

Reform and Practice of Architectural Technology Courses in the Context of Digital Transformation of Architecture—Taking Architectural Physics as an Example

Yue Jin, Ning Zhang, Xinzhi Gong, Xiao Wang, Xuan Luo

*School of Civil and Architectural Engineering, Guilin University of Technology, Guilin, Guangxi,
541000, China*

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Abstract: Under the general trend of digital change, "digital architecture" formed by the integration of digital technology and the construction industry is an important kernel for the upgrading and transformation of the construction industry. As important curriculum support for architecture majors, architectural technology courses need to rapidly adapt to digital change to meet the market and national strategic needs. The traditional technical courses are faced with the problems of string theory, weak informationization, short class time, and poor integration with engineering. Therefore, how to improve students' engineering application ability and digital technology under the condition of existing class time is the main purpose of this study. Digital technology is not only embodied in the teaching means, but also should be embodied in the teaching content. This study takes the course "Building Physics" as an example, and proposes a hybrid teaching method based on "SPOC + offline subject investigation mode", which is based on high-quality online resources, adding virtual simulation technology of actual engineering, and forming "engineering research" subject groups according to the interests and abilities of the students, through which the students can learn about the engineering application through the "engineering research" subject groups. "Students form engineering research groups according to their interests and abilities, internalize and extend their classroom knowledge in the form of "project research", and carry out the new "online + offline" learning mode, which provides teaching ideas for other technical courses.

1. Introduction

With the arrival of the information age, the construction industry has also ushered in new changes and transformation needs. The Ministry of Education issued the "14th Five-Year Plan for Teaching Informatization", which will take "building a safe, stable, integrated, open and intelligent education informatization environment" as the goal, implement the strategy of "networked education, data management, intelligent learning", and realize the development idea of "full coverage of education informatization" [1]. The development idea of "full coverage of education informatization".

Encouraging and building several public service platforms for a series of online open courses, such as the University of China (MOOC) Mucue and Xuedang Online, is of great significance in promoting the construction of large-scale online open courses in China to embark on the road of development with Chinese characteristics of "the main body of the university, government support, and social participation". At present, the online open course system represented by "Xuedang Online and China University Mucous Class" has been initially formed, and tens of thousands of online courses have been opened, including national high-quality online courses[2]. Tens of thousands of online courses have been opened, including national high-quality online courses. China's online open courses are developing in the direction of synchronizing construction and application, balancing openness and exclusivity, combining public welfare and market, and placing equal emphasis on introduction and export. Although MOOC has obvious advantages in teaching resources, there are some shortcomings in personalized tutoring, interactive communication, and teaching management.[3]. Therefore, a new online teaching mode SPOC (small private online course, SPOC) has been developed and applied.SPOC (Small Private Open Online Courses) small-scale restricted online courses began to appear. The concept was put forward by Professor Armando Fox of the University of California, Berkeley in 2013, aiming to supplement the existing classroom teaching online.SPOC is characterized by small scale, high flexibility of student learning, good interaction between teachers and students, and specialized services.[4] SPOC is characterized by small scale, high flexibility of student learning, good interaction between teachers and students, and specialized services. Blended teaching based on SPOC inherits the advantages of traditional teaching on the one hand; on the other hand, it fully relies on the advantages of modern informatization teaching and realizes the organic integration of "online + offline" teaching and learning.

Meanwhile, given the problems of difficulty, theory, and complicated calculation of the architectural technology courses, the application of architectural informatization modeling and architectural virtual simulation technology provides an effective way for the deep integration of architectural technology courses with informatization technology. Through information technology to establish a three-dimensional building model, the use of BIM, Designbuilder, and other software, simulation of building lighting, ventilation, energy consumption, materials, and external environment in the real environment of the building, so that students can understand the physical environment of the building after its completion in the virtual scene to create learning scenarios so that the entire teaching is visualized. Based on the digital economic transformation and the demand for training talents in new engineering disciplines, the architectural technology courses need to focus on promoting the in-depth integration of informatization and digitization of teaching resources and theoretical teaching, and cultivating highly skilled talents with solid theoretical foundations, strong engineering practice ability and innovation ability[5]. This course reform takes the teaching of the "Building Physics" course as an example, and innovatively proposes a hybrid teaching method based on "SPOC mode + information technology + offline flip" with engineering as the background, theoretical teaching and virtual simulation technology as the horizontal axis and "case study research" as the vertical axis, vertical and horizontal intertwined to form a set of the real world and virtual technology integration of the curriculum network system. Students are inspired to take the initiative to explore engineering problems, which ultimately enables them to learn independently and effectively.

