



# Design and Application of University Intelligent Learning Environment Centered on Improving User Experience

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**Abstract.** With the emergence of new technologies, such as the Internet of things (IoT), big data, cloud computing and mobile communication, smart education has gradually become a new driving force for national education development. China's Ministry of Education called for the in-depth promotion of "Internet + higher education", breaking the time-space boundaries and school walls of traditional education. Currently, China's reconstruction of the intelligent learning environment is mainly focused on the design of smart learning spaces. The difference between the stage of wisdom education and other stages of informationization development is to emphasize the cultivation of learners' creativity. This directly becomes the main starting point for the design of a new generation of learning spaces. Therefore, the intelligent learning environment will combine the combination of creativity and digital as the key to innovation. However, there is currently a lack of innovation in the improvement of the user experience in an intelligent learning environment. Therefore, this paper focuses on the analysis of the main problems of the current Chinese university learning environment, such as teaching-centered classroom setting unsuitable for classroom interaction, public learning space with low user experience, and lack of teaching decisions supported by big data analysis and learning behavior analysis, and then achieves the best student learning effect through the reconstruction of the smart learning environment centered on improving the use experience, including physical and virtual environments. The use experience-centered smart learning environment ultimately has been evaluated in a case study, which indicates that the environment can effectively improve students' self-learning and problem-solving abilities.

**Keywords:** Intelligent learning environment · User experience · Learning environment innovation · University students · Learning space · Interactive learning · Learning behavior · Learning-centered furniture design · Space interaction

## 1 Introduction

At present, with information technology developing, technological change on people's lives have a huge impact. With the emergence of new technologies, such as the Internet of things (IoT), big data, cloud computing and mobile communication, smart education has gradually become a new driving force for national education development [1].

In 2018, China's Ministry of Education called for the in-depth promotion of "Internet + higher education", breaking the time-space boundaries and school walls of traditional education, and promoting the rapid development of higher education with profound changes in the mode of education and teaching. It requires to vigorously promote the application of modern information technology, build smart classrooms, smart LABS, and smart campuses, which needs to explore and implement networked, digital, intelligent, and personalized education, reshaping education and teaching patterns [2].

Currently, China's reconstruction of the intelligent learning environment is mainly focused on the design of smart learning spaces. The difference between the stage of wisdom education and other stages of informationization development is to emphasize the cultivation of learners' creativity. This directly becomes the main starting point for the design of a new generation of learning spaces. Therefore, the smart learning environment will combine the combination of creativity and digital as the key to innovation. However, there is currently a lack of innovation in the improvement of the user experience in a intelligent learning environment. Therefore, this paper focuses on the analysis of the main problems of the current Chinese university learning environment, and then achieves the best student learning effect through the reconstruction of the smart learning environment centered on improving the use experience, including physical and virtual environments.

## 2 The Main Problems on the Learning Environment in Universities in China

### 2.1 Teaching-Centered Classroom Setting Unsuitable for Classroom Interaction

In general, the traditional teaching-centered or teacher-centered classroom is not conducive to teacher-student interaction, and is not conducive to brainstorming and association creation. From the perspective of physical environment, it is difficult to maintain efficient group discussion, group collaboration and effective classroom interaction with fixed tables and chairs and little discussion writing space. Raised platform, is not conducive to the teacher down the platform, the platform position also pull far the distance between the teacher and the students. From the perspective of equipment, a single multimedia device cannot show and evaluate students' achievements in real time. The power supply and wireless network in the classroom have weak support for students' own device, i.e. bring your own device (BYOD).

## 2.2 Public Learning Space with Low User Experience

In the early point of view, the public learning space in the teaching buildings of universities is more concerned with the economy and safety of public space and other factors, and it is not recommended to gather people freely. Closed Spaces and corridor are more used, and students cannot enter without permission. In an interview with the Colombian newspaper EL Tiempo, Frank Locker, a professor at harvard's school of education/school of architectural design, even called the learning space a prison, arguing that schools should have a sense of community. At present, the public learning space of most universities, from the spatial structure and the size of the venue to the indoor and outdoor supporting facilities, is basically constructed from the perspective of "educator" teaching, giving priority to the convenience of teachers and facilitating managers [3]. In addition, the shortage of classrooms and library seats is a common problem in universities. The public spaces such as school corridor and lobby are mostly standardized design of traffic space, and the ecology is not friendly enough, resulting in relatively low user experience. Lack of connectivity to the surrounding classroom learning environment and social features are not conducive to creating a learning atmosphere of interactive communication and collision of wisdom.

