Design Studies and Intelligence Engineering
L.C. Jain et al. (Eds.)

doi:10.3233/FAIA231518

Virtual Simulation Experimental Teaching Method and Practice Based on BOPPPS Teaching Model: An Example of Virtual Simulation Experiment Platform of Jiajiang Bamboo Paper Making Skills

Fangyu LI[a] and Jiayi LI[b,1] and Yefei LI[c]
[a] *School of Design, Southwest Jiaotong University*
[b] *Art Design Dept, The Engineering&Technical College of Chengdu University of Technology*
[c] *School of Mechanical and Electrical Engineering, University of Electronic Science and Technology of China*

Abstract. Based on the research of intangible cultural heritage, this study summarizes and organizes the non-heritage knowledge of the bamboo paper making techniques of the JIJIANG River, takes the characteristics of virtual simulation experiment into reasonable consideration, and carries out the design of the virtual simulation experiment platform of the bamboo paper making techniques of the JIANG River based on the BOPPPS teaching model and task-driven teaching method. The platform includes the integration of the theoretical basic knowledge of the technique of making bamboo paper and the establishment of a 3D virtual scene of the paper-making workshop one by one. By combining the techniques of paper making with virtual simulation technology, students can be highly immersed in the "experiment" and motivated and motivated to learn. At the same time, it enriches the way of preserving and passing on the craft, leading users to explore it actively and enhancing their sense of participation. It also provides a reference for the preservation and transmission of other intangible cultural heritage, especially traditional crafts, in the virtual simulation experiment environment.

Keywords. Virtual simulation experiment, BOPPPS teaching mode, intangible cultural heritage, Jiajiang bamboo paper making skills

1. Introduction

Virtual simulation experiments integrate virtual reality, multimedia, human-computer interaction, databases, network communications and other technologies, and are the main direction of the informatization construction of experimental teaching in my country [1]. Li Ping and other scholars gave a detailed description of the characteristics of the virtual simulation experiment center, pointing out that the essential characteristics of the virtual

[1] Corresponding Author: Jiayi Li, 1027268187@qq.com

simulation experiment consist of information technology features, highly simulated experimental environments and objects, and meeting undergraduate teaching requirements[2]. In 2018, the Ministry of Education pointed out in the "Opinions of the Ministry of Education on Accelerating the Construction of High-level Undergraduate Education and Comprehensively Improving Talent Training Capabilities" that we should vigorously promote the construction of virtual simulation experiments. In 2019, the Ministry of Education pointed out in the "Implementation Opinions of the Ministry of Education on the Construction of First-Class Undergraduate Curriculum" that the professional layout is reasonable, the teaching effect is excellent, and openness and sharing are effective. Among them, the five major categories of first-class courses include virtual simulation experimental courses, and a national virtual simulation experimental teaching course sharing platform (http://www.ilab-x.com/) has been built and is open to the public.

2. Research status of virtual simulation experimental teaching construction

2.1. Overview of research on virtual simulation experimental teaching construction

"Virtual simulation experiment" was first proposed in 1989 by Professor William Wolfe of the University of Virginia in the United States. Since its introduction, it has been widely used in various professional fields. In the early days, it was mainly used for teaching basic courses in engineering colleges, such as the Microelectronics Online Laboratory of the Massachusetts Institute of Technology, the Surgical Simulation Laboratory of the University of North Carolina, the Virtual Physics Laboratory of the University of Houston, and the Dynamic fluid virtual simulation experimental system at George Mason University, etc. [3]. Wang Weiguo and others have done some research on the current situation and development of virtual simulation experimental teaching in foreign universities and pointed out some new trends worthy of attention[1]. According to the content of cultural heritage and different experimental purposes, Zhu Kerong divided the virtual simulation experimental teaching center related to cultural heritage inheritance into comprehensive cultural protection and display, national-level "intangible cultural heritage" skill inheritance, cultural heritage scene reproduction and application, innovative application of cultural heritage tourism industry, and proposed a “two-level, three-link, four-module” virtual simulation experimental teaching system[4]. Zhu Kerong analyzed the current situation of the construction of virtual simulation experimental teaching centers in the liberal arts in 2016. Due to the late start of liberal arts laboratory construction and the limited application of virtual simulation technology in the liberal arts field, the overall construction level is relatively low[5].