2. Analysis of Problems and Causes of Traditional Construction Technology Programs

All along, traditional architecture majors have been implementing small-class teaching systems, and its curriculum system is significantly different from traditional science and technology majors, which contain multidisciplinary knowledge such as architectural design, architectural history,

building technology, structure, landscape architecture, urban planning, etc. As an important supporting discipline, the teaching content of the architectural technology course is wide-ranging, difficult, cross-disciplinary, and innovative, and needs to be matched and supported by the architectural design course. Students need to master the skills and knowledge is too large, and building technology courses, short course hours, and high difficulty, in the actual teaching, teaching is not student-centered, single teaching method, mainly relying on PPT presentations, explanation of knowledge and basic experiments of the link. The students are generally weak in the mastery of the content of the architectural technology courses, or even uninterested, resulting in the entry into the workplace on the building structure, building structure, building energy efficiency, and other multi-disciplinary subjects, and need to match and support each other with the building design courses. This has led to a lack of basic theoretical knowledge reserves for practical engineering problems such as building construction, building structure, and building energy efficiency. With the continuous development of building technology, new materials, new structures, and computer-aided means that some of the calculation methods and construction principles in the course tend to lag, and students are not interested in the complex calculation formulas, which can easily lead to their low acceptance of the other contents of the course. The actual engineering mainly relies on computer software simulation, but the course failed to adapt to it so the knowledge learned by the students and the design of the actual requirements of the industry is out of touch.

Therefore, the online course based on SPOC and the engineering case base of virtual simulation technology is undoubtedly a useful supplement to the traditional construction technology course[6-7].It can make full use of the advantages of MOOC's massive high-quality resources, engineering case library, and SPOC's refined classroom management to supplement classroom teaching with insufficient class time and poor understanding. Students use the fragmented time to enrich the knowledge points not taught by teachers or not understood by themselves in offline courses through online course resources; at the same time, the small scale and restrictive nature of SPOC courses limit students to complete the course discussions, course practice and other extracurricular links required by teachers, changing the traditional teaching mode based on "mechanized indoctrination + standardized test". The traditional teaching mode of "mechanized indoctrination + standardized test" is changed [8-10]. This will change the traditional teaching mode based on "mechanized indoctrination + standardized test", and eventually form a new mode of integrating online excellent resources with offline teaching.

Applying BIM technology in classroom teaching to visualize and analyze the real information of the building, and at the same time using Ecotect, Phoenics, Designbuilder, and other software that are compatible with Sketchup and CAD, can enable students to have a real prediction of the lighting, ventilation, heat preservation, and insulation effects of the building in the built environment. In this way, it changes the shortcomings of previous architectural learning which was dominated by aesthetics and ignored the performance of the building, and at the same time, it also stimulates their interest in using virtual software for independent learning.

3. Integration of "SPOC + offline project investigation + virtual simulation" teaching model

3.1 "SPOC + offline subject exploration" blended teaching mode

Architecture, as a traditional engineering specialty, has rigorous engineering technology attributes while meeting aesthetic and humanistic requirements, and has certain interdisciplinary attributes itself [11]. Architectural technology courses include three major blocks of technical fundamentals, architectural technology, and digital technology, involving courses such as building materials, building physics, building structure, building construction, digital technology, etc., with a lot of theoretical knowledge, strong application, and difficulties as the main characteristics of technical

courses. How to establish and utilize excellent online teaching resources, integrate offline teaching, and carry out small-scale restricted (SPOC) deep learning is the main content of this research, which contains the following aspects:

(1) Classroom Management in SPOC Building Technology Programs

SPOC classes require students to first complete online learning before class, students can use fragmented time to pre-study in advance, pre-study basic knowledge points, and understand the content of the next class in advance. In the classroom, teachers test the results of students' pre-study through exercises to ensure the effectiveness of pre-study before class, and good assessment and management of pre-study before class is an important prerequisite to ensure the smooth articulation of online courses [12]. In the teaching of Building Physics, the SPOC online platform is used to combine the MOOC resources of Chinese universities and the rain classroom teaching platform to establish the online course group of Building Physics, one week before the class, the teacher pushes the basic content of this week's study to the students through the rain classroom, and through the system, he can understand the learning situation of the students, and in the class, he will ask questions and explain the knowledge involved in the pre-study, which will help to master the Students' basic knowledge.

