福建省中电海峡智能装备研究院
Fujian Zhongdian Straits Institute of Intelligent Equipment
Asia Pacific Science Press
Advances in Management and Intelligent Technologies
ISSN(O):3079-5869
ISSN(P):3079-5850
Vol. 1 No.5 (2025)

Research on the Construction and Application of Personalized Learning Mode in Colleges and Universities under the Smart Classroom Environment

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Abstract: The digital transformation of education is the development direction for deepening the reform of China's education system and also the contemporary demand for promoting higher education to keep pace with the times. As a major form to apply digital information technology in education, smart classrooms can help students make use of fragmented time for autonomous learning, enhance thinking and exploration abilities as well as their sense of autonomy, and provide technical support for students' personalized learning. This research is based on the personalized learning needs of students in China's higher education institutions. It conducts construction and application research on the personalized learning model of college students in smart classrooms from aspects such as the drawing of digital graphs of personal learning characteristics, the identification of learning goals, the design of personalized learning, and individualization learning support. It is hoped that this research can provide more references and perspectives for optimizing the personalized learning of college students. It also contributes its humble efforts to promoting the development of Chinese higher education towards a more personalized and intelligent direction.

Keywords: Smart Classroom Environment; College and University; Personalized Learning Mode

Published: Oct 30, 2025

DOI: https://doi.org/10.62177/amit.v1i5.865

1.Preface

The report of the 20th National Congress of the Communist Party of China clearly put forward the educational development goal of "Promoting the digitalization of education and building a lifelong learning society and nation for all", which provides an important basis for promoting the reform and development of China's education system and also serves as a guide for schools to continuously advance the digitalization of education. At present, with the development of information technologies like artificial intelligence, the Internet of Things, precision algorithms and blockchain, the digital transformation process of education in China is accelerating. Especially during the COVID-19 pandemic, the exploration and application of online education technology by educational institutions in China have further promoted the upgrading and development of digital education technology. The construction and application of smart classrooms can fully leverage the significant role of digital technology in the interaction between teachers and students, among students, and between humans and computers. Relying on the advantages of digital teaching virtual scenarios and massive information resources, it provides conditions for students

to rationally utilize their spare time, enrich their learning methods, and formulate personalized learning plans. Therefore, in general, the application of smart classrooms is conducive to return education in China to its original purpose of cultivating people with both ability and integrity.

Colleges and universities are the main ground for cultivating outstanding young talents in China. Personalized learning is a key factor in fostering innovative talents and also an urgent need for students to possess the lifelong learning ability to adapt to a learning society. The National Medium and Long-Term Education Reform and Development Plan (2010-2020) clearly states that "We should adhere to the people-oriented concept, respect students' individual choices, encourage individual development, innovate talents cultivation models, and cultivate talents in a flexible way." Meanwhile, the "Ten-Year Development Plan for Education Informatization (2011-2020)" also proposes to attach great importance to personalized learning, emphasizes to stress the provision of personalized and lifelong learning and offer environmental support for all learners. It can be seen from this that the education department of China highly affirms the positive role of personalized learning in cultivating innovative talents. The research on the construction and application of personalized learning models in colleges and universities under the smart classroom environment will help to explore a more efficient, convenient and personalized learning path for college students, and also contribute to promoting the development of higher education in China towards a more intelligent and humanized direction.

2.Analysis of the Connotations and Coupling Mechanism of Smart Classroom Environment and Students' Personalized Learning

2.1 The Connotation of Smart Classroom and Personalized Learning for Students

2.1.1 The Connotation of the Smart Classroom

To promote the development of smart classrooms, the Ministry of Education in China has successively issued policy documents such as the Ten-Year Development Plan for Education Informatization (2010-2020), the 13th Five-Year Plan for Education Informatization, and the Action Plan for Education Informatization 2.0. Among them, the Action Plan for Education Informatization 2.0 has clearly put forward the concept of Smart Learning Environment. And in the 2022 work priorities, it was pointed out that "We should promote the construction of smart classrooms and accelerate the transformation of classroom teaching models". With the support of a series of policy documents, smart classrooms in China have begun to enter a stage of regular exploration and application.

