



Research on Open Innovation Experimental Teaching of Building Environment and Energy Application Engineering

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Abstract. The experimental teaching is an important role of talent cultivation in Building Environment and Energy Application Engineering major under the new engineering background. In order to let students enter the laboratories and improve their innovative consciousness, we should strengthen the management construction of professional laboratories, transform the traditional teaching experiments into open innovative experiments, increase the opening strength of laboratories, and improve the function of open laboratory and better serve students. This paper first analyzes the problems existing in the traditional experiments and then makes the reforms to experimental teaching from four aspects: setting up independent experimental courses, opening innovative teaching, building school enterprise cooperation laboratories and configuring laboratory managers. The four aspects can well solve the problems in experimental teaching. It not only allows students to arrange experiments reasonably, but also allows enterprises to use laboratories to carry out cooperative research.

Keywords: experimental teaching · independent experimental courses · open innovation teaching · laboratory managers

1 Introduction

Professional experiment courses are an important part of professional practice teaching, and they are also an important link for students to integrate theory with practice. Moreover, experiment courses play an important role in cultivating students' engineering consciousness, practical ability and innovation ability, and improving students' comprehensive quality. The laboratory opening is the inevitable trend of education reform and social development, the laboratory opening is a necessary means to improve the comprehensive ability of undergraduate students, and the laboratory opening is also an important condition for students to carry out innovation and entrepreneurship projects and cultivate scientific research ability [1, 2].

2 Problems in Professional Experiments

2.1 Problem of Experiment Time

The traditional teaching experiments are put in each professional course, and are carried out after the theoretical study of the course. Therefore, the experimental time is relatively scattered, students can not get effective and systematic training. This will result in low utilization of experimental equipment and laboratory.

2.2 Problem of Experiment Classification

Most of the traditional teaching experiments are demonstration, confirmatory and comprehensive. There are not innovative experiments designed and operated by students. Students only need to complete the specified experimental operation within the specified time. The experimental theme, experimental content and experimental operation are mainly demonstrative and confirmatory experiments. There are few innovative experiments and design experiments, which can not meet the requirements of the students who have spare power to develop scientific research and innovation ability [3, 4].

2.3 Problem of Experiment Course and Management

The traditional teaching experiments are all closed management, and the experimental projects are all arranged at the beginning of the semester. At that time, the students and teachers are arranged to do the experiments on time. Moreover, there are many courses and many experimental projects in the major. If the students have classes or other situations on that day, the students can't finish the experiment, and then they just make up the experimental data of other students. The courses of the experimental project are shown in Table 1.

2.4 Problem of Experiment Refrain

In the traditional teaching experiments, each course has its own teaching content, so there are repetition phenomena in the experimental courses[5], such as “comprehensive experiment of air conditioning system” in the