



Construction of MOOC Teaching System for Double Helix Architectural Energy Saving

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ABSTRACT

MOOC network teaching has brought great changes to the current university teaching mode. In this paper, the author takes online teaching project construction -- "technology for architecture energy saving" as an example, combining his teaching experience of the past ten years, putting up the method of teaching structure adjustment and classroom teaching extension, optimizing the teaching purpose, content, management and the teaching mode of technical practice, the teaching model, team building, time control, and other aspects of MOOC online course. He also brings interactive "on line" and "open" double helix teaching, which effectively updates and improves the traditional architectural teaching system, and receives better teaching effect.

Keywords: Building energy-saving technology Course, MOOC, Online, Open, The double helix teaching system.

1. INTRODUCTION

MOOC teaching mode which is combined with network information, has brought great changes to the teaching methods, content, mode and teaching management system of university class. It also has brought a new era to the teaching reform for higher education [1-2]. Therefore, the Ministry of education pays close attention to the trend of the combination of network and teaching, encourages the construction of online, open teaching platform with professional characteristics [3-5], tries to achieve its promotion in education concept renewal, education quality promotion, teaching method optimization, education mode reform, etc [6]. Encouraged by these policies, in January, 2016, the construction of MOOC project launched in Shijiazhuang Tiedao University tentatively. The "building energy saving technology" online course in architecture major is included. As one of the first teaching reform and construction projects, under the "online open courses" MOOC mode, everyone is exploring how to adapt to the new teaching system in the form of online teaching with online and open interactive sessions.

2. CONSTRUCTION OF ONLINE AND OPEN DOUBLE SPIRAL TEACHING SYSTEM PLATFORM

Construction project "building energy-saving technology" course which is taught and learned through online, differs from face-to-face teaching mode of "teaching and learning" [7-8]. Online teaching requires an objective and course introduction, intuitive technology theory, lively and interesting integration cases. Teaching contents in many aspects, such as the advanced simulation of interaction on how students feel in online lectures as well as teachers' qualification are also required. [9] Online teaching obtains the characteristics of fast, efficient and unlimited online turnover which is one of the efficient ways of solving current teaching problems such as college enrollment, shortage of teachers, low efficiency, etc [10]. MOOC network teaching mode, which is a type of "silent" online interactive teaching mode where the audience can not be seen, is regarded as a subversive teaching reform, compared to the traditional interactive teaching mode of architecture that has lasted for so long time like the direct face-to-face explanation or "hand in hand" apprenticeship type [11].

On the basis of summarizing the teaching experience of the past ten years, combined with the characteristics of the course itself and online teaching, an attempt has been made to establish a set of "online" and "open" double helix teaching system by our research group: the teachers use online

teaching to teach basic theory in class time, then use spare time to tutor students to expand the contents. That is to say, in the helix rise building teaching system, online classroom is paralleled with extracurricular development. This teaching system makes up the hole of the knowledge in the class, fills in the professional practice lessons, optimizes the corresponding class theory system. (Figure 1) The teaching mode of “building energy saving technology” under MOOC, requires professional teachers’ rapid improvement in teaching method, teaching content, the quality of their own as well as professional enthusiasm, then establish a set of effective online open architecture teaching system.

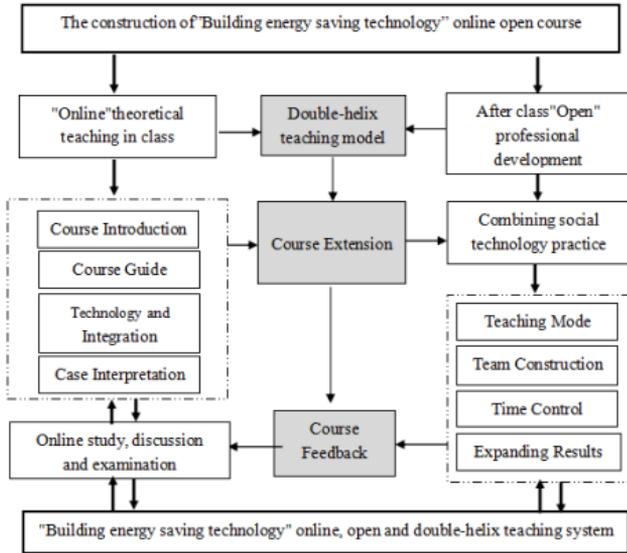


Figure 1. The framework of teaching system

3. THE CONSTRUCTION OF ONLINE MOOC CLASSROOM

According to the development of the times and the characteristics of MOOC online teaching, the subject group has finished the appropriate optimization and adjustment about “building energy saving technology” for online classroom on teaching objectives, teaching content, teaching main line, curriculum management, etc.