(2) Internalization and deepening of offline classroom knowledge

Focusing on the deepening of the content of classroom teaching, combining practical engineering with classroom teaching, and guiding students to internalize knowledge is the second focus of this research. Mixed teaching is to let students in the classroom do the problem and difficulty "initiative", to realize the situation of teachers and students to discuss on an equal footing. The offline classroom explains the key points, difficult points, and related engineering design cases feedback from students, including building construction, building materials, physical properties, and other engineering knowledge related to building design. For the "extended knowledge", students are encouraged to carry out independent research in the form of study groups, and can also be practiced and applied in the large assignments of the design class.

(3) Feedback and Evaluation of SPOC Post-Course Instruction

Strengthening curriculum innovation and extension, emphasizing knowledge transfer and feedback, and encouraging open, independent, and mutually supportive learning. Taking the design course as a platform, we strengthened collaboration with design course teachers of the same grade and interspersed lectures on architectural technology courses in the design assignments to encourage students to explore the application of building materials, passive and active design of buildings, and so on, so as to combine theoretical knowledge with actual engineering design. Some study groups have proposed the innovative project of "Improvement of Thermal Stability of Campus Buildings Based on Measurement and Simulation" to renovate old buildings with poor thermal environments according to the knowledge of thermal engineering, while some study groups have combined the design of their own courses, such as renovation of old buildings, museums, libraries, etc., with the building physics course to form an energy-saving topic and optimize the building design. Some study groups combine their own course designs, such as renovation of old buildings, museum buildings, library buildings, etc., with the building physics course to form an energy-saving topic to optimize building performance and quality. The teaching effect is not only limited to the final examination but also relies on online course evaluation, stage assessment, design works, and other channels, which are aimed at examining the student's mastery of knowledge.

3.2 Virtual simulation technology "embedded" in online and offline education

In the context of the era of education informatization 2.0, the use of new-generation information technology such as the Internet, big data, cloud computing, virtual reality, and other information

technology in teaching and classrooms has become a reality[13]. However, how to effectively use information technology is the key to the means of teaching, neither can students and teachers be tired of dealing with various types of software, nor can they be informed for the sake of information technology. The teaching team has found in years of course polishing and practice that the combination of architectural digital BIM technology, virtual reality technology, and professional course demonstration helps students intuitively understand the relationship between building construction, building materials, structures, and equipment pipelines while assisting the building energy simulation and other virtual tools to visualize abstract theoretical knowledge and case studies. Teachers show the BIM model in the virtual space and simulate it, and by changing the model parameters, such as wall thickness, maintenance structure construction, and other conditions, students visualize the relationship between the construction of the building maintenance structure and energy consumption. Students can also operate BIM models, Designbuilder, and other simulation software offline to learn and simulate building energy consumption and understand the changes in building performance when design conditions are changed.

4. Teaching results

Through the combination of information technology and offline classrooms, the way of checking and examining is more diversified and practical. Specifically, the traditional lecture-examination evaluation mode is changed to the mode of subject research-engineering cases, which pays more attention to the diversity of course evaluation. At the same time, the teaching activities are centered on students' abilities and needs, and students are encouraged to take the initiative and help each other to learn. Through the medium of "independent projects" and design courses, students internalize their knowledge through case studies, virtual space modeling, and project research. If students do not understand some of the knowledge points during the learning process, they can repeat the learning process through the online courses released by the teachers, and they can also ask questions through platforms such as Rain Classroom, and the teachers will answer the questions after class, so that the knowledge can be supplemented through multiple channels and layers, and the teaching resources can be utilized more efficiently. The overall implementation objectives of the hybrid course are detailed in Figure 1. The overall implementation objectives of the blended course are detailed in Figure 1.

