

Experimental Teaching Learning Space Model Construction

Jingyao Wang, Yahong Jin

*Experimental Teaching Center for Media and Communication Studies, Zhejiang Normal University,
Jinhua, 321004, China*

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Abstract: With the rapid development of information technology, the design and construction of learning spaces are increasingly valued. In this paper, on the basis of the PST model, combined with the current situation of experimental teaching learning space construction, a theoretical model framework of three layers and four elements of experimental teaching learning space (PSMT) is proposed. The three layers refer to the element layer, the functional module layer and the implementation layer, and the four elements include experimental pedagogy, experimental space, management and service mode and technical support. It is hoped that the proposed framework will provide theoretical support for the design and reconstruction of experimental teaching learning spaces and lay the foundation for the next concrete application.

1. Introduction

Experimental teaching center is an important teaching base for higher education institutions to organize high-level experimental teaching and cultivate students' practical ability and innovation spirit [1]. The purpose of the construction of demonstration center is to cultivate students' practical ability, innovation ability and improve teaching quality, the core of which is the reform of experimental teaching and the foundation is the open sharing of experimental resources, as proposed in [No. 1 of Education High [2005]] "Several Opinions on Further Strengthening Undergraduate Teaching Work in Higher Education Institutions". The rapid development of artificial intelligence, big data, cloud computing and other information technology means has brought unprecedented changes to the field of education, and blended learning, intelligent learning, innovative learning and active learning are emerging, while most of the teaching space in the current experimental teaching demonstration centers is still dominated by the traditional rice-field classroom plus the layout of experimental equipment, and the teaching method of teacher transmission and student acceptance. The new teaching style and the traditional teaching environment have produced great incompatibility, and the experimental teaching space has become one of the most important parts to be considered in the design of campus learning space. Although learning space projects supported by smart classrooms and future classrooms have been carried out, their effectiveness and matching degree with learning needs are still to be verified. Such status is difficult to achieve for the development of students' personalized, innovative, and practical skills. Therefore, it is necessary to break through the shackles of the previous traditional learning spaces

and re-invent the existing experimental teaching learning spaces with technology-enabled spaces [2], from the perspective of experimental teaching-oriented research, with the cultivation of students' independent learning ability and innovative practical ability as the goal.

In response to the above problems, this study explores the model framework for the construction of learning space in experimental teaching center: around the personnel training objectives of experimental teaching center and the special needs of teaching and learning of experimental courses, a three-layer theoretical model framework (PSMT framework Pedagogy-Space- Management-Technology) containing an elemental layer, a functional module layer, and an implementation layer is constructed, including key modules on experimental pedagogy, physical space, social space, and open operation mode.

2. Current Research Status

Through a large amount of literature reading and analysis, what is quite concerned by scholars at home and abroad is the reform of learning space in the context of digitalization, which involves theoretical foundation research, application research, and evaluation research, etc. Based on the need of this study, this paper reviews the connotation of learning space and the research on the development framework of learning space.

2.1. Connotation of Learning Space

The concept of learning space has not yet been clearly defined by domestic and foreign scholars, and the richness of its connotation can be more clearly understood from the research on the connotation and types of learning space.

2.1.1. The Connotation of Learning Space

Chen Xiangdong et al. (2010) consider learning space as a physical entity in the education system, consisting of the overall campus environment, individual buildings, and other types of places that promote learning, carrying a specific campus culture and spirit of place, and being the intersection of education, technology, and spatial design. [3] According to Wang Jixin and Zheng Xudong (2010), a learning space is an environment that allows learners to have open access, free participation, and interactive communication, includes learning resources, information resources, technical resources, equipment resources and human resources.[4] Through a study of the field of learning spaces abroad, Yang Junfeng et al. (2013) argue that learning spaces refer to the entire school learning environment and that the transformation of the learning environment with technological support is the current focus of attention.[5] Xu Yafeng et al. (2015) explain space as "a place used for a specific purpose" and define learning space as "a place used for learning", which covers not only teaching spaces such as classrooms and laboratories but also any place where learning behaviors can occur, including both physical and virtual scenes. The ultimate goal is to promote learners' learning by means of information technology. [6] Qu Yidan (2017), starting from the meta-concept of learning space, defines learning space as "a special field in which the learner is the main subject of practice and experience, the production, transmission, dissemination and consumption of knowledge is the intermediary, and the broad expansion and deep excavation of learning activities is the purpose.[7]

Du Xingyue (2017) sees learning space as a combination of educational theory and learning environment, and prefers to build a virtual learning space at the level of learning theory and teaching theory. [8] Allen (2018) believes that learning space is not a material but a property of material, and refers to teaching facilities such as campuses, classrooms, and laboratories as