## 2.3 Lack of Teaching Decisions Supported by Big Data Analysis and Learning Behavior Analysis

Since the form of the class teaching system of Comenius "The Great Didactic" has been established, the same or similar age characteristics and cognitive level are the basic premise of the traditional school placement teaching. The formulation and adjustment of teaching decision such as teaching objectives, teaching activities, and teaching evaluation in the teaching process of teachers are standardized behaviors at the expense of individualized needs of students. At the same time, due to the large number of students, the traditional classroom teaching observation method is difficult to obtain the behavior data of all students. It is difficult for teachers to comprehensively observe and record the learner's learning situation. It is difficult for managers to accurately quantify the teacher's teaching behavior and student learning behavior in classroom teaching, students are difficult to fully express themselves, the evaluation of teaching and learning is difficult to be scientific and precise, the optimization and improvement of teaching and learning lacks the support of data.

At present, most universities do not have an information-based classroom interaction system, such as the handheld feedback system. Even if equipped with a small number, it is difficult to benefit all classes. Due to the lack of appropriate auxiliary tools for classroom interaction, it is difficult for teachers to grasp the design of the form, time and content of classroom interaction and the control of the interaction process [4].

Such a learning environment affects students' performance in the classroom more or less, the students' participation in the classroom is low, and the teacher-student interaction is less. In addition, limited by class time and the number of students, teacher-fronted closed questions only require students to show specific facts, which makes it difficult to complete the initiation-response-feedback IRF interaction cycle [4]. Hence, "Class questions" is ineffective.

### **3 The Overall Design Idea of University Intelligent Learning Environment Centered on Improving User Experience**

The learning environment is the place and foundation for effective learning. The learning environment renovation is the premise of education and teaching reform. The learning environment with good user experience will make the dialogue happen more naturally. The “Redesign Learning Space” has been mentioned in the Horizon Report (Higher Education) for the past three years. In the 2018 report, it has changed from the “mid-term trend” in 2017 to the “short-term trend”. Redesigning the learning space will be the focus of higher education. The purpose of redesigning the learning space is to design a variety of physics teaching spaces under the support of digital technology to help individuals and groups find a more appropriate learning style [5], so that the environment can inject new impetus into the growth of learners. It can be seen that the design of the learning environment mainly starts from two aspects: physical space and virtual space [6].

After researching the learning environment of Nanyang Technological University, Sichuan University, Peking University and Shanghai Jiaotong University, this research starts with the human-oriented physical learning environment design and the smart learning environment supported by digital technology, and analyzes the design concept of a smart learning environment centered on improving user experience and its application practice in South China University of Technology.

### **4 Design Concept and Practical Case of Physical Learning Environment Centered on Improving User Experience**

#### **4.1 Learning-Centered Furniture Design on the Comfort Level of Students**

The use of free combination of mobile tables and chairs, focus on the combination and application of teaching furniture, highlighting the comfort, flexibility and harmony, and requirements to meet the needs of different course scenes. As shown in Fig. 1, different classroom layouts can arrange different learning activities and educational practices. Flexible indoor layouts and seats are convenient for students to participate in classroom teaching activities. Bright modern office facilities are conducive to mobilizing students’ excitement and sense of professionalism. The seats are ergonomic in design, and the tables and chairs are flexible, movable and can be combined as needed. Students sit together in groups of three or five. Even with their backs to the teacher, mobile learning devices and screens on multiple walls can ensure all-angle classroom interaction to meet the needs of different teaching and group discussion. The splicing of the desk adopts strong magnetic tape and clasp to achieve double fixation and overall uniformity. The wiring hidden in the floor can be used with the application of BYOD mobile terminals such as tablet and notebook.



**Fig. 1.** Learning-centered furniture design for intelligent learning environment to enhance user experience.

The space layout is flexible and the desks and chairs are ergonomic. Depending on the area, each classroom provides 1–3 all-in-one machines. Each wall is covered with a glass whiteboard or coated with nano wall. Different learning groups can be freely combined according to different teaching needs, and carry out group learning with the corresponding wall display screen or writing board.