2.2. Overview of research on virtual simulation experimental teaching construction

In the development of virtual simulation experiments in the field of cultural heritage, in 2010, P.A. Fishwick and others built the Second China Project as a hybrid immersive, knowledge-based software platform for Chinese cultural training[6]. E. Selmanović and others added interactive digital stories to a virtual simulation system related to the diving tradition of the Old Bridge in Mostar, and conducted a user experience evaluation to prove that this method can create empathy among participants[7]. Marilena Alivizato and others took the i-treasures project as an example to study the establishment of a virtual learning environment for cultural heritage.It also verified that this platform is not only used as a "scientific experiment", but also requires intangible cultural heritage practitioners to participate in the design, research and implementation process, in order to stimulate the potential of intangible cultural heritage[8].Our country's research focus is mainly on technology exploration and the design and development of virtual simulation experiment platforms.For technology exploration, Chen Jianqiang used NGRAIN technology to improve the quality of real-time display images of 3D models[9].A three-dimensional model library system of ethnic minority costumes for clothing design teaching and learning has also been established through the combination of VR (virtual reality) and AR technology[10]. Zhou Hua and others used high-precision three-dimensional laser scanning and texture mapping technology to model the three-dimensional model of Tang Sancai for research on virtual simulation experimental teaching of cultural relics appreciation[11]. On the national virtual simulation experimental teaching course sharing platform, you can see virtual simulation courses related to intangible cultural heritage from many universities. Sichuan Normal University independently developed a virtual simulation experimental teaching project for traditional building mortise and tenon structures. This project uses 3D high-precision modeling to fully restore the East Hall of Foguang Temple, a wooden building in the Tang Dynasty, and creates 8 traditional building mortise and tenon joint production and combination experiments to demonstrate the exquisiteness of the mortise and tenon joint structure. Zhengzhou University of Light Industry has developed a virtual simulation experimental teaching project for Jun porcelain firing. Under the guidance of teachers, students conduct independent experimental operations, in-depth observation, experience and learning on the entire process of Jun porcelain firing in wood kilns in the form of 3D real scenes. Those type of virtual simulation experiment simulates different types of culture, effectively solving the problem of users being unable to "immerse themselves", and also contributing to the protection and inheritance of intangible culture.

Scholars' design and development of virtual simulation experiment platforms mainly focus on teaching method design, experimental system construction, experimental process design, interactive interface design, assessment system design, etc., mainly in order to solve the problems of high teaching costs, low student participation, and vulnerability to seasonal and venue factors.

3. Overview of the BOPPPS Teaching Model

The BOPPPS teaching model is the theoretical basis of ISW, a widely implemented teacher skills training system in Canada. This model emphasizes the student-centered teaching concept and modularizes the classroom teaching process. In the teacher training process, micro-teaching methods are used to conduct drills, allowing teachers to re-examine and improve the teaching process through small-scale, short-term, high-intensity drills, thereby ensuring the effective realization of the established course teaching objectives[12].

The BOPPPS teaching model divides the course into six modules: Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary. Because this teaching model emphasizes student-centeredness, pays attention to student participation, and has a clear structure and is easy to operate. Therefore, this model is not only used to train teachers' teaching skills, but has gradually been widely used in all types of teaching and has been highly recognized. With the development of online teaching, many scholars combine the BOPPPS teaching model with online teaching. Li Qi and other scholars studied the implementation of classroom teaching activities based on the BOPPPS teaching model throughout Rain Classroom to improve classroom efficiency, and verified its effectiveness through teaching effect analysis[13]. Feng Yongwei combined the BOPPPS teaching model with the Lanmoyun class APP to solve practical problems such as the low efficiency of the existing classroom and the weak sense of student participation[14]. Wu Changdong successfully verified the effectiveness of this model through real application[15].

The BOPPPS teaching model emphasizes student participation, interaction and feedback, and can be well applied to teaching methods with highly experimental and operational teaching content. It is suitable for teaching virtual simulation experiments, and students can conduct in-depth learning during the participation process. The combination of BOPPPS teaching model and virtual simulation experiment can improve the efficiency of the experiment and ensure the quality of the experiment. First, it can realize a closed loop of the experimental process to ensure that nothing is missed during the experiment and a virtuous cycle is formed. Second, it can greatly improve students' participation, be student-centered, goal-oriented, and guide students to learn independently. Third, it can help teachers analyze the teaching process based on subsequent real experimental results, thereby designing teaching content more effectively and improving teaching quality.