"learning space objects", and believes that learning space should have the function of cognitive support, environmental optimization, and include all teaching equipment that can support teaching and highlight students' independent learning. [9] Crina Damşa et al. (2019) conceptualize learning spaces from an ecological perspective as learning spaces that are co-constructed by learners, generated through their practices, interactions and activities, and facilitated by teaching arrangements.[10]

2.1.2. Types of Learning Spaces

Regarding the typology of learning spaces, Yang (2013) proposed that learning spaces include formal, informal and virtual, with formal learning spaces mainly having conventional physical environments, such as classrooms and laboratories, informal learning spaces mainly having lounges and outdoor learning areas, and virtual learning spaces mainly having learning management systems, social networking sites or online environments. [5] Allen (2018) classified physical learning spaces in schools into seven categories with reference to the taxonomy of educational equipment. According to the structure of the place, there are closed spaces, semi-closed spaces, and open spaces. According to the functional properties of disciplines, they can be divided into humanities learning spaces, natural science learning spaces, social science learning spaces, sports learning spaces and art learning spaces. According to the structure of teaching and learning, there are three types of space, such as structured teaching and learning spaces, semi-structured teaching and learning spaces and unstructured teaching and learning space. Classified by the type of knowledge, it can be divided into knowledge-based space, knowledge-competency balance space and competency-based space. There are office space, teaching space, sports space, and free activity space by natural space. There are physical learning spaces and virtual learning spaces by form. They are divided into learner-centered learning space, knowledge-centered learning space, community-centered learning space, and evaluation-centered learning space according to the degree of freedom. ⁵With reference to the concept of whole space proposed by Professor Zhu Zhiting and others, Jing Yuhui (2018) divides learning spaces into physical and virtual according to space form; into classroom space and social space according to whether they are built for educational purposes; and into real learning space and virtual learning space according to the authenticity of the learning scene or not.[11] Qu Yidan classifies learning spaces from two perspectives: the historical evolution of learning spaces and the specificity of educational fields.[9] In brief, the learning space is divided into physical learning space and virtual learning space according to the reality of the scene; and the physical learning space is further divided into formal learning space and informal learning space according to the nature of learning.[12]

Although different scholars have different elaborations on the concept and types of learning spaces, their basic connotations and concerns are the same. Broadly speaking, all places where learning behaviors can take place belong to learning spaces. This study specifically refers to an efficient knowledge exchange and sharing learning environment supported by information technology under the guidance of constructivist learning theory and humanistic learning theory, with the ultimate goal of facilitating learners' learning, which can satisfy different teaching methods such as independent learning, cooperative learning, and inquiry learning, and promote learning behaviors such as interaction and collaboration. This study is concerned with experimental teaching learning space as one of the formal learning space places, specifically the physical physical space used for student experimental teaching in higher education institutions.

2.2. Study on the Design Framework of Learning Spaces

The learning space design framework is a theoretical structure used to guide the design and

development of learning spaces, and is the basis for the design, development, and evaluation of learning spaces. It contains factors such as the elements of a learning space, the relationship between the elements, the learning space design process, and the evaluation dimensions.

Brown (Brown, 2005) considers learner characteristics as a major factor in determining the design of learning spaces [13]. He argues that the construction of learning spaces is based on different learning theories and that learner characteristics determine the learning theory base, configuring different technological tools for different learning spaces. Dr. Kenn Fisher (2005) argues that different pedagogies correspond to different learning space designs, such as "seedling" for didactic classrooms, "symmetrical" for application-based classrooms. The JISC (2008) published a research report on "Design Guidelines for 21st Century Learning Spaces", pointing out that learning spaces should meet the different needs of both "teacher-centered" and "student-centered" teaching modes. The design of structure, ventilation, and lighting should be flexible and adjustable to future needs, and should support individual self-learning and group learning. David Radcliffe Professor (2009) proposed a PST framework that has been widely cited in the field of learning spaces and can be used for the design and evaluation of various learning spaces, namely the Pedagogy-Space-Technology (Figure 1) framework, which considers pedagogy, space, and technology as the three core elements that interact with each other in the design of learning spaces.[14]

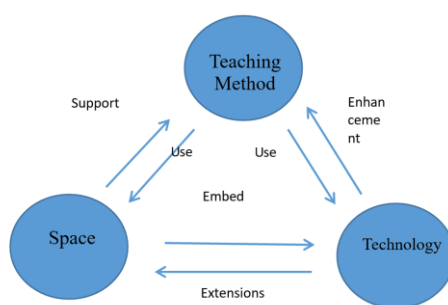


Figure 1: PST framework (adapted from Radcliffe 2009)