Regarding the definition of smart classrooms, scholars like Cheng Wei (2024) defined it as an important model that integrates modern digital technology and teaching methods into traditional teaching, and promotes the digital development of education. Comparing with traditional teaching environments, smart classrooms are more informationalized and intelligent, and provide stronger interactivity environment between teachers and students. Scholars like Xu Hongkai(2023) believe that smart classrooms can achieve two-way interaction between teachers and students through a human-machine combined mode, deepen and optimize the process of students' knowledge construction, emphasize the subjectivity of students' learning, and thereby promote the development of students' comprehensive qualities and overall abilities. The application of smart classrooms is of great significance for cultivating students' independent exploration and autonomous learning abilities.

Based on the above viewpoints, the research concludes that a Smart Classroom refers to a new teaching method and means that relies on digital information technology for reform and innovation. That is, digital information technology, artificial intelligence and other information tools are added to the traditional classroom teaching model to facilitate teachers in using intelligent technology to analyze students' efficiency and learning needs, promote individualized learning, and improve overall teaching efficiency. Compared with traditional classroom teaching where the teacher is the main body, the smart classroom is a process of interaction between teachers and students, rather than a simple process of knowledge transmission and acquisition. It places greater emphasis on the student as the main body and focuses on cultivating students' innovative thinking, inquisitive spirit and individualized learning ability.

2.1.2 The Connotation of Personalized Learning

The personalized learning refers to in this research is a customized learning plan formulated by students in a smart classroom environment based on their own learning schedules, ability levels, learning progress, and learning goals. It is a

value manifestation of the smart classroom empowering students' autonomous learning. Students can conduct online and offline autonomous learning, assessment, and watch teaching videos in the smart classroom environment according to their own learning situations, and build exclusive learning scenarios, thereby cultivating independent thinking and autonomous judgment abilities.

Compared with middle and primary school students, college students usually have more mature logical thinking and learning abilities. Moreover, universities offer a more open learning environment for them. Therefore, it is particularly important to cultivate personalized learning plans for college students. In the smart classroom environment, college students can flexibly adjust their learning plans based on their own learning characteristics and needs, and choose suitable learning resources and methods for themselves. This personalized learning model not only can stimulate students' interest and motivation in learning, but also encourage college students to explore actively and practice bravely. This is of great significance for cultivating innovative and practical talents in China.

2.2 Coupling Mechanism between Smart Classrooms and Personalized Learning Education Function in Higher Education Institutions

2.2.1 Smart Classrooms are Helpful in Cultivating College Students' Individualized Learning Ability

With the diversity of career choices, college students group also shows significant differences in learning needs during their study. The traditional One-size-fits-all teaching model has become unable to meet college students' different learning needs in preparing for civil servant recruitment, postgraduate entrance exams, or employment application. At the same time, in traditional classroom teaching, time and space limitations, such as the uneven distribution of teaching staff, different study time arrangement and learning effectiveness, have further exacerbated the contradiction between individualized learning needs and the One-size-fits-all teaching model. Smart classrooms rely on digital technology to track students' learning performance, homework completion, and online learning behaviors in real time across multiple dimensions. It can precisely draw a digital learning profile for each student and intelligently recommend course content and exercise resources that are adapted to different knowledge foundation and learning progress. Moreover, students can also use fragmented time to communicate and discuss with teachers and classmates through tablets, smart terminals, etc. in the virtual learning community, and raise personalized learning questions. Thus, the application of the smart classroom has broken the time and space limitations of traditional classrooms, providing technical support for students' individualized learning needs and comprehensively cultivating students' comprehensive learning abilities.

