning space construction. The *learning space architecture based on intelligent technology integration* and *learning space teaching based on intelligent big data technology* should become the direction and trend of vocational education learning space construction. The national smart education platform includes one vocational education brain-digital cockpit system, two secondary platforms, four sub-systems, and four sub-centers. By the end of March 2022, the first professional and curriculum service center was online; by the end of June, the development and online of other centers were completed; by the end of December, the development and online of all planned functions of the platform were completed. In the human-machine collaborative classroom, intelligent machines can analyze students' learning data, assignments, and testing results and provide teachers with timely feedback on students' learning performance. Teachers can understand students' learning in real-time and adjust their teaching strategies on time. The evaluation of knowledge in the human-computer collaborative classroom will change from a result-oriented assessment to a dynamic and diagnostic evaluation focusing on the process. Reviewing learners' learning effects should simultaneously be integrated into the professional job standards. The evaluation process needs to combine process evaluation and summative evaluation. The organic combination of assessment and teaching is realized. It is necessary to monitor students' learning trajectories utilizing information technology, such as comprehensive analysis and evaluation of the learning status during the teaching process, by wearing neurophysiological data measurement tools such as brain wave meter, electrodermal meter, and cerebral oximeter in physical space. By combining academic data such as course learning, resource management, online discussion, practice test, and result summary in the information space, scientific evaluation of the whole process of student learning is formed to accurately portray the individual portrait and group portrait of students to comprehensively understand the learning and development status of students [13], supporting learners' deep learning effectively and completely.

6.3 Create a Learning Society and Realize Lifelong Learning

The spatial structure of modern vocational education is to mesh the massive fragmented information resources and then deliver them to learners in the form of structured information flow, which forms precise educational resources to meet learners' personalized needs and stimulate the willingness to learn in depth [25]. Establishing a vocational education credit bank is a powerful tool for implementing lifelong vocational education and integrating academic and non-academic teaching. It cooperates with secondary and higher education institutions, employers, and third-party evaluation institutions and realizes the *flexible flow of credits-instant. Accumulation-conversion certification* to support the *cross-school learning-certificate integration-credible service* of vocational education. When the learning outcomes of vocational education can be certified, accumulated, and transformed, *lifelong* will have a practical basis. At present, the exploration of credit bank design supported by blockchain, cloud computing, big data, and other technologies [26] also fully proves the feasibility of credit banks to enable lifelong learning in vocational education.

6.4 Improve the Information Literacy of Various Subjects in Vocational Education

The information literacy of principals, teachers, students, and parents is directly related to the success or failure of modern vocational education teaching reform in China. The first problem of online teaching in Chinese vocational education is the insufficient informatization ability to teach subjects. Therefore, vocational education teaching reform needs to improve the informatization literacy of various [27]. Firstly, for front-line teachers, we should strengthen the training of in-service teachers' informatization ability, popularize informatization teaching technology, and continuously improve the informatization teaching ability of teachers in vocational colleges and universities. Secondly, vocational education learners learn and master various operating and practical skills of information-based learning. Learners actively integrate and adapt to the teaching mode of online teaching and blended learning. Thirdly, parents or other related subjects should follow the pace of information-based education, improve their information literacy and ability, and become the *backup group* for students learning.

7 Summary

Modern vocational education is the most easily linked to new economic growth points, such as the industrial economy and enterprise development in the intelligence era. The comprehensive creative abilities cannot be replaced by machines, such as cross-disciplinary resource linkage and technology combination [25]. Let vocational education embrace *digitalization*. Learners develop lifelong learning abilities in an immersive, human-computer collaborative intelligent learning space. In addition, there are also some problems in this article, for example, how to protect learners' privacy in the Intelligent learning space; how to prove the occurrence of deep learning of learners under the learning space model. Therefore, the executability and effectiveness of the vocational education intelligent learning space model have yet to be researched and verified.

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