Chinese scholars are also actively exploring the design and implementation of learning spaces, and have made valuable research results. During the practice of the PST framework, Chen Xiangdong (2010) found that the three elements of education, space, and technology could not cover all the important factors of learning space development, so he proposed the education-society-space-technology (PPST) framework. The PST framework was further improved by categorizing the issues related to project creation, funding, application, management, and other social factors as social dimensions.[15] Xu Yafeng et al. (2013) considered the PST framework too general, refined the specific dimensions and steps of learning space design, development, and evaluation based on the PST framework, and proposed an improved PST framework. [16] Based on the PST framework, Hua Zixun et al. (2017) proposed a learning space redesign process based on the OPST framework, which includes the overall purpose in the PST process, and provides design strategies for learning spaces with specific purposes through the redesign of learning spaces in pedagogy, space and technology. [17] Based on the idea of engineering sociology, Bin Jiang (2021) and others proposed a technology selection model with the value of problem solving, maturity of technical scenarios, difficulty of application, and tolerance of innovation risk as elements, and elaborated the "pedagogy-space-engineering" as the three elements from the perspective of system engineering. The theory of PSE learning space development framework with "pedagogy-space-engineering" as the three elements has been implemented in the national medical experimental teaching center project, and is the only study directly related to this study among a large amount of literature reviewed.

The above review shows that pedagogy, space, and technology are the three dimensions that have received the most attention in the framework of learning space design. Scholars at home and abroad have made many meaningful attempts to construct the framework, but still have not found a framework with wide coverage and practicality. From the viewpoint of research objects, the construction of learning space about experimental teaching space in China has been carried out rarely. As an important place for cultivating college students' independent learning ability, practical innovation ability, communication and collaboration ability, the experimental teaching space is also a traditional form of learning space that cannot be ignored. Based on the framework of PST model, this study combines with experimental teaching practice and tries to build a learning space model framework with universality that can be used for reference.

3. Experimental Teaching Learning Space Model Framework Construction

As a teaching unit facing and serving the majority of teachers and students, the management and service factors of the experimental teaching center play an important role in guaranteeing teaching activities and promoting student learning, so on the basis of the PST model, the management and service model is also included in the model factors, as shown in Figure 2.

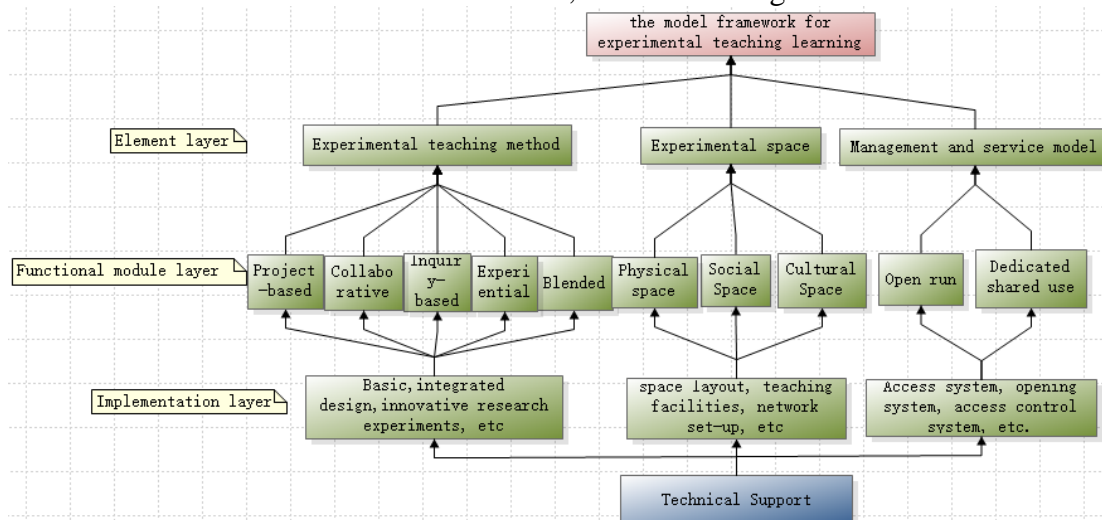


Figure 2: Framework of the model for constructing learning space for experimental teaching

The framework of experimental teaching learning space model (PSMT) is composed of three layers and four elements. The three layers refer to the element layer, the functional module layer and the implementation layer, which are in-depth and specific. The element layer is summarized after reading and analyzing a lot of literature, and the four main elements that need to be considered in the process of constructing the current experimental teaching learning space include experimental teaching method, experimental space, management and service mode, and technical support. The functional module layer further decomposes the four elements in the form of modules on the basis of the element layer. The implementation layer corresponds to the realization of the functional module layer through specific executable measures. The technical support elements are placed at the bottom layer in the framework, mainly considering their support role for the whole framework. Starting from each element, the model can be understood more clearly from a vertical perspective.