3.1 Course orientation

“Building energy saving technology” course of Shijiazhuang Tiedao University which has been opened for ten years, belongs to an elective course and is set for 16 hours (1 credit). The focus of curriculum outline transforms from the “energy efficient technical analysis in building design” to “interactive applications of energy saving technology and architectural design” in this curriculum reform. In the same time it regards to “assist and optimize the architectural design” as the teaching objectives. The new teaching system will form the teaching main line as the “Energy and environment - Technology - Case Analysis - The cultivation of the consciousness” to teach, and will form a teaching system that aims to train students to foster the ability of applying energy-saving technologies flexibly, practical ability as well as innovative ability in daily project design.(Table 1). Specific course contents are as follow:

Table 1. Composition of online course content construction

Part	Chapter Contents	Teaching time	Video length requirements	The set of discussion class
Part 1	Urban environment and green energy (The introduction of the course included) Building	4Hours	70% -100%	1
Part 2	energy saving technology and integration Analysis of	10Hours	50%-70%	3
Part 3	construction Green cases	2Hours	70%	2
Part 4	consciousness cultivation	0	Conscious learning after class	1

At the same time, “building energy saving technology” course acts as the school's online open courses. Thus, some auxiliary teaching resources can be uploaded on the online teaching platform to supply and improve the content of online teaching. For instance, the relevant teaching materials, professional videos, public resources for students' extracurricular courses. In the process of learning online courses, students are required to watch videos that lasts for different times, as online teaching system set in accordance with the task points, the general control of which is 50%, 90%, 70%, 100%, etc, which plays the role of supervision of learning. In addition, the curriculum also set up the corresponding class homework, classroom discussion, classroom examination and other management links. For teaching staffs, the online teaching system set teaching teams or assistants to do online Q & A and management, therefore a relatively perfect online classroom building education can be formed.

3.2 Classroom integration

Content integration and adjustment is the main focus of the reform of online courses. In the new teaching mode, classroom construction and management methods can be learned and improved through rule-based professional software. However, whether the teaching content is vivid, as well as students’ interactive acceptance level, above these require professional teachers continue to try, to adjust, to improve the teaching effect according to the experience and practice. In the “building energy saving technology” online and open course construction, our project team has summed up the previous teaching experience, and has carried out a lot of adjustments about the outline of the framework and the focus points of the content are :

Table 2. The optimization of curriculum structure

Class time	Chapter sections	Specific contents	Key points	Difficulties	Reference Materials
1	Course introduction	Course introduction	Why we save energy		
2	Urban environment and green energy	Urban environmental problems	To explore the relationship between energy and architecture forms	Green energy and architecture design	exists
3		The development of building energy conservation			
4		The usage of green energy			exists
5-8	Architecture energy saving technology and integration	Energy saving in building space (Building ventilation, lighting and shading, Micro space and outdoor environment)	Architecture technologies and design of form	Boring, hard to understand, integrated design of the building	exists
9		Retaining structure technology			
10-11		The surface of green architecture (1), (2)			exists
12-13		Technology integrated design (1), (2)			exists
14		Low carbon model of urban design			
15	Architecture case analysis	Case of traditional building energy efficiency	To foster potential consciousness	Flexible application	exists
16		Case of modern building energy efficiency			exists

(1) Urban environment and green energy sector (including course introduction): This is a guiding node, whether it is successful or not, related to the students' interest and acceptance of the course. Based on architectural education, starting from the analysis of tense energy equations under the background of environmental pollution, the new urbanization, analyzing the problems of energy utilization, combined with the background of industrial revolution and the trend of modern architectural design, I put forward the relationship between environmental habitat form and the construction of energy-efficient design: “form follows function”, “form follows climate” and “form follows energy,” these are three

evolving design progress which naturally transits to the importance of utilizing building energy.