4. Design of virtual simulation experimental teaching model of Jiajiang bamboo paper skills based on BOPPPS

The BOPPPS teaching model focuses on student participation, and the task-driven teaching model embodies the idea of "teaching as the leader and learning as the main body". According to the teaching process of BOPPPS, the "Bridge-in" and "Objective" are introduced to lead students to learn the background information and basic knowledge related to Jiajiang bamboo paper making techniques. Through the pre-assessment phase, students' mastery of the learning content is tested and used as a basis for whether students can enter the next stage. The participatory learning stage is the key, using simulation production experience to allow students to participate in the process of making Jiajiang bamboo paper. The Post-assessment phase generates an experimental report based on students' performance in the participatory learning phase, and invites students to self-evaluate their learning satisfaction in this experiment. In the summary stage, students are guided to review the learning content and stimulate students to think. Through analysis, the teaching plan of the Jiajiang Bamboo Paper Skills Virtual Simulation Experiment Teaching Platform was obtained. As shown in Figure 1, according to the teaching model that combines the BOPPPS teaching model and task-driven teaching, students enter the virtual simulation experimental teaching platform. Through the textual declarative knowledge designed by the developer, students have a clear understanding and positioning of the learning content. Students can clearly understand the overall goal and task of the experiment and improve their learning motivation. After students complete the study of basic knowledge, assessments will be used to evaluate their mastery of knowledge. Passing the test proves that students have the basic knowledge background required for the experiment and have clarified the specific content of the task, and can enter participatory learning that focuses on operations. In the process of participatory learning, students are required to complete multiple operational tasks using the basic knowledge learned in the early stage and combined with experimental requirements. After completing all tasks, obtain the corresponding experimental report and summary. Abandoning the traditional one-way indoctrination teaching model, the entire process is controlled by students independently. Through different multimedia means, information exchange is made more abundant and natural, allowing students to learn in a relaxed, free, pleasant and positive environment, and realizing a truly student-oriented teaching model.

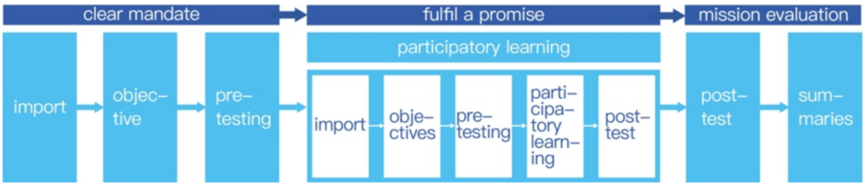

Figure 1. Virtual simulation experimental teaching model based on BOPPPS.

The BOPPPS teaching model runs through the task-driven teaching method, refining and supplementing the entire task-driven process. This method can strengthen interactive links, obtain timely feedback, and improve teaching efficiency. The specific teaching construction framework is shown in Figure 2.

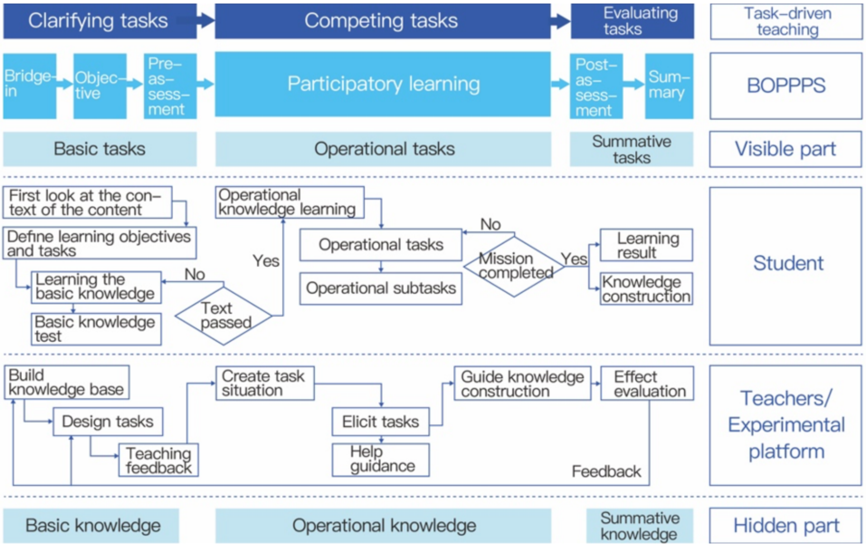

Figure 2. Virtual simulation experimental teaching construction framework based on BOPPPS.