3.1. Experimental Teaching Method

Pedagogy is the method and means used to achieve the pedagogical goals in a given educational situation. It determines the type of learning space, plays a unifying role in the whole constructive

model, and contains the theoretical basis of learning, teaching models and strategies. Experimental teaching method refers to the teaching method that is unique to experimental teaching as opposed to theoretical teaching. With the enrichment of learning theories and the advancement of technology, experimental teaching has been given more responsibilities and meanings. It is not only the mastery of experimental content, but also the cultivation of students' ability to collaborate, analyze problems, solve them, and practice innovation. Project-based learning, cooperative group learning, independent inquiry learning, experiential learning, and blended learning occupy an increasingly important role in experimental teaching.

3.2. Experimental Space

Space is not only space on the physical level, it also has social and cultural attributes. The space element contains three functional modules: physical space, social space and cultural space. Physical space refers to the physical environment, spatial layout and teaching facilities of the learning space, mainly focusing on the physical environment such as light, temperature and air of the learning space as well as the reasonable arrangement of the area division, furnishing and teaching equipment of the space. The interaction of space users and the transfer of knowledge make the space have invisible social attributes and show certain flowing variability. It has been pointed out that the frequency and level of interaction in the space positively affect the effectiveness of the learning space. How to make the social attributes of space more active, extensive and deep is one of the key issues of space effectiveness. The learning space is also a display of the campus cultural atmosphere and spirit.[18] Cultural space integrates learning space culture into physical space and social space by using inconspicuous corners of learning space and harder-to-use space for soft environment decoration. The physical space, social space and cultural space are integrated with each other to form a composite space that can both create knowledge and improve social interaction.

3.3. Management and Service Model

The management and service model is a new spatial element based on the PST framework. As one of the teaching departments of the university, the research and exploration of the management mode of the experimental teaching center has been one of the main directions of the research of the demonstration center. How to achieve highly effective opening, accurate and proper management, and maximize the space efficiency and time efficiency of the learning space is the problem that needs to be solved for the management element. On the basis of the original management mode and mechanism of laboratory opening and operation, we explore the use of information technology tools to break through the original management mode and construct a management and service mode that matches the concept of learning space construction.

3.4. Technology Support

The technology element is an important driver for the reconfiguration of learning space design [19]. Technology primarily refers to the information technology tools and instruments that can support and facilitate learning. As shown in the framework diagram, the main reason for placing the technology support element at the bottom of the framework is that this element is the foundation that supports the entire framework, which is integrated at all levels. With the support of technology new pedagogy can be implemented, with the support of technology the space is more flexible, and with the support of technology the space is fully open to be realized. However, technology is not the more the better, the newer the better, and the phenomenon of disconnected construction and use and construction for the sake of seeing exists in the past. The highest level of technology use should be

to minimize the threshold of technology use, the technology will disappear in the invisible.

In a word, pedagogy is the soul and goal of the learning space, and the experimental space, management and service model, and technical support elements all serve to achieve the goal of pedagogy. Space and technology are the material basis of the learning space, and management is an important guarantee for the learning space to function well. The four elements of the PSMT framework promote each other and influence each other.

4. Summary

The transformation of experimental teaching learning spaces is a process that persistently requires updates and iterations, and like other learning space transformations, will continue to change with innovations in learning theories, learning styles, new technologies, and other learning elements. The above transformation of experimental teaching learning spaces from model framework construction, implementation to application evaluation represents only part of the process; whether the learning spaces are truly effective and what improvements are still needed are questions that need to be addressed in practice in subsequent studies. Overall, the transformation of the current experimental teaching learning space should pay more attention to students' learning, reasonably introduce information technology, create an open and independent learning space, and create more opportunities for students to interact, collaborate, investigate, and practice. We hope that through active attempts, we can draw the attention of researchers, teachers and administrators to the learning space of experimental teaching, further deepen the reform of experimental teaching, and promote the connotative development of experimental teaching center.

Acknowledgements

1) Zhejiang Normal University Experimental Technology Development Project: Reconstructing Learning Space for Experimental Teaching Based on PST Design Framework (20230015).

2) Zhejiang Normal University Digital Reform Research Project "Exploration and Practice of Experimental Teaching Information System Construction".

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