(2) Building energy saving and integration technology sector : This part is the difficult point of the whole course, technical abstraction is not easy to understand, the final teaching effect depends on the professional content and teaching methods of this part. Many reference books in this part, but we are lack of the authoritative textbooks which is written from the perspective of the architectural design. According to nearly ten years teaching experience, the project team of online courses, respectively starts from the technology integration of architectural nodes of ventilation and lighting parts, uses method of informative references as well as architectural culture and cases to summarize, so as to improve the dull characteristics of the single boring technology course. The difficulty lies in how to make a professional technical problem clear combined with the explanation of a program designed in an online course, so as to achieve the purpose of online education.

(3) The analysis of construction cases sector: This application part of the technology integration belongs to the display section of summary analysis. We will analyze the two parts of the traditional and modern green buildings design cases combined with technology analysis, as long as the cases are typical, the language is vivid, it is generally easy to cause the resonance of the students in entertaining and technology. The emphasis of the course is to understand the design method of green building and the way of implementation. The difficulty lies in the correct analysis of the domestic and international construction cases as well as the thought-leading.

(4) Green consciousness cultivation sector: This part does not belong to the content of the teaching, but it is the ultimate teaching purpose of the course. Through the whole process of online lectures, the aim is to let the students form a design concept of the subconscious green living environment from both the physical space and spiritual space (two aspects), then achieve the perfect combination of formation for architectural design and recessive dominant ideology of the realization.

Four teaching parts mentioned above of urban environment and green energy sector, building energy-saving technologies and integration construction sector, case analysis sector as well as green awareness training sector are partially cross but continuous and progressive on the whole.

4. OPEN EXTRACURRICULAR PROFESSIONAL DEVELOPMENT

The technical development of open class, as an important extended part of the online open teaching system, has the function of classroom assistance and verification. Architecture is a competitive profession full of competitions and bidding term are often heard in class, after class or throughout working life. This is the particularity of architectural design occupation, which belongs to a public form of professional technology competition. There is open test part in online courses of the building energy-saving technology course, however the real professional application requires us to jump out of the ivory tower of college and return to social practice to verify the effect of teaching through social design competitions. The number and quality of students in winning the competitions is also becoming one of the social evaluation standards of the students' professional level.

As for the interactive relationship between design competitions and the “building energy saving technology” online courses, it can be reflected in the following points:

4.1 Non classroom open teaching development

Teaching associated with social competition requires the change of the teaching mode [12]. This type of open curriculum is different from the normal design of teaching, which tests the teachers and students’ love and passion for professional online courses. Extracurricular stage mainly depends on students themselves to find their own races, then make use of spare time after class and find the relevant professional teachers to complete architectural design competitions. Of course, for students and teachers, the teaching behavior of non-classroom teaching is of no pressure and constraints of classroom teaching, which is a kind of extracurricular development and spontaneous learning behavior. This kind of extracurricular teaching behavior often comes from the professional interests of both sides who must obtain a lot of enthusiasm and go all out to produce a high level of extra-curricular teaching effect [13].

“Building energy saving technology” online course mainly teaches the application of solar energy and related energy in architectural design, of which the corresponding architectural design competitions are a lot. The extracurricular development link of “Building energy saving technology” online open courses has been based on this design contest for many years and we have been verifying the teaching effect of the course and online students’ professional application abilities through it.

4.2 The construction of the best professional developing team

In the professional study in university, as a person's energy is limited, it is difficult for one to be very proficient in all aspects. Design competition requires participants to produce high quality professional design programs and final expressions in a short period of time which requires the formation of a complementary design team. In view of non classroom teaching which is free from the constraints of the teaching class and the formation of the team is relatively free, I put forward the following requirements to set up the teams [14]:

(1) The number of teams should be suitable: “Efficiency and high level” is the purpose of building teams, participants must carry out their duties, handle well the relationship between solidarity and cooperation to play the best team level. For a common competition, the area of the site won't be too large and the contest requires deep thinking, so the number of the team should not be too large, otherwise the team will form an atmosphere of buck passing, slack, in which unnecessary disputes and conflicts will break out. “Everybody's business is nobody's business” phenomenon will arise and cause the team to lose confidence, leading to the final death of the plan.

