Teaching Reform of Architectural Physics in China
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Abstract. Architectural physics is a fundamental and compulsory course in Chinese universities. With the development of architectural technologies and the improvement of requirements on environmental quality, new challenges have been encountered in architectural design. Thus, it is highly important for universities to continuously update and reform this course to meet the requirements of modern society. As an effort to analyze the architecture curriculum system, and further clarify the position of architectural physics, this paper discusses teaching reforms in terms of syllabus, aim, knowledge, method and evaluation. This paper also offers several recommendations, which can be used to guide the teaching reform of architectural physics. Students, therefore, can be better prepared for future jobs.

1. Introduction

Architecture is a multi-disciplinary interdisciplinary, which is summarized as a synthesis of art and technology [1]. Architectural technologies are one of the three basic elements that make up an architecture [2]. In order to realize the architectural function and architectural image, it is inseparable from the support of architectural technologies [3]. Architectural designers must have relevant knowledge about architectural technologies and application abilities, which shows the importance of architectural technology.

In China, undergraduate education on architecture pays more attention to the training of space organization and aesthetics, and less attention to the training of architectural technologies. As a result, there is a lack of integration between architectural design and architectural technologies. From the relevant architectural meetings and works of international architectural competition, it is clear that the quality and level of education on architectural technology of Chinese architects are lower when compared with those in developed countries. Moreover, Chinese architects lack capabilities in meeting the actual demands of high-tech construction projects. The lack of competitiveness of Chinese architects in bidding also exposed the problem of insufficient education on architectural technologies and science in China [4].

2. Relationship between Architectural Physics and Architectural Technology

Architectural physics is a compulsory course of architectural technological courses, and its status in the teaching of architecture is very important [5]. With the diversification of architectural functions and the improvement of environmental quality requirements, designers’ dependence on science and technology has become increasingly apparent. Only when contemporary architects possess solid basic theory and knowledge can they better combine the humanistic and artistic conception of architectural design and creation with engineering technologies that reflect the requirements of the times. Setting up the course of Architectural physics in the major of architecture can meet the requirements of cultivating architects' abilities to control the physical environment and comprehensive design.

In the architecture curriculum system, the curriculum group of architectural technologies and the curriculum group of humanities and arts are the key elements of the core curriculum group of
architecture. Architectural physics is one of the compulsory courses in the course group of architectural technologies. It analyzes the physical and mental requirements of people on the internal and external environment of architecture from the perspective of physiology and psychology. The discipline of creating a suitable physical environment for people in planning and architectural design is indispensable for the professional career of architecture students. It has received more and more attention from universities both in China and abroad, and its necessity and importance have received continuously attentions.

3. Relationship between Architectural Physics and Architectural Design

Architectural design is a process of continuous problem-solving. As the concept of green energy is deeply rooted in people’s hearts and people’s requirements for the quality of the built environment continue to increase, relevant departments of the state and provinces have clearly stipulated that the architectural energy assessment should be added to the architectural design process. Ideas and technologies are integrated into the process of solving problems in architectural design, enabling energy conservation to be implemented. Moreover, the need for architectural physics knowledge and capabilities in the field of architectural design is becoming increasingly apparent.

The process of architectural design can be divided into three stages: early design stage, middle design stage and final design stage. The knowledge and ability of teaching architectural physics will be involved in all these three stages, revealing its important role.

In the early stage of scheme design, students are asked to propose a preliminary design scheme based on site selection, planning layout, basic shape, height, roads, etc., and use concept sketches to express design intents. At the same time, ecological architecture master simulation software is used to analyze the physical environment. In the middle design stage, teachers rely on the green and energy-saving architectural laboratory to conduct verification experiments on architectural sound, light, heat, etc., to analyze and compare the students' preliminary design plans, including lighting, illuminating, thermal analyses, noise, ventilation, etc., and then the plan is modified based on the analytical results.

In the final design stage, the standards of thermal insulation, lights of the windows and doors etc. are further calculated. The software analyzes the energy consumption of the building and other issues and forms the final plan.