#### **4.2 The Wall-Centered Space Design for Assisting Students' Creativity and Achievements**

According to the school's funds, around the wall, deploy a blackboard, whiteboard, glass magnetic whiteboard, or paint a writable paint such as rewritable nano wall paint on the wall. At least two "walls" in each classroom can be used by students to write, and become a brainstorming, discussion, and learning achievement display area, as shown in Fig. 2. Through the change of the space environment, the students actively participate in, interact, explore and contribute to the learning behavior, and stimulate teachers to have more interest and willingness in the innovation and exploration of the teaching form. Committed to designing an open learning space that allows teachers and students to work together and interact more.



**Fig. 2.** The wall-centered space design to assist students' creativity and achievements in terms of user experience.

Deploy a fixed or mobile all-in-one machine, display screen, etc. in the classroom, and use the split-screen display technology and multi-screen interactive technology to support the interaction between teachers and students, and give full play to the role of students' own devices. Media with memory functions such as electronic blackboards can extend the brain function of learners, making it easy for teachers and students to remember at any time. Inside and outside the classroom, teachers can interact with students' handwriting, image interaction and video interaction. The student terminal can interact with the group discussion screen, the teaching dual screen and the group discussion screen, and the group discussion screen. Rich interactive means deepen the level of interaction and enhance students' sense of learning achievement and self-efficacy.

### **4.3 Renovation of the University Public Learning Space to Create a Learning Environment Concept - Study Everywhere**

In the renovation of public learning space, the concept of service education and intensive integration is adopted. Natural energy is utilized to strengthen space greening design. Different learning spaces are provided according to different learning forms to attract and guide students to study, research, communicate or relax in the public learning space, as shown in Fig. 3.



**Fig. 3.** Renovation of the university public learning space.

Moreover, the first phase of learning space renovation was carried out in the Boxue building of South China University of Technology, giving full play to the public learning space as a demand for learning, exhibition, social contact and rest. According to the adult reading distance of 3.75–8 m, set up the creative reading area, provide the network and power interface, equipped with books, media resources and so on; renovate the patio to learn the garden; in the overhead floor, corridors and corners, public spaces, corners and bumps. In the area, there are small leisure tables and chairs with a variety of tones combined with each other; through moving furniture, green plants, bookshelves and other movable building components, the space is enclosed, and a relatively independent and quiet immersive learning space is established.

Furthermore, China is in the era of mass innovation and mass entrepreneurship, universities pay great attention to the cultivation of students' awareness of entrepreneurship and innovation and innovators' ability. In the public learning space,

the theme corridor will be built, and the theme display panels and other publicity materials will be built to superimpose the demand on the function of learning needs, so as to satisfy the display of student innovators and practical works. The informal learning space can be seen everywhere, and it becomes a complex space for various functions such as traffic evacuation, communication activities, and display, creating a learning environment of “study everywhere” and a learning atmosphere of “everyone learning”.

## **5 Case Study on the Design and Application of Intelligent Learning Environment in University to Enhance User Experience**

On June 21, 2018, the ministry of education held a new era national conference on undergraduate education in institutions of higher learning. At the conference, 150 colleges and universities jointly issued the declaration on first-class undergraduate education, proposing to cultivate first-class talents and build first-class undergraduate education. There are ten articles in the declaration on first-class undergraduate education, among which Article 5 proposes to promote the classroom revolution and turn the silent and one-way classroom into an interactive place for collision of thoughts and enlightenment of wisdom. Article 7 proposes to vigorously promote the application of modern information technology, build smart classrooms, smart laboratories and smart campuses, explore and implement networked, digital, intelligent and personalized education, and reshape education and teaching forms [2]. In order to reconstruct learning, it is necessary to reconstruct the classroom, get through the physical space and virtual space, and avoid ‘High Technology Low Learning’. Therefore, with the hardware renovation, highlighting the advantages of the new generation of information technology represented by the IoT, cloud computing, and big data, the teaching quality analysis supervision can be controlled, and provide data and decision-making assistance for the optimization of teaching and learning. Learning analysis, IoT technology, and mobile internet technology supported by big data can better realize the informationization and intelligence of teaching and management processes, and create a smart learning environment with high user experience.

### **5.1 Use Existing Equipment to Renovate and Optimize Resource Allocation**

Make full use of the original equipment in the classroom for low-cost renovation, pay attention to diversification, multi-function, and re-usability. For example: using standardized monitoring equipment to achieve normalized recording, online supervision, cross-campus interactive live classroom. The existing classrooms are classified and renovated, and the large classrooms are used for the large class teaching of famous teachers, so as to make full use of the resources of famous teachers, and the small classrooms are used for the personalized and discussion-based small class teaching, so as to achieve the optimal allocation of classroom resources.