5. Design of the Jiajiang bamboo paper making skills virtual simulation experiment platform

5.1. Information architecture

Based on the summary of key knowledge points and research on the teaching model of the virtual simulation experiment of Jiajiang bamboo paper making techniques, the information architecture is divided into two major sections: "knowledge popularization" and "process". They correspond to the two parts of "basic knowledge" and "operational knowledge" in the teaching model. And based on this, the design of the entire information architecture is carried out, as shown in Figure 3.The specific contents of the two modules are as follows.

- Knowledge popularization: In this module, students can independently view and learn the detailed graphic content of historical evolution, masters and celebrities, and papermaking raw materials. They can also take assessments in the knowledge quiz module. Passing the assessment indicates that they have mastered the basic knowledge.
- Process: In the process stage, students can first recognize and learn the tools and understand the overall process of Jiajiang bamboo paper production. After learning, students can move and view independently in the three-dimensional simulated papermaking environment. They can click on raw materials and tools during the roaming to experience the overall process of papermaking.

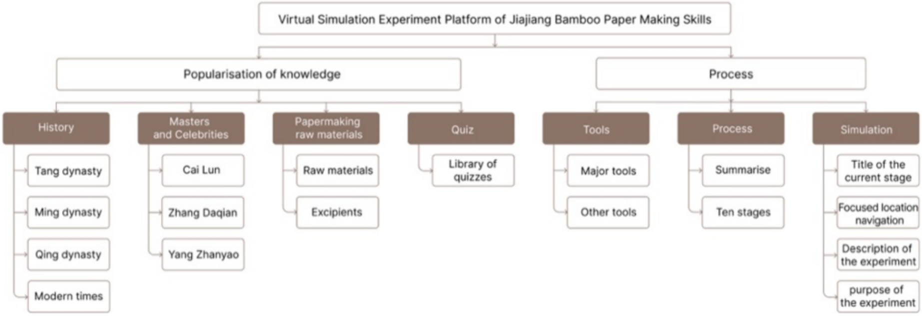

Figure 3. Information architecture of the Jiajiang bamboo paper making skills virtual simulation experiment platform.

5.2. Process design

The process design clearly displays the interactive process of the entire experiment. The operation process is designed based on the process in the teaching framework, the information architecture of the Jiajiang bamboo paper making skills virtual simulation experiment platform and the actual needs of users, as shown in Figure 4.

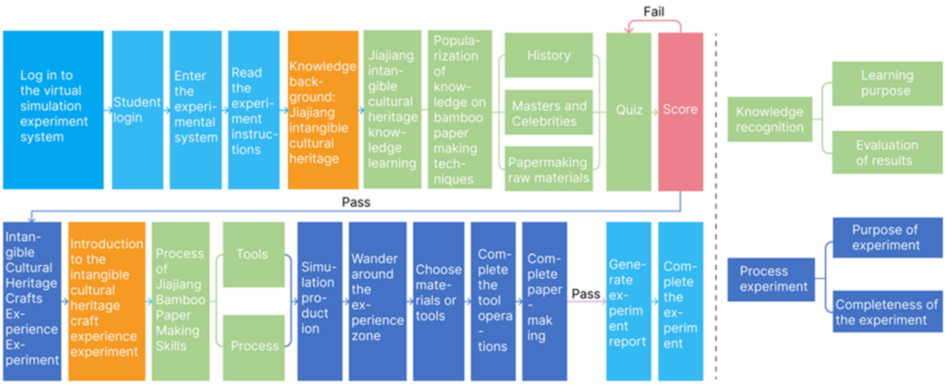

Figure 4. Operational flow chart of the Jiajiang bamboo paper making skills virtual simulation experiment platform.