4. Current Situation and Problems

4.1. Teaching status

At present, from the syllabus development to the teaching task arrangement to the teaching, there is a gap or a lag between the quality inspection of architectural physics and architectural design courses. The syllabus is formulated based on the principle that the teacher who teaches the course is also responsible for writing or revising the syllabus of that course. Therefore, the course syllabus of architectural physics is naturally completed by the original teacher. The teaching tasks of architectural physics are generally performed by teachers with a professional background in architectural technologies. If universities have no teacher familiar with this area, external employments are often adopted, as long as the curriculum tasks are implemented. Since the teacher of architectural physics does not view the curriculum from the perspective of architecture, they lack a sense of integrating architectural physics with design, which will lead to a situation where teachers only need to teach the stipulated content of architectural physics, and evaluate the students. Thus, architectural physics receives insufficient attention, and it is not linked with other courses of architectural design.
4.2. Problems

The orientation of architectural physics is not clear, and the degree of attention is not enough. This is manifested by the instability of the teachers and the lack of understanding of the course. The teaching style is monotonous and the content is relatively outdated, which is due to insufficient research on training programs of teachers and curriculum systems.

Compared with other courses, architectural physics is relatively unattractive to students who are not highly motivated, which lead to a lack of concentration in class listening, inactive learning outside of class, and careless assignments. The reason is that the students are not clear about the learning objectives of the course and always think that it is useless. Hence the sole consideration is passing the exams and getting credits.

The content of architectural physics is out of touch with the architectural design. It is demonstrated in the lack of awareness and abilities to actively use architectural technologies in the design process, the lack of depth in design works, and the lack of awareness of green energy conservation. The reason is that the course is inadequate in cultivating students' technical skills in architecture [2].

5. Teaching Reform and Practice

5.1. Revision of syllabus

First, regarding the curriculum system, it is highly necessary to fully study and analyze the relationship between all architectural courses, and clarify the position of architectural physics during the process of formulating or revising teachers' training plan. Furthermore, with regard to the syllabus, it is essential to organize the corresponding teaching team to conduct research. Besides, the teachers of architectural design should be included to complete the compilation of the syllabus of architectural physics.

The general idea of the syllabus revision is to focus on the objectives of training professional teachers in architectural design, and to meet the needs of design industries, to cultivate students' energy-saving conception and the abilities of analyzing using the software. When formulating the syllabus of architectural physics, it is necessary to include conceptions of green energy, natural lighting, sound quality and other crucial elements. Further, the syllabus should be made with the aim of training the architectural design abilities of students.

5.2. Aim of ability development

In order to ensure that the teaching of architectural physics is conducted with the purpose of serving architectural design, it is necessary to clarify the relationship between ability development, knowledge learning and project implementation [6]. Thus, the curriculum system with abilities as the goal should be built. The teaching of architectural physics should be shifted from knowledge transferring to ability training, from basic analyzing abilities of architectural physics to comprehensive application abilities of architectural physics.

5.3. Knowledge system

As to progressively teaching the knowledge system, architectural physics should be organized based on four major modules: disciplines, architectural thermal engineering, architectural optics and architectural acoustics. It is also required to specify the corresponding content for each module, and to keep the knowledge concise to the students [7].

5.4. Method of ability development

With the aim of abilities development, four major abilities namely independent study, design of architectural thermal engineering, design of architectural optics and design of architectural acoustics should be cultivated. Each ability should be arranged with relevant training programs and practices. Thus, the aim can be clarified and the training can be reliable.

Considering that the teaching contents of architectural energy, natural lighting and indoor acoustics are easy to be combined with architectural design, students are trained with tasks of...
projects concerning the design of energy-saving, architectural lighting and indoor acoustics. Besides, group discussions in the class and independent studies after class are encouraged. Therefore, what students learn from the class can be consolidated, and the theoretical knowledge of architectural physics can be applied with real problems, achieving the purpose of applying [8].

5.5. Evaluation

Different from traditional methods of evaluation of architectural physics, paper examinations are abandoned and a series of assessments such as group discussion report, energy-saving analyses, light environment simulation, and architectural acoustics simulation are adopted. The transformation aims to cultivate students' self-learning abilities, abilities of architectural thermal design, abilities of architectural optics design and abilities of architectural acoustic design. Further and more importantly, students' evolvement can be improved and their enthusiasm of learning architectural physics can be motivated [9-11].

6. Summary

The teaching of architectural physics is an important part of implementing the course group architectural technologies and serving the course group of architectural design. As an effort to better teaching architectural physics, it is highly important to look at the overall situation, connect architectural physics with the other courses and find the orientation of the course. Moreover, it is also necessary to integrate architectural physics with the demands of real projects and new technologies.

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References


182