2.2.2 Smart Classrooms are Helpful to College Students in Better Adapting to the Development of the Intelligent Era

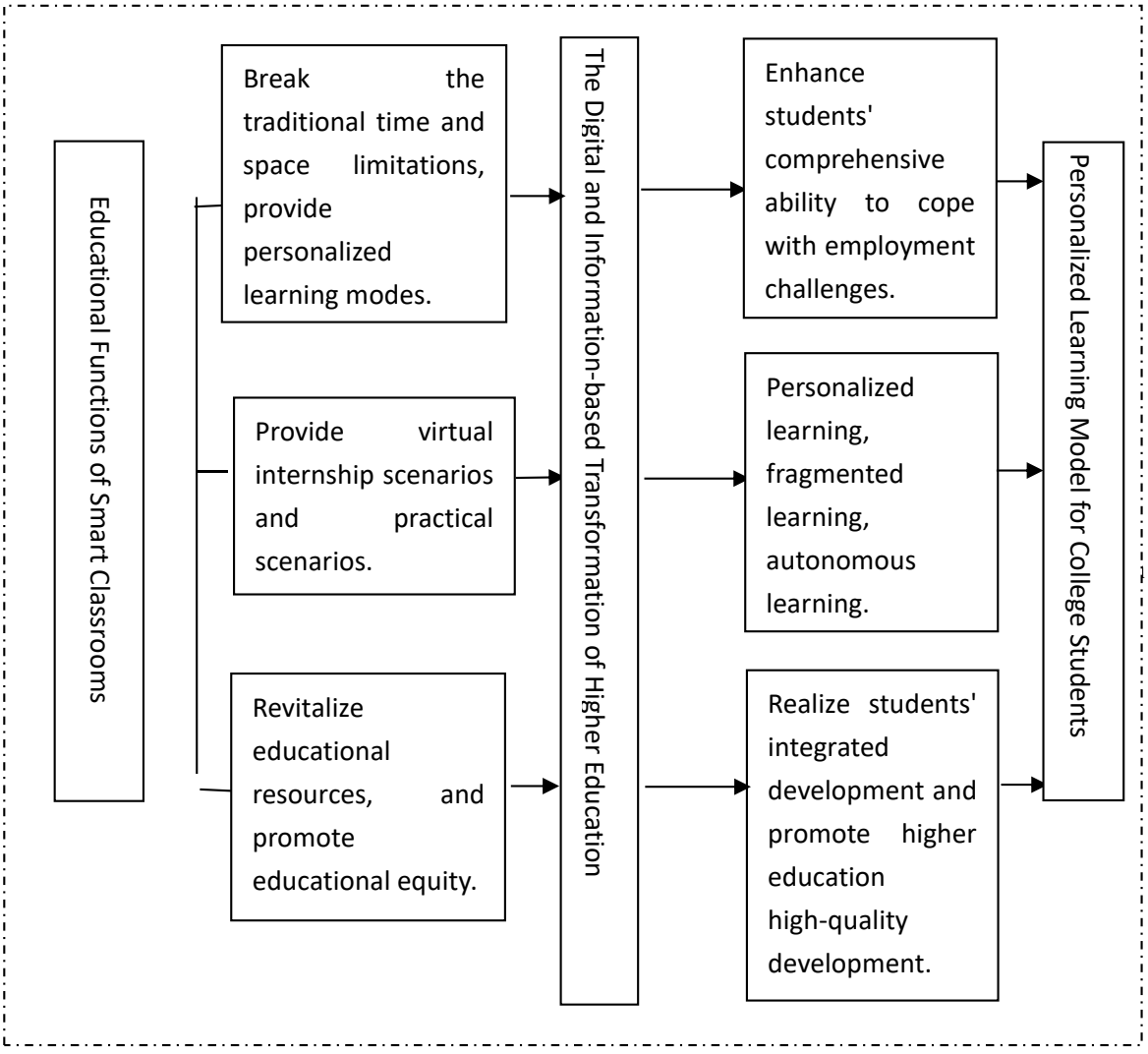
The development and application of smart classrooms are mutually reinforcing with artificial intelligence technology. In the context of the artificial intelligence era, the industrial structure of China's manufacturing sector has been rapidly optimized and upgraded. Traditional manual labor positions have been replaced by mechanical and intelligent technologies, and automated production has been fully implemented. College students, as the main body of quality-oriented higher education in China, have received social attention due to changes in the external employment environment. In the employment environment where artificial intelligence technology is widely applied, traditional low-skilled industries and jobs have suffered unprecedented impacts, which also places higher demands on the practical ability, independent exploration ability, and innovative ability of college students in their careers. Smart classrooms are different from traditional classroom education, they create more virtual employment scenarios and practical scenarios for students' learning through digital technology, providing more learning opportunities for college students to combine theoretical knowledge with practical ability, and creating a favorable learning environment for students to better cope with employment challenges.