5.3. Main module design

The first module of the Jiajiang Bamboo Paper Making Techniques Virtual Simulation Experiment Platform is "Knowledge Popularization". In this module, users can select and view relevant knowledge about Jiajiang Bamboo Paper Making Techniques by clicking. It can be divided into three parts: historical evolution, masters and celebrities, and papermaking raw materials, as shown in Figure 5. The main teaching objectives are to let students understand the historical development and cultural connotation of Jiajiang bamboo paper making techniques, understand the celebrities and stories related to Jiajiang bamboo paper making techniques, and master the raw materials, accessories and their functions of Jiajiang bamboo paper making. In the knowledge popularization interface, users can click to switch between different knowledge points for repeated learning. After the user self-assesses their learning and meets the standards, click to participate in the knowledge contest. The questions in the knowledge quiz are derived from the knowledge learned by users of this module, and their function is to test whether students have mastered the content in the knowledge popularization. If the user passes the quiz, it proves that he has mastered the background knowledge and can enter the next stage of learning. If he fails, he can consolidate and learn the knowledge independently, and then participate in the knowledge quiz again until he passes.

Figure 5. The rendering of the initial interface of the knowledge popularization interface.

The second module of this virtual simulation experiment platform is "process".

Users can choose to learn tool cognition, process flow or simulation production sections.

In the Tool Awareness and Process section, users can click to view graphic and text introductions to learning-related knowledge. Students can learn about the appearance, materials, usage and other information of the main tools in the Jiajiang bamboo paper production process, gain an in-depth understanding of the specific content of each step of the process, and prepare for subsequent simulation production. In the simulation production part, users will be placed in a three-dimensional virtual environment of traditional papermaking, allowing users to immerse themselves in the real environment of Jiajiang bamboo paper production during free roaming. And in this virtual environment, users will be asked to complete staged tasks. Users can experience the specific steps of Jiajiang bamboo paper production in depth, which will help users master the overall production process of Jiajiang bamboo paper.

After selecting tool cognition, the user enters the tool cognition interface, which is divided into two parts. The left side is the first-level navigation. In this part, users can quickly select the tool they want to view based on the tool name. The right side is the information display part, which will display the picture and text information of the selected item according to the user's selection on the left. The effect is shown in Figure 6. If you select other tools, a secondary navigation will appear on the right, and users can select the corresponding small tool according to its name to view and learn.

Figure 6. Rendering of the tool awareness section (drawn by the author).

After selecting the process flow interface, an overview of the process flow will be displayed first, and the relevant knowledge content of the process flow will be briefly introduced in text form. After entering, the interface is divided into upper and lower parts. The ten stages of the process flow are arranged in sequence at the top, and users can click to select different stages for learning. After selecting a certain stage, the picture and text information of that stage will be displayed, as shown in Figure 7.

Figure 7. Rendering of the process section.

In order to provide users with the best experience, this experiment is implemented using the Unity engine. Build and adjust the model material and scene model in Unity to make it closer to the real effect, as shown in Figure 8 and Figure 9.

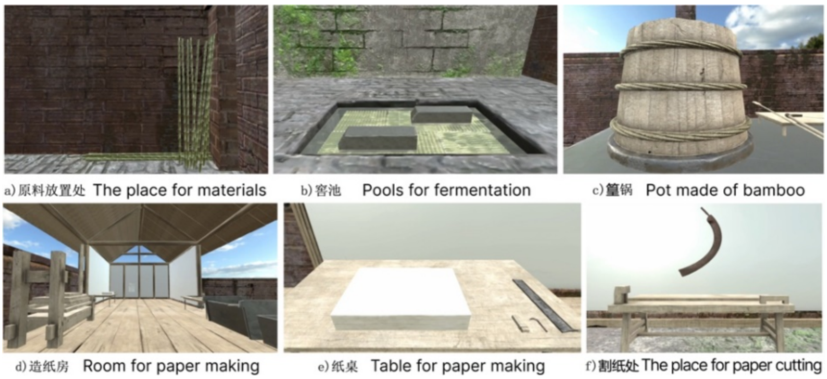

Figure 8. Partial rendering of the scene.

Figure 9. The process of scene building and animation production in Unity.