(2) To complement each other in professional ability: An efficient team must have collaborative team members. A set of perfect design work needs cooperation with people who grasp various professional abilities. International design competitions are very demanding in the design ability, technical application ability and software performance as well as English skills, which requires team members to have professional complementary capabilities and flexible design

thinking, time coordination between class work and non classroom competition also needs to be handled well.

(3) Clear division of labor: After all, the architectural design competitions are of high level, which requires the team members to have a good command of professional skills and a solid foundation of knowledge as well as mutual cooperation, only in this way a nice design work will come out. At the beginning of team construction, the volunteers should have the true evaluation of their own from of all aspects, like the abilities of conceptual design, technical application, software performance, language expression, etc. Then make use of their own professional expertise to contribute to the team and have a suitable position in the team.

(4) Perseverance: The competition organized outside the classroom is different from the teaching competition in the classroom. First of all students are voluntary to participate, team members can be from different classes (or even different grades). As long as we have a common purpose, we may become the members of the team. What's more, the students are engaged who will not quit. A perfect design contest often needs a month or so to figure out. A lot of time and effort need to be paid and students need to solve the problem by mutual help.

4.3 Design work and control of time

Design competitions are a kind of social competitive activity, especially the international ones. Teams that participate are specialties from all over the world. Even college teachers and students, designers and corporate R & D personnel may participate in. Awards are not from accidental, thus clear, reasonable schedule and adequate preparation are needed.

Generally, a university curriculum design last for eight weeks, this kind of pattern has been kept for many years, and everyone has got used to that. When faced with the design competitions with no teacher's supervision and no time pressure, many students choose to withdraw from the competition or leave the design team in the middle, which is a very bad phenomenon. Therefore, for extra-curricular practice, schedules need to be developed from the beginning, covering preliminary research, design work, technology integration, building performance as well as final integration and combination. Time arrangement should be reasonable, then we need to gradually improve and modify the inspection of each node to control the main points effectively and to promote the formation following the prescribed order scheme, and finally accomplish progressive design progress.

5. SUMMARY

Online open courses under MOOC mode enters into the university classroom which is not just a simple recording and tailoring of the professional course but many parallel spiral teaching sectors including curriculum guidance, theory teaching, practice analysis and later expansion of knowledge, is a complete professional network teaching system[15-16].

In the construction of “building energy-saving technology” online open course, it takes the research group nearly one year to summarize, analyze, discuss, then sets up the two parallel interactive teaching parts of online theoretical teaching and later period technology expansion, and form an overall open online course from theory to practice. Finally we

ensure the double effect tests of online classroom teaching and knowledge application after class (Figure 2). Apart from hard work we have also gained a lot of experience and feelings, hoping to be helpful to the relevant scholars of the online open teaching and practice.

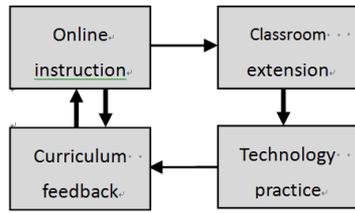


Figure 7. Spiral teaching

REFERENCES

[1] Yanmei LIU, “Chinese higher education reform under the wave of MOOC,” *Higher Education of Social Science*, vol. 9, no. 3, pp. 23-27, Mar. 2015. DOI: [10.3968/n](https://doi.org/10.3968/n).

[2] Paul DIVER, Ignacio MARTINEZ, “MOOCs as a massive research laboratory: opportunities and challenges,” *Distance Education*, vol. 36, no. 1, pp. 5-25, Jan. 2015. DOI: [10.1080/01587919.2015.1019968](https://doi.org/10.1080/01587919.2015.1019968).

[3] David ONG, Manimekalai JAMBULINGAM, “Reducing employee learning and development costs: the use of massive open online courses (MOOC),” *Development and Learning in Organizations: An International Journal*, vol. 30, no. 5, pp. 18-21, May. 2016. DOI: [10.1108/DLO-08-2015-0066](https://doi.org/10.1108/DLO-08-2015-0066).