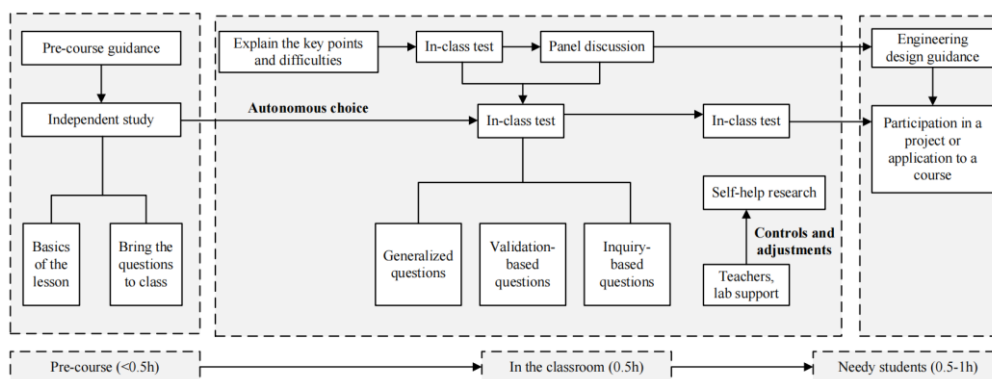


Figure1: Objectives of the "SPOC+Offline" blended teaching model course

5. Conclusions

Based on the background of new engineering and building informatization, the architecture major has higher requirements for talent cultivation, on the one hand, it needs students to master the relevant knowledge of traditional architectural design, and at the same time, it requires students to adapt to the

intelligent and data-oriented society, and to be able to skillfully master building information technology. Architectural technology courses, as an important curriculum support for architecture majors, impart theoretical knowledge while focusing on cultivating students' ability to use data and information technology. Therefore, this paper focuses on the problems of personalized tutoring, interactive communication, and teaching management of traditional technology courses, and innovatively puts forward, a hybrid teaching method based on "SPOC + offline subject exploration + virtual simulation", which assists the virtual simulation technology such as BIM and Designbuilder, so that students can do what they have learned, and learn what they have learned when they are doing it. Students changed from passive listening to lectures to active participation in discussions, and integrated the knowledge into the course design, and finally completed the transformation of traditional learning methods to achieve the optimization of learning results.

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References

- [1] Zhong Jiling. *Research on Informatization Development Planning Ideas of Higher Vocational Colleges and Universities in the 14th Five-Year Plan*[J]. *Computer Knowledge and Technology*, 2021, 17(19):270-272.
- [2] Wang Yu. *Design and application of "MOOC+SPOC" hybrid education mode in higher vocational colleges and universities under the background of "Internet+" - Taking art appreciation major as an example*[J]. *Satellite TV and Broadband Multimedia*, 2019(22).
- [3] Li Xiongying, Leng Wenjun. *Research on the change of interdisciplinary learning mode of college students under the background of MOOC*[J]. *Chongqing Higher Education Research*, 2017, 5(4):101-107.
- [4] Shen Ling, Liu Ganlin. *Research on hybrid teaching mode under SPOC environment--Taking the "Industrial Robot Programming and Operation" course as an example*[J]. *Journal of Hubei Institute of Industrial Vocational Technology*, 2020, 33(5):82-84.
- [5] Zhang He. *Informatization teaching design of construction courses based on BIM*[J]. *Journal of Shazhou Vocational Engineering College*, 2014, 17(02):37-40.
- [6] Xu Xiaofang, Fang Liao, Liu Yanghui. *Teacher's Role in Hybrid Teaching Mode in Post-MOOC Era - A Research Perspective Based on SPOC+FCM* [J]. *Research on Higher Financial Education*, 2018 (1):1-5,10.
- [7] Wang Zheng, Su Xiaohong. *Research on MOOC + SPOC hybrid teaching*[J]. *Computer Education*, 2017(1):91-94.
- [8] Liu Zhiyong, Chen Yuanjuan, Zhang Wenlin. *Research on teaching evaluation method of blended teaching mode based on SPOC* [J]. *Education Modernization*, 2017(13): 105-133.
- [9] Xue Yun, Zheng Li. *Exploration and reflection of SPOC-based flipped classroom teaching mode* [J]. *China Electrified Education*, 2016, 352(05):137-142.
- [10] Su Xiaohong, Zhao Lingling, Ye Lin. *Exploration and practice of blended teaching based on MOOC+SPOC*[J]. *China University Teaching*, 2015(7).
- [11] Li Jiansheng. *Countermeasures of architectural education to adapt to the BIM era*[J]. *Journal of Western Habitat*, 2014, 29(06):1-5.
- [12] Xu Wei, Jia Yongzheng. *From MOOC to SPOC-An Academic Dialogue Based on MOOC Practices at UC Berkeley and Tsinghua University* [J]. *Modern Distance Education Research*, 2014, (4):13-21.
- [13] Sun Cheng, Shao Yu, Dong Yu. *Exploration of Teaching System of "Intelligent Architecture and Construction" Specialty: Reflections on Architectural Education under the Concept of New Engineering* [J]. *Time Architecture*, 2020(02): 10-13.