2.2.3 Smart Classrooms Promote the Optimization of Educational Resources Allocation and Application in Universities and Colleges

In traditional classroom teaching, due to differences in educational staff, facilities, and policies, college students often have difficulty accessing fair educational resources. However, in the smart classroom environment, the allocation and utilization of educational resources have become more efficient and reasonable. Smart classrooms rely on massive network information

and digital technology to break geographical barriers and achieve the sharing of educational resources. They can gather high-quality educational forces and advanced teaching methods to form online education courses, and distribute high-quality digital education courses equally. This optimization of resource allocation not only improves students' learning efficiency but also promotes the fair distribution of educational resources, enabling each student to obtain suitable learning opportunities and resources. In the long run, the application of smart classrooms will promote a continuous expansion of the higher education resources scope in China. Through personalized learning and utilization, students will drive the positive feedback and interaction between smart classrooms and higher education, ultimately promote the sustainable development of higher education in China.

Figure 1：The Theoretical Framework For the Coupled Development of the Smart Classroom Environment and Students' Personalized Learning.



3.Research on the Construction of Personalized Learning Models for College Students in Smart Classrooms

3.1 Drawing of Digital Maps of Students' Learning Characteristics

The personalized characteristics while learning are the basis for identifying college students' individualized learning needs. To provide personalized learning models for college students in an intelligent classroom environment, it is necessary to first identify and construct the learner's profile. Through the precise algorithms of the smart classroom, learners' individualized characteristics can be mined, and then the students' learning time arrangement, learning level and ability, learning attitude, learning interactivity, and learning habit preferences can be comprehensively evaluated. By drawing personal digital maps, corresponding personalized learning materials can be precisely pushed.

Table 1:Personalized Digital Profiles of College Students as Learners

Information Dimension	Information Decomposition	Third-level Sub-information
Basic Information	Identity	gender\grade\major\hometown\nation\politics status, etc.
	Economic Situation	annual household income range\ loans and scholarship situation\ monthly living expense standard
	Enrollment style	Whether be enrolled by recommendation or special talents.
Learning Level and Ability	Basic ability	English proficiency level\computer skills\mandarin Chinese level
	Professional competence	GPA\professional competition award situation\ scientific research experience(paper publishing or research participating situation)
	Study potential	learning ability self-assessment\test results of thinking ability (including dimensions such as logical reasoning and innovation ability)
Learning Habit Preferences	Study Time Management	average daily study duration\ peak study times (morning/noon/afternoon)\ fragmented learning habits (such as study during commuting)
	Learning Resource Preferences	preferred learning platforms (MOOCs, Bilibili, Netease Cloud Classroom, etc.)\ preferred learning formats (video courses / textual materials / live lectures)\ frequently followed learning bloggers or public accounts
	Learning Style	self-study frequency\ participation in group cooperative learning\ whether willing to make public statement, etc.
	Types of Learning Motivation	self-motivated (seeking knowledge)\ goal-driven (for exams/certifications)\ pressure-driven (fear of failing)
Interests and Special Talents	Interested Subject	interested subjects apart from the major (such as psychology, economics)
	Interests	hobbies (music, painting, sports) and club activities participation (positions held situation)
	Skills	skills that be proficient in (such as sports, programming, innovative design, writing)

3.2 Identification of Students' Personalized Learning Goals

By applying digital models and artificial intelligence technologies to draw the personalized learning digital map of college students, personalized learning goals can be calculated based on their learning habits. In the smart classroom environment, students' personalized learning goals can be decomposed into short-term goals, medium long-term goals, and coordinated development goals. Thus, the personalized learning environment for students can be designed with a focus on their learning goals. Table 2 shows the decomposition of students' learning goals.