6. Conclusion

Through the analysis and combination of the BOPPPS teaching model and the task-driven teaching method, this paper determines the virtual teaching model of Jiajiang bamboo paper skills virtual simulation experiment, and designs a specific teaching construction framework. In the virtual simulation experiment, the BOPPPS teaching model is combined with the task-driven teaching method. Through the setting of total tasks and sub-tasks, students can better master the basic knowledge, operational knowledge and summary knowledge in Jiajiang bamboo paper making techniques in the process of completing the tasks. This virtual simulation experiment platform can lead students to experience the charm of ancient bamboo paper making techniques and inspire students' sense of identity and protection awareness of intangible cultural heritage. This platform can also carry out repetitive simulation exercises anytime and anywhere, helping the digital protection of Jiajiang intangible cultural heritage bamboo paper making skills and the dissemination and popularization of Jiajiang bamboo paper making skills.

Acknowledgments

Funding Supported by the New Interdisciplinary Cultivation Fund Program of Southwest Jiaotong University (YG2022002) .The First Batch of Provincial Research and Reform Practice Projects of New Liberal Arts in Sichuan Province--Multidisciplinary Integration of Interaction Design Curriculum and Teaching Material System in the Context of "New Liberal Arts + Intelligence". Ministry of Education Industry-University Cooperation Collaborative Education Program

References

[1] Wang Weiguo, Hu Jinhong, Liu Hong, Current Status and Development of Virtual Simulation Experimental Teaching in Foreign Universities, *Laboratory Research and Exploration* **34** (2015) , 214–219.
[2] Li Ping, Mao Changjie, Xu Jin, Carry out the Construction of a National Virtual Simulation Experimental Teaching Center to Improve the Informatization Level of Experimental Teaching in Colleges and Universities, *Laboratory Research and Exploration* **32** (2013), 5–8.
[3] Wu Juan, Sun Yuemin, Lei Wei, Xu Chunhong, Qin Yizhen, Song Aiguo, Planning Ideas and Progress in the Construction of the Electromechanical Comprehensive Virtual Simulation Experimental Teaching Center of Southeast University, *Experimental Technology and Management* **31** (2014), 5–9.
[4] Zhu Kerong, Construction of Virtual Simulation Experimental Teaching Center for Cultural Heritage Inheritance Application, *The Road to Digitalization of Museums* (2015), 132–135.
[5] Zhu Kerong, Issues and reflections on the construction of virtual simulation experimental teaching center for liberal arts, *Modern Education Management* **01** (2016), 87–91.
[6] P.A. Fishwick, A.J. Coffey, R. Kamhawi and J. Henderson, An experimental design and preliminary results for a cultural training system simulation, *Proceedings of the 2010 Winter Simulation Conference* (2010), 799-810.
[7] Selmanovic E, Rizvic S, Harvey C, et al, VR Video Storytelling for Intangible Cultural Heritage Preservation, E*urographics Workshop on Graphics and Cultural Heritage* (2018).
[8] Alivizatou, Marilena, Digital Intangible Heritage: Inventories, Virtual Learning and Participation, *Heritage & Society* **12** (2019), 116–135.
[9] Chen Jianqiang, Research and implementation of desktop 3D VR system for national cultural heritage based on NGRAIN technology, *Journal of Guizhou University for Nationalities (Philosophy and Social Sciences Edition)* **06** (2017), 80–91.
[10] Chen Jianqiang, Application of VR and AR technology in teaching ethnic minority clothing design, *Laboratory Research and Exploration* **36** (2017), 111–113.
[11] Zhou Hua, Zhang Ziying, Huang Kejia, Zhang Junna, Han Jianye, Feng Xiaobo, Research on virtual simulation experimental teaching of cultural relics appreciation - taking the appreciation of Tang Sancai as an example, *Laboratory Research and Exploration* **35** (2016), 77–82.
[12] Cao Danping, Yin Xingyao, Canadian BOPPPS teaching model and its inspiration for higher education reform, *Laboratory Research and Exploration* **35** (2016), 196–200+249.
[13] Li Qi, Yang Mei, Han Qiufeng, Smart teaching design and application based on Rain Classroom - Taking "College Computer Fundamentals" as an example, *Computer Engineering and Science* **41** (2019), 139–143.
[14] Feng Yongwei, Research on the teaching model of advertising major under the intelligent Internet technology + BOPPPS model - taking the "Advertising Copywriting" practical training class as an example, *Media* **08** (2019), 79–82.
[15] Wu Changdong, Jiang Hua, Chen Yongqiang, Research and application of BOPPPS teaching method in MOOC teaching design, *Experimental Technology and Management* **36** (2019), 218–222.