## 5.2 Intelligent Management and Operation of Learning Environment

As students study in the classroom for a long time, classroom illumination and air quality not only greatly affect the students' physical health, but also play an important role in the students' learning quality and efficiency. Studies have shown that working or learning efficiency decreases by 4% at warmer temperatures and 6% at cooler temperatures [7]. Therefore, the classroom, based on the IoT and Internet technology, combines new technologies, such as big data, cloud computing and artificial intelligence to automatically monitor and adjust environmental data such as temperature, humidity, illumination and carbon dioxide content in the learning environment and public space, as shown in Fig. 4. According to different teaching scenes and standards, automatic start and adjustment of air conditioning, fresh air system and other environmental equipment are carried out to enable students to study in a healthy and comfortable environment with high efficiency. In terms of operation and maintenance, equipment assets in the learning environment are managed and operated in the whole life cycle to improve the quality and efficiency of equipment use and greatly reduce failure rate through early warning. At the same time, indoor and outdoor visual system and all-in-one machine that are unified with the campus image system are deployed at the main entrance and exit of the corridor. In combination with the electronic class board and other information release terminals at the entrance of the classroom, efficient campus information dissemination can be realized with the help of cloud technology and network technology.

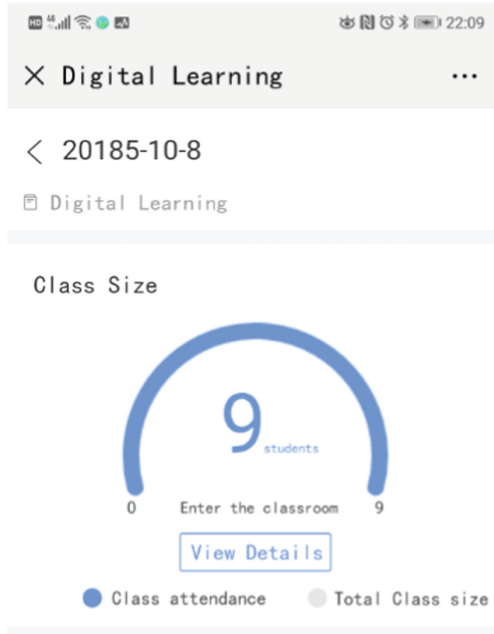


Fig. 4. Intelligent classroom control system of South China University of Technology.

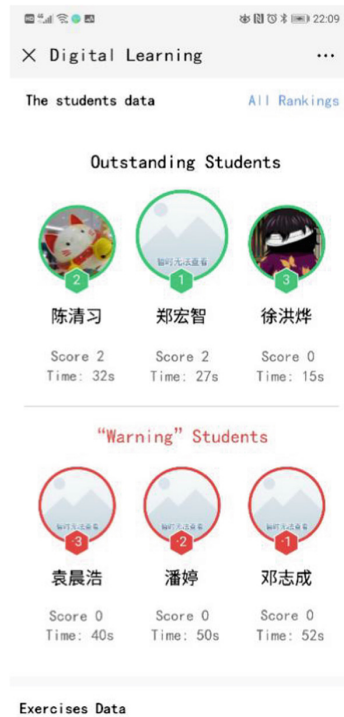
### 5.3 Intelligent Analysis of Teaching and Learning Behavior

The collection and analysis system of learning behavior based on classroom big data, real recording classroom scenes through the recording and broadcasting system, collecting multi-modal data of learning behaviors such as language, expressions and actions of students, providing multi-dimensional intelligence analysis information such as students' concentration curve, number of interactions between teachers and students and multimedia use, S - T behavior curve, head-up rate, and head-down rate, provide big data analysis results for teaching supervision, teachers' improvement of teaching methods and students' improvement of learning methods, support teaching method innovation, and provide personalized teaching resources and activity design; Through procedural quantitative assessment, timely warnings help teachers find learning underachiever, provide big data support for teaching and learning scientific decision-making, improve the objectivity and standardization of teaching effect evaluation.

As shown in Fig. 5, the system recorded the number of times that students visited the courseware of the “digital learning” course in the first semester of the 2017–2018 academic year. The system automatically records the students' answers to questions in a class, and displays the scores and time of all students' answers in real time in the mobile terminal of the teacher, and shows an early warning for students with low accuracy and high time consumption, as shown in Fig. 6.