Table 2: Identification of College Students' Personalized Learning Goals

Learning Goals	Short-term Goals	expected semester GPA\ passing the final exams of specific subjects\ obtaining certain certificates (such as the junior accounting qualification certificate, teacher qualification certificate)
	Medium and Long-term Goals	postgraduate entrance examination goals (target university, major, preparation progress)\ civil servant recruitment goals (target application, position type, study plan)\ employment goals (expected career, position, enterprise type)\ study abroad goals (target country, university, language proficiency requirements)
	Coordinated Development Goals	improve communication and expression skills\ cultivate teamwork abilities\ enhance professional practical skills

3.3 Personalized Learning Design in Smart Classrooms

Firstly, targeted design and precise delivery of learning resources should be given. Compared with traditional offline classrooms, one advantage of smart classrooms is that they can provide students with a wealth of learning resources for their individualized learning, promoting the transformation of learning materials from single, static paper-based materials to various dynamic learning resources such as videos, audio, courseware, and electronic texts. Due to differences in learning styles, learning cognition, and preferences among students, they can freely choose from different resources. Moreover, in the smart environment, teachers' teaching methods are not limited to traditional lecturing-style teaching, but can also make greater use of the interactivity of digital technology to achieve interaction between teachers and students, and between humans and machines. By providing learning resources with different teaching characteristics such as explanatory, exploratory, and demonstration types, the needs of students' individualized learning can be met.

Secondly, personalized learning paths should be designed. Learning paths are important carriers that reflects the individualized learning process of students under the support of intelligent technology. The smart classroom, based on the preset curriculum model, can provide students with more options for initiating personalized learning. In the smart classroom environment, teachers can recommend learning courses and resources to students through the learning platform, and students can also choose self-study modes based on their learning goals. The former is that the learning system or platform, based on the students' electronic files, analyzes the data of their learning process and recommends an appropriate learning path for them, including a series of learning resources, learning content, test questions, etc. The latter is that students, based on their self-awareness of learning foundation, preferences and styles, independently choose the learning path. However, whether it is system recommendation or students' independent selection, the prerequisite is to conduct differential diagnosis of students' individual knowledge levels, interests, etc. Based on this, personalized learning paths need to provide learning content and evaluation methods with certain differences to meet different individualized learning needs.

Finally, personalized learning effectiveness evaluation should be implemented . Traditional offline classroom teaching evaluation often focuses solely on the students' academic performance, rarely considering the process-related evaluation elements such as students' attitudes, methods, and enthusiasm during the learning process. Smart classroom can precisely and objectively evaluate the overall learning effectiveness by tracking students' online platform learning performance in real time. Moreover, the smart classroom can break the single evaluation method in traditional classrooms that is dominated by the teacher, and evaluate students' personalized learning through human-computer interaction, student-student interaction, and teacher-student interaction, from different entities such as teachers, classmates, and group members. Thus, it realizes pre-evaluation, in-evaluation, and post-evaluation in the learning process; teacher evaluation, classmate evaluation, and member evaluation in terms of the main body; and questionnaire evaluation, scale evaluation, and student work evaluation in terms of methods. This enables various diversified evaluation methods such as questionnaire evaluation, scale evaluation, and student work evaluation, achieving closed-loop management of students' personalized learning.

3.4 Analysis of Support for Students' Personalized Learning in Smart Classrooms

To implement the personalized learning methods for college students in a smart classroom environment, it is essential to establish corresponding software and hardware teaching environments and corresponding teaching staff. From the above description of the essence of a smart classroom, it can be seen that the implementation of a smart classroom requires at least four elements: complete infrastructure, network environment, learning resources, and teaching staff.