[4] Robinson ROBERT, “Delivering a medical school elective with massive open online course (MOOC) technology,” *Peer J*, vol. 4, pp. e2343, 2016. DOI: [10.7717/peerj.2343](https://doi.org/10.7717/peerj.2343).

[5] Xinyi ZHENG, “The Enlightenment of MOOC for the college english teaching in China,” *Higher Education of Social Science*, vol. 8, no. 6, pp. 57-60, Jun. 2015. DOI: [10.3968/7153](https://doi.org/10.3968/7153).

[6] Li Hongmei, Lu Guodong, Zhang Jianping. (2014, Nov.). “The new teaching mode of higher education in the post MOOC period.” *Research on Higher Engineering Education*, vol. 06, pp. 58-67. Available: <http://www.docin.com/p-1703690148.html>

[7] Nan LI, Himanshu VERMA, Afroditi SKEVI, Guillaume ZUFFEREY, Jan BLOM, Pierre DILLENBOURG, “Watching MOOCs together: investigating co-located MOOC study groups,”

Distance Education, vol. 35, no. 2, pp. 217-233, Feb. 2014. DOI: [10.1080/01587919.2014.917708](https://doi.org/10.1080/01587919.2014.917708).

[8] Rob FIRMIN, Eva SCHIORRING, John WHITMER, Terrence WILLETT, Elaine D. COLLINS, Sutee SUJITPARAPITAYA, “Case study: using MOOCs for conventional college coursework,” *Distance Education*, vol. 35 no. 2, pp. 178-201, Feb. 2014. DOI: [10.1080/01587919.2014.917707](https://doi.org/10.1080/01587919.2014.917707).

[9] Yu Xinjie. (2015, Dec.). Online open courses need to be built to use. *Higher education in China*. [J]. 24, pp. 9-10. Available: <http://www.zhixing123.cn/baijia/52514.html>

[10] Wang Shuhai, Han Lihua, Yang Jie, Chen Guohua. (2015, Dec.). Research on the network teaching of adult higher education in local colleges. *Journal of Shijiazhuang Railway University (SOCIAL SCIENCE EDITION)*. [J]. 04, pp. 96-100. Available: <http://www.docin.com/p-1455565340.html>

[11] Olga BUCOVETCHI, Radu D. STANCIU, Cristina Petronela SIMION, “Study on designing a curriculum suitable for MOOC Platforms starting out the Romanian students’ expectations,” *Procedia Technology*, vol. 22, 2016. DOI: [10.1016/j.protcy.2016.01.160](https://doi.org/10.1016/j.protcy.2016.01.160).

[12] Yuanna XU, “The mode reform of superior education in the MOOC Times,” *Higher Education of Social Science*, vol. 8, no. 3, pp. 32-36, Mar. 2015. DOI: [10.1080/01587919.2014.917708](https://doi.org/10.1080/01587919.2014.917708).

[13] Gao Liqiang, Liu Xiaofeng. (2010, Sep.). The developing of ecological consciousness in the design of architectural undergraduate graduation. *Journal of Zhejiang Shuren University (NATURAL SCIENCE EDITION)*[J] 03, pp. 37-43. Available: <http://www.cnki.com.cn/Article/CJFDTotalsRZR201003013.htm>

[14] Gao Liqiang, Gao Feng, Zhu Jiangtao. *The Dynamic Design Method of Modern Architecture*, vol.05, China Construction Press, Beijing, China. 2016, pp.168-171.

[15] Da Liu, “The reform and innovation of english course: a coherent whole of MOOC, Flipped Classroom and ESP,” *Procedia - Social and Behavioral Sciences*, vol. 232, 2016. DOI: [10.1016/j.sbspro.2016.10.021](https://doi.org/10.1016/j.sbspro.2016.10.021).

[16] S. Rayyan, C. Fredericks, K.F. Colvin, A. Liu, R. Teodorescu, A. Barrantes, A. Pawl, D.T. Seaton, D.E. Pritchard, “A MOOC based on blended pedagogy,” *Journal of Computer Assisted Learning*, vol.32, no.3, Mar, 2016. DOI: [10.1111/jcal.12126](https://doi.org/10.1111/jcal.12126).