**Fig. 5.** A example of mobile learning system automatically counting the number of people watching the courseware.



**Fig. 6.** A example of mobile learning system automatically recording the score and time spent in answering questions.

#### 5.4 Use of Interactive Classroom Teaching System for Intelligent Classroom Teaching

This study takes “digital learning” in the first semester of 2017–2018 academic year as an example to carry out flipped classroom teaching in an intelligent learning environment. Using the student group high viscosity of mobile devices, smart phones and mobile applications, to carry out the teaching reform of mixed learning modes such as flipping classrooms, enhance the learning effect, and solve the individualization of students with different cognitive levels and information literacy skills to a certain extent. The released class time is used to develop high-level thinking skills such as collaborative task solving. Before class, teachers send notices, micro video and other teaching resources and assignments to students’ mobile phones, encouraging students to use fragmented time for personalized learning at their own pace. In class, the teacher’s PowerPoint file is pushed to the student’s mobile phone synchronously, and the student can check it in time during the course of listening, as shown in Fig. 7. Use mobile phones to organize teaching activities such as check-ins, votes/questionnaires, question answers, as shown in Fig. 8, in-class quizzes, bullet screens, snap answers, random roll call answers, designated student answers, discussion groups, etc., so as to improve the participation rate of students in class, continuously bring about a small

climax in class teaching and hold students' attention. If students do not understand a certain slide, they can click the “do not understand” button on the page or make comments. The teacher can see which slide the student does not understand in real time on the mobile phone, as shown in Fig. 9, after the class, they are specifically explained by voice or text. The data are analyzed according to the learning behavior, and the consolidated learning resources are pushed out after class. To some extent, classroom reform realizes “discovering differences, improving capabilities and developing personality”.



Fig. 7. Slides played by the lecturer can be seen by the students synchronously and asynchronously in the interactive classroom teaching system.

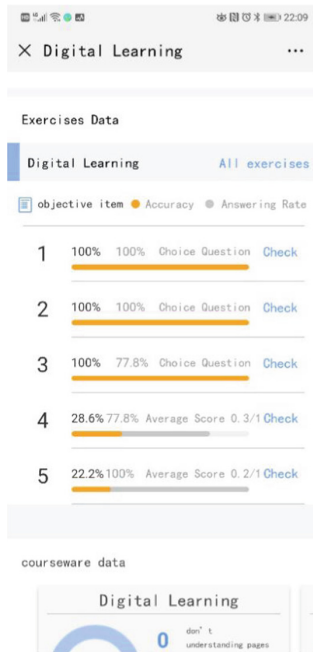


Fig. 8. Students' responses to the objective questions in class teaching.



Fig. 9. Students' feedback for the teaching.

## 6 Results

After a semester trial, the mean value of the students' experience in the five courses are all above 4.8, where the full score is 5 points, which is highly praised by the students. The scores of the students are 10% before the general education class, and the quality of the undergraduate classroom teaching is excellent. The students interviewed believe that the use of mobile apps as interactive tools in class can improve their concentration in class, enable them to actively think and participate in class, and help them get to know their learning partners in class through interaction, so that they have a strong sense of learning achievement. The questionnaire survey of 128 students shows that all students think that the physical environment of the smart classroom and learning space is better than the traditional physical environment, and they like it very much, and the user experience is very high [8]. According to the data analysis of learning behavior analysis, the sleeping rate in class is almost zero. Students say that in this kind of class, the attention of teachers and the dominant position of students in the classroom are not easy and they are embarrassed to doze off. This study adopts the self-learning quantization table and problem-solving ability quantization table, which are verified by credibility and validity. Respectively in the first week of the semester and the last week of the student to carry on the preliminary test and post test, the use of SPSS 11.5 for data statistics and independent sample t-test, Sig. (bilateral) = 0.000 < 0.01, that is, there are significant differences between the pre-test and post-test scores, and the post-test scores are significantly higher than the pre-test scores, indicating that the environment can effectively improve students' self-learning ability and problem-solving ability.

## 7 Conclusion

In an increasingly people-oriented smart society, universities as an important training base for talents, are more focused on building a smart learning environment centered on enhancing user experience. To promote the innovation of teaching content, teaching method, learning method and school organization with the innovation of learning environment, and improve the quality of innovative talents.

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