The Internet of Things infrastructure is the core of the entire physical facility layer. The network seamlessly connects the physical space and virtual space of the smart classroom. The Internet of Things infrastructure mainly includes switches, cameras, network communication systems, etc. The smart classroom focuses on the acquisition and preservation of generative resources. Learning resources are not static but are updated in line with the learning content. Generative learning resources are precisely pushed and designed based on students' digital profiles, embodying the concept of personalized learning. In addition, the courses provided by the smart classroom should also be able to support students to access rich learning resources at any time and anywhere for ubiquitous learning.

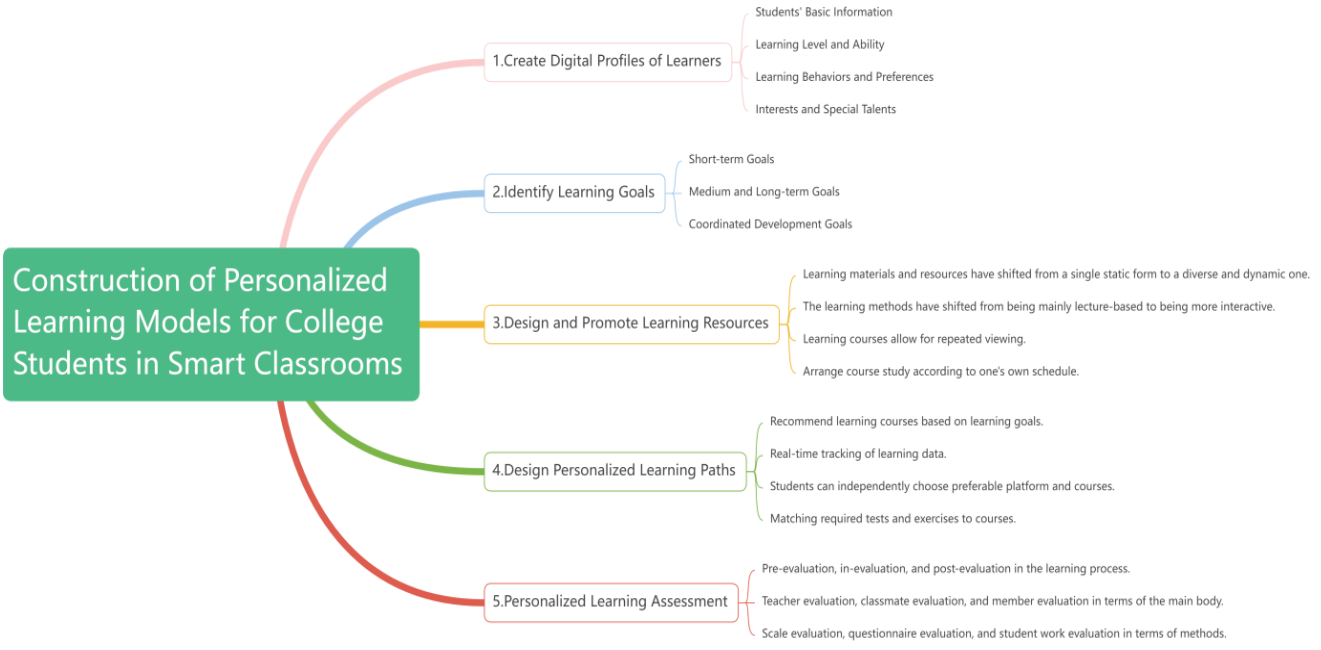
Finally, teachers remain the main body for conducting individualized teaching for students. Therefore, teachers need to be

proficient in applying smart classrooms and online education platforms, be skilled in using digital teaching methods such as initiating discussions, organizing voting, assigning homework, and conducting online assessments, and also possess the ability to conduct in-depth analysis and interpretation of students' learning data. When implementing individualized learning for college students in a smart classroom environment, teachers also need to focus on cultivating students' autonomous learning abilities, encouraging them to explore actively and practice diligently, and helping students construct and internalize digital learning knowledge.

3.5 Individualized Learning Model in Smart Classrooms

Based on the above analysis, this study has constructed a five-dimensional personalized learning model based on four elements: infrastructure, network environment, learning resources, and teaching staff. The dimensions and contents of individualized learning for college students are specifically shown in Figure 2. Regarding the presentation of the entire model diagram, compared with the traditional learning model in offline classrooms, the personalized learning in the smart classroom environment places greater emphasis on students' autonomous learning and personalized choices, and weakens teachers' intervention role during the learning process. This model, based on the concept and method of scaffolding teaching, enables teachers to gradually withdraw these scaffolds while ensuring that students can ultimately complete the scaffolding learning tasks, which is conducive to better cultivating students' autonomous learning ability and logical inquiry ability.

Figure 2:The Overall Construction of Students' Personalized Learning Model in Smart Classroom Environment



4.Evaluation of the Application of Personalized Learning Model for College Students in the Smart Classroom Environment

After four-month observation on the personalized learning model designed in this study, the results show that the smart classroom environment can better support universities in implementing personalized learning models. The designed learning model has played a positive role in cultivating students' autonomous learning abilities, promoting the rational use of fragmented time, and helping students formulate personalized learning plans. However, at the same time, it was also found in the research that the implementation of the smart classroom still requires improvement.

4.1 The Advantages of the Personalized Learning Model for College Students in the Smart Classroom Environment

Through a four-month learning observation, college students in the smart classroom environment can reasonably plan their study time based on personal schedules and plans, the learning model provided more support for students to efficiently utilize fragmented time.

Secondly, online education courses allow students to repeatedly watch teaching videos, and teachers can provide in-depth explanations by combining dynamic learning resources. These technological supports help break through the time and space limitations of traditional offline classrooms in terms of teaching content. At the same time, the smart classroom environment supports functions such as student questioning and online discussions, which can enhance students' interest in learning and encourage them to actively participate in interactions. This not only promotes the development of students' logical thinking abilities but also boosts their learning enthusiasm.

Finally, the smart classroom environment provides more scenarios for college students to engage in personalized and in-depth learning. By simulating scenarios such as factory production, business negotiations, and court debates, students can exercise their practical abilities in a realistic environment, thereby better adapting to future career development. This in-depth learning experience enables a closer integration of theory and practice for students, enhancing their comprehensive qualities and employment competitiveness.

4.2 Deficiencies of the Personalized Learning Model for College Students in the Smart Classroom Environment

There are also some deficiencies exist in the designed personalized learning model, mainly manifested in the following two aspects.

Firstly, smart classrooms require high quality network environment. Unstable network conditions or slow speeds may occur when a large number of users crowd at a same peak time, causing lagging and affecting the normal operation of students. Therefore, when promoting the smart classroom, colleges must attach importance to the construction and optimization of the network environment to ensure that students can access the network stably and quickly, thereby fully utilizing the various functions and resources provided by the smart classrooms.

Secondly, some teachers are not yet proficient in the application of digital platforms when using the smart classroom. Teachers are still in lack of the ability to deeply analyze students' personalized learning needs and learning data. Some teachers are still accustomed to traditional lecturing-style teaching and have certain deficiencies in how to design personalized learning paths, push learning resources, and implement precise teaching using the digital technologies and interactive functions provided. Therefore, when promoting the smart classroom, colleges also need to enhance teachers' digital literacy and teaching ability, so that they can better adapt to the teaching needs of the smart classroom environment and better serve students' personalized learning.

5.Conclusion

The application of smart classrooms provides excellent external conditions for the individualized learning of college students and is an innovative teaching method that meets the talent cultivation needs of the 21st century in China. Under the environment of smart classrooms, college students can better adapt to the workplace demands of the intelligent era through self-directed learning arrangements. In the future, smart classrooms in universities will better integrate technologies such as bring artificial intelligence and big data into teaching process, achieve precise delivery of teaching content, make intelligent diagnosis of the learning process, and offer personalized evaluation of learning outcomes. Conducting research on the teaching practice of smart classrooms in universities will help promote the integration and innovation among disciplines and provide students with a more comprehensive and personalized learning experience.

Funding

No

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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