The Construction of Smart Learning Space in Colleges Based on Blended Learning

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The arrival of the “Internet+” era has made a tremendous impact on the traditional model of talent training in colleges and universities, and the social expectations for college graduates have changed greatly compared with the past. As the cultivation base for talents, colleges and universities must adapt to the trend of the times to reform the mode of talent training. The blended learning mode based on the combination of face-to-face learning and online learning can meet the requirements of the teaching reform in the new era to some extent. This paper discusses how to build the intelligent learning space based on blended learning from the aspects of the technology environment, the teaching process, the learning mode, the smart evaluation and so on and constructs the evaluation index system to be demonstrated, in order to make contributions to the establishment of the new teaching mode, the cultivation of talents, and the establishment of a lifelong learning system.

1. Introduction

The arrival of the “Internet+” era provided unparalleled opportunities in a favourable digital environment that can break through space-time constraints and meet the needs for individual development, as well as unprecedented challenges such as information explosion and cognitive load. In order to satisfy the varied needs of talents in this information age, it is the core of the educational reform and talent competition in countries around the world to transform the classroom of knowledge into the classroom of smart creation [1]. Smart education is an inevitable choice and an important trend in the development of education in the future.

The understanding of smart education supported by the information technology can be traced back to IBM’s “A smarter Earth” strategy. In 2008, IBM first proposed the concept of smart earth in “A Smarter Planet: the Next Leadership Agenda” (Palisano, 2008). IBM’s vision for “A Smarter Planet” is to take advantage of the new-generation information technologies (such as the sensor technology, Internet of Things technology, the mobile communication technology, big data analysis, and 3D printing) to make everything on the Earth instrumented, interconnected, and infused with intelligence [2]. With the support of these new technologies, the world full of technological “nerves” will become smaller, more flat, more open, and smarter. When the idea of “A Smarter Earth” impacts on different fields, more new ideas will emerge, such as smart cities, smart medical care, smart transportation, and smart grids. When these technologies interweave with culture in education, smart education comes into being as the time requires. In 2009, IBM initiated the advocacy of smart education and put forward five road maps for smart education (Rudd et al., 2009), which include learners’ technological immersion; personalized and diversified learning paths; knowledge and skills of the service economy; the global integration of systems, cultures, and resources; and the key role of the economic development in the twenty-first century [3].

Based on the exploration of smart education, we can see that it is closely related to the rise of Internet technologies. Smart education mainly consists of learning resources, intelligent tools, learning communities, learning methods, and other elements. Some scholars have also put forward their points of view. For example, the essence of smart education is to build a learning environment that integrates technologies, where teachers can implement effective teaching methods and learners...
can obtain appropriate personalized learning services and development experience, so that it turns the impossibility into possibility and limited ability to great ability, hence cultivating talents with value orientation, action ability, thinking ability, and creative potential [4]. The smart education model has become the trend in the development of educational informatization [5], and we can build a smart education framework to guide the design of future smart education systems [6]. In addition, some scholars have proposed that smart education is a process that optimizes a series of elements such as manpower, technologies, and resources in educational institutions [7]. Its attributes include ICT, open learning environments, self-directed learning, customized learning, and social learning [8]. However, the current smart education is unsatisfactory, and a new mode needs to be innovated [9].

The concept of “blended learning” first emerged in the early 21st century. Professor Curtis Bunker of the Indiana University defined the meaning of blended learning in his book “Handbook of Blended Learning: Global Perspectives, Local Designs” in 2006 [10]. He proposed: “blended learning is a proprietary concept in the field of teaching, so we believe that ‘blended learning’ is defined in a ‘Combination of Face-to-face Instruction with Online Learning’ such a range is appropriate” [11]. The design concept of “blended learning” combines face-to-face learning with online learning, giving full play to the advantages of the two learning methods. Face-to-face learning compensates for the shortcomings of the direct interaction in online learning, while online learning can expand the space and time of learning and the adjustment of the learning process by self-directed learners, so as to adapt for learners with different learning styles [12–15].

Therefore, we define smart education based on blended learning as the combination of face-to-face learning and online learning in order to foster intelligent talents with active practical abilities with the support of the information technology. To fulfill this goal, we should build a smart learning space in colleges and universities in line with related concepts, so as to cultivate talents that meet the diversified requirements of the society with outstanding characteristics such as intelligence and ingenuity, good personality, practicality, and creativity [16–18].

The traditional teaching system is made of four elements, teachers, students, content, and media, which are interconnected. In the smart learning space, the relationship among the four elements of teaching is mainly reconstructed in such context, where the roles of teachers will change from traditional teaching instructors and controllers to teaching organizers, instructors, and supporters; passive recipients (students) will be transformed into active builders; the media will transform from a single tool to diverse tools to promote students’ cognition; the content will transform from a single source of teaching materials to multiple accesses of diverse forms, dimensions, and openness [19]. This paper believes that the smart learning space is mainly composed of four parts: a technical environment, the teaching process, the learning mode, and a smart evaluation. In the construction of these four parts, the teaching mode and the learning mode are converted to improve the effect of smart learning. The construction of the smart learning space based on blended learning focuses on the design and development of the learning environment, learning activities, and learning resources. At the same time, a teaching design analysis report will be produced in each link to provide preparation for the next link to make the teaching design sound and feasible [20].

2. The Technical Environment for the Smart Learning Space

The construction of the intelligent learning space needs to be backed by the Internet technologies; thus, relevant measures are taken to complete the integration of teaching and learning, achieving the goal of teaching and learning complementary for both teachers and students or smart talents, as shown in Figure 1.

2.1. Learning Scenes Collection. The collection includes individual data such as students’ learning preferences, cognitive characteristics, and learning styles and the learning status data such as students’ cognitive level, emotional conditions, and attention state. With these information and data, we can figure out possible problems and needs for every student and provide suitable support in the adaptive learning and the whole process of learning.

2.2. Mobile Communication Interconnection. Supported by the mobile network communication technology, the smart learning terminals are light and compact and easy to carry; and its adaptive learning system provides learners with a variety of real-time communication services. The information can be transmitted instantly upon sending so that the real-time distributed learning between teachers-students and students-students before class and after class is constructed.

2.3. Real-Time Content Delivery. According to the different demands of learning, in groups or individually, we actively and real-timely push learning content to different students, combining the knowledge content with the learning needs, associating the learning environment with learning time, and realizing the flexible sharing, multidimensional expansion, and effective reuse of distributed resources. Students do not need to be concerned with the details of the push content, so that their attention can be focused on the process of discussion and information understanding, which enhances students’ adaptability to the environment and experience in deep immersion.

2.4. Stratified Sharing of Resources. Teachers can categorize resources following the purpose and the object of teaching; therefore, teachers and students can download and acquire various resources regardless of time and space; the effective integration of various media resources brings rich audiovisual experience to the learners; the system automatically captures and associatively stores the generated resources in the classroom, realizing the self-adaptive and personalized allocation of resources.

2.5. Collaboration and Communication. By the use of smart terminal devices (such as tablets, notebooks, electronic whiteboards, and software communication platforms), it dynamically
diversifies the time, place, object, and form of communication, such as multidimensional and multifactor group learning of one-to-many or one-to-one to enhance learning interactivity.

2.6. Smart Learning Analysis. Relying on technologies such as clustering, data mining, and machine learning, we comprehensively manage all data in the student’s learning process, record the process of teacher-student interactions in the classroom, practice performance, and network connectivity, and conduct comprehensive calculations, comparisons, and analysis to track and analyze the classroom learning and assist in teaching decision-making for teachers with big data.

2.7. Instant Feedback and Evaluation. With the efficient and real-time two-way communication between teachers and students, visual feedback of the system and instant evaluation are accomplished so that students can understand their current learning situation in real time, adjust their learning status in time, and stimulate their learning enthusiasm; meanwhile, it allows teachers to know better about the learning status of students, give timely guidance, and adjust their teaching content accordingly.

3. The Construction of the Teaching Process of the Smart Learning Space

3.1. The Construction of the Teaching Process and the Learning Mode of the Smart Learning Space

The construction of the smart learning space is the result of the two-way integration of the information technology and education, so that students can change their understanding of the discipline, learn in scientific paths, and ultimately achieve the goal of smart talent cultivation. Teachers use the information technology to create real-life scenarios to help students acquire knowledge better, assign tasks or problems worth thinking, researching, and analyzing for the students in the classroom, and analyze the system of problem-solving or task completion and provide practical teaching cases for and solutions to typical problems or the completion of tasks [21, 22]. On this basis, the database of the teaching target is therefore set up to sustain the evaluation of the academic performances of students. The model is shown in Figure 2.

Teaching and learning are the two aspects of a problem, and they are often inseparable. In order to build a smart learning space, the teaching process and learning mode can be built based on the suitable technical environment, in accordance with the process above, as shown in Figure 3.

3.1.1. Before Class. Before class, teachers can apply the technology of real-time content push to create learning scenarios to guide students in conducting inquiries and exploration to some extent; at the same time, teachers use the layered sharing function of the system resources to classify the teaching resources and push them to different students through the system terminals, so that students get those learning resources, learn about the background knowledge, answer some questions, and enter the learning scenarios. Teachers can also use the learning outcomes shared by students before class and apply the evaluation techniques of collaborative interaction and immediate feedback for the organization of interactive learning activities; moreover, they can take advantage of a variety of terminals to organize quiz shows, group discussions, and game practices in the classroom.

During the practice, teachers can set up the rules by stages; the system embedded with the technology of intelligent learning analysis consistent with the practice results of students is capable of giving adaptive feedback of the time and analysis of the practice completion and practice results to teachers, automatically determining whether a student can enter the next stage of study or not, and pushing customized learning resources to students in different stages.

3.1.2. In Class. In class, teachers make clear of the course requirements and employ the technology of real-time content push to create learning scenarios to guide students in conducting inquiries and exploration to some extent; at the same time, teachers use the layered sharing function of the system resources to classify the teaching resources and push them to different students through the system terminals, so that students get those learning resources, learn about the background knowledge, answer some questions, and enter the learning scenarios. Teachers can also use the learning outcomes shared by students before class and apply the evaluation techniques of collaborative interaction and immediate feedback for the organization of interactive learning activities; moreover, they can take advantage of a variety of terminals to organize quiz shows, group discussions, and game practices in the classroom.

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3.1.3. After Class. After class, teachers and students can use the technology of immediate feedback evaluation to review and summarize the entire teaching process, a two-way evaluation. Teachers can use the mobile communication interconnection technology to assign homework to students, using the real-time content push tools for the extended resources of related topics to students, allowing students to adjust in the learning direction and difficulty, so that more students can expand their thinking space and improve their abilities in analyzing and solving problems.
3.2. The Construction of the Learning Model of the Smart Learning Space

3.2.1. Before Class. Students can utilize the mobile communication tools to complete the tests pushed from teachers, analyze problems, receive learning resources and suggestions from teachers, and share their learning outcomes with teachers and learning partners.

3.2.2. In Class. Students use the technology of mobile communication interconnection to group learning partners, discuss with each other, share resources, and solve problems through interaction and collaboration for those problems that cannot be explained or solved in a single class; students can use the technology of collaborative interactive communication for real-time recording and interaction. The interactive system reaches beyond the horizon of classrooms and seeks interdisciplinary help from teachers or students.

3.2.3. After Class. Students can access and complete the homework and tests given by teachers at any time so that teachers can check the teaching effect easily. They can also freely choose learning resources and methods to consolidate the knowledge acquired according to their actual needs.

4. The Intelligent Evaluation System for the Smart Learning Space

4.1. The Design of the System Index. The basic concept of the evaluation of the smart learning space lies in the ultimate goal of students seeking smart development. With the support of the information technology, the roles of teachers...
and students will both change, as students are no longer required to passively accept knowledge but actively construct the knowledge; at the same time, it requires teachers to be transformed from the transmitters and carriers of information to the helpers and promoters, guides students in the active creation of knowledge [23, 24], and eventually makes students smart learners.

The evaluation of the smart learning space works in order, and it is a scientific and active system [25]. This article establishes a smart evaluation system for teachers and students in learning covering three dimensions, before class, in class, and after class, as shown in Tables 1 and 2.

4.2. System Effect Evaluation. The result of the smart learning space evaluation system is conducted based on the design of the evaluation index system and is carried out on the constructed evaluation system for teachers and students, respectively. The analytic hierarchy process is mainly employed, which is referred to as AHP. AHP is a hierarchical weighted decision analysis method proposed by Professor Satie, the American operations researcher of the University of Pittsburgh in the early 1970s. The method breaks down those elements related to the decision-making into different steps, objectives, criteria, comparisons, and alternatives, hence qualitative and quantitative analysis. The decision-making method of the qualitative and quantitative analysis is a systematic and hierarchical analysis method [26]. It is systematic, hierarchical, qualitative and quantitative, concise and practical, and flexible and is widely applied in evaluation.

Generally speaking, the effect evaluation of the smart learning space system is to decompose the system and form a hierarchical structure model for the teacher and student evaluations. Taking the multiobjective decision-making problem of teacher and student evaluation as a system, the problem can be cut into goals or criteria covering preclass, in-class, and after-class on the basis of the nature and needs of the problem. According to the mutual influence and affiliation between the teachers’ and students’ evaluation system in and before class, in class, and after class, it can be divided into multiple indicator levels to form an index system of multilevel and orderly

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**Table 1: The evaluation index system for the smart learning space for teachers.**

| Evaluation index          | Evaluation standards                                                                 |
|---------------------------|--------------------------------------------------------------------------------------|
| **Before class**          | **Collect learning scenes**<br>Collect valid information based on student characteristics and provide information for the setting up of learning situation scenes. |
| **Push learning content** | **Use relevant media and technologies to push learning content to students in advance.** |
| **In class**              | **Build learning scene**<br>Specific learning scenes are set up based on student characteristics and teaching goals. |
| **Organize interactive learning** | **Students are organized in class to interact effectively and complete the teaching objectives in the process.** |
| **Comment on shared explanation** | **According to the learning state of students to comment and share in the angle of relevant knowledge points.** |
| **After class**           | **Summarize feedback and evaluation**<br>Summarize the previous learning conditions and give feedback of the learning evaluation results to students in effective ways. |
| **Push extension resources** | **Use relevant media to push extended learning resources to students and enrich their knowledge in accordance with the teaching objectives and learning conditions.** |

**Table 2: The evaluation index system for the smart learning space for students.**

| Evaluation index          | Evaluation standard                                                                 |
|---------------------------|--------------------------------------------------------------------------------------|
| **Before class**          | **Self-study**<br>Actively self-study the learning content pushed by teachers before class. |
| **Share collaboration results** | **Cooperate with others to study according to the requirements and share the learning achievement and experience in a certain extent.** |
| **Enter the learning scenes** | **Quickly enter the learning scenes set up by the teacher in combination with the previous self-study knowledge in class.** |
| **In class**              | **Interactive and collaborative learning**<br>Interact with learning partners in the class according to the requirements of the learning scenes. |
| **Achieve learning goals** | **Achieve the required learning goals in the set learning scenes environment.** |
| **Share self-evaluation** | **Make an objective assessment of the learning results after class and share with others the learning outcome and experience in a certain extent.** |
| **After class**           | **Rethink and internalize goals**<br>Reflect on the entire learning process and integrate the learning objective into personal qualities. |
| **Expand thinking space** | **The self-thinking ability can be improved in the entire learning process and the expanded learning resources pushed by the teacher.** |
progressive structure evaluation standard. The relative importance of each factor of the evaluation index is determined by pairwise comparisons, and the overall ranking of the relative importance of the index system is determined for consistency. The professional test software was used and the specific test results are as follows: as shown in the index system in Table 1, a judgment matrix is constructed for the evaluation system for teachers, and the weight of each index is obtained by using yaahp (see Table 3), and the consistency test of the judgment matrix is carried out, that is, the CR is 0.0516. It can be seen from Table 3 that the weight ratios of the first-level indicators before, in, and after class in the middle layer to the smart learning space for the teacher evaluation system are 0.3325, 0.1396, and 0.5278. And the evaluation for teachers mainly concentrates before and after class. The weight ratios of pushing resources, summarizing feedback and evaluation, commenting and sharing explanations, organizing interactive learning, and creating learning scenarios are 0.2771, 0.554, 0.1320, 0.3959, 0.0363, 0.0457, and 0.0576. In the index system in Table 2, a judgment matrix is constructed for the evaluation system for students, the weight of each index is also obtained by using yaahp (see Table 4), and the consistency test of the judgment matrix is carried out, that is, the CR is 0.0279. From Table 4, it can be seen that the weight ratios of the first-level indicators before, in, and after class in the middle layer for the evaluation of students in the smart learning space are 0.1140, 0.4054, and 0.4806. The evaluation for students is mainly concentrated in and after class. The indicators at the program level are self-learning, collaborative sharing of results, entering learning scenarios, interactive and collaborative learning, achieving learning goals, sharing self-evaluation, reflecting and internalizing the goals, and expanding the thinking space, and their respective weight ratios are 0.0760, 0.0380, 0.0495, 0.2628, 0.0931, 0.2000, 0.0606, and 0.2201.

It can be seen that in the evaluation system for teachers, the preclass and postclass stages are more important than the in-class, and it is the main task of teachers in the smart learning space to summarize the feedback evaluation. Moreover, it is the collection of learning scenes that accounts, which provides prerequisites for the setting up of those learning scenes catering to the characteristics and styles of students in learning; in the students’ evaluation system, the in-class and after-class stages are more important, and the ratio of interactive collaborative learning and self-evaluation is relatively higher, especially for the interactive and collaborative learning, which gives full play to students’ subjective initiative, transforms students from

| Smart learning space–teacher evaluation system | Collect learning scenarios | Push learning content | Expand push resources | Summarize feedback and evaluation | Comment and share | Organize interactive learning | Create learning scenarios | $W_i$ |
|-----------------------------------------------|---------------------------|-----------------------|-----------------------|----------------------------------|-------------------|-----------------------------|--------------------------|-------|
| Collect learning scenarios                    | 1                         | 5                     | 1                     | 1/3                              | 1                 | 1                           | 1                         | 0.2771|
| Push learning content                         | 1/5                       | 1                     | 1                     | 1/3                              | 1                 | 1                           | 1                         | 0.554 |
| Expand push resources                         |                           |                       |                       |                                  |                   |                             |                           | 0.1320|
| Summarize feedback and evaluation             |                           |                       |                       | 1/3                              | 1                 |                             |                           | 0.3959|
| Comment and share                             |                           |                       |                       | 1/3                              | 1                 | 1                           | 1/2                       | 0.0363|
| Organize interactive learning                 |                           |                       |                       | 1/3                              | 1                 | 1                           | 1                         | 0.0457|
| Create learning scenarios                     | 2                         |                       |                       | 1/3                              | 1                 | 1                           | 1                         | 0.0576|

| Smart learning space–student evaluation system | Self-study content | Collaborate and share results | Enter the learning scenes | Interactive collaborative learning | Achieve learning goals | Share self-evaluation | Reflect on and internalize goals | Expand thinking space | $W_i$ |
|------------------------------------------------|-------------------|-----------------------------|--------------------------|-------------------------------|----------------------|-------------------------|--------------------------|----------------------|-------|
| Self-study content                             | 1                 | 2                           | 1/2                      | 1                             | 1/5                  | 1/2                    | 1/3                      | 1                    | 0.0760|
| Collaborate and share results                  |                   | 1                           | 1                       | 5                             | 1                   | 3                      | 2                       | 1                   | 0.0380|
| Enter the learning scenes                      |                   | 1                           | 1/2                     | 1                             | 1/5                  | 1/2                    | 2                       | 1/3                  | 0.0495|
| Interactive collaborative learning             |                   |                             | 1/2                     | 1                             | 1                   | 3                      | 1                       | 1                   | 0.2628|
| Achieve learning goals                         |                   |                             |                          | 1                             | 1                   | 1/3                    | 1                       | 1                   | 0.0931|
| Share self-evaluation                          |                   |                             |                          | 1                             | 3                   | 1                      | 1/3                     | 1                   | 0.2000|
| Reflect on and internalize goals               |                   |                             |                          | 1/3                           | 1                   | 1/4                    | 1/3                     | 1/4                 | 0.0606|
| Expand thinking space                          |                   |                             |                          | 1                             | 4                   | 1                      | 1                       | 1                   | 0.2201|

Table 3: The weight distribution of the teacher evaluation in the smart learning space.

Table 4: The weight distribution of the student evaluation in the smart learning space.
knowledge consumers to knowledge creators, and cultivates students’ innovative abilities. It has been demonstrated that the smart learning system has changed the traditional learning method, with teaching activities student-centered, hence the mutual experience and dynamic interactions. Through the interactive and collaborative learning between students and teachers, teachers summarize and reflect on the feedback evaluations, and students can achieve the learning target better. It is relatively rational, scientific, and effective.

5. Conclusion

In the final analysis, the purpose of the construction of a smart learning space based on blended learning is to cultivate talents of values, action, thinking, and creative potentials. Compared with the traditional teaching model, the smart learning space has the following advantages and characteristics:

(1) The smart learning space provides learners with more informationalized tools and resources to change the traditional learning style of passive acceptance to the learner-centered, core-oriented, and experience-based learning, social learning, game-based learning, competitive learning, research-based learning, and collaborative learning and provides data for the setting up, group division, and evaluation criteria formulation for these activities and content

(2) The interconnection between quality Internet educational resources and the smart learning space, widening the content of learning for learners, and making learning go beyond the teaching content. Furthermore, the learning scenes-based analysis and digital learning content will be pushed to learners in more specific and customized ways. The analysis data generated by the smart learning space can clearly reflect the learner’s weaknesses, learning fluctuations, and bad learning behaviors or habits, which makes the review and remediation more accurate and targeted

(3) The learning data generated by the smart learning space will truly mirror the learner’s behavior and learning results. The resulting analysis results of the learner’s ability structures, learning preferences, learning styles, learning habits, and so on will be used as important reflection materials for the learner, which in turn makes the reflection more reasonable and profound; and it is valuable in optimizing the learner’s mental model and improving the learning decision-making

By devoting to the building of a space system based on smart learning, a smart learning and teaching ecology is formed, and a student-centered teaching environment and a smart learning space where teachers participate in the whole process is set up. In addition, the development of personalized teaching is effectively promoted, the implementation of smart teaching is propelled, and the profound reform of education informatization is achieved. As a result, a new education ecology with a life-long learning system is finally established.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

It is declared by the author that this article is free of conflict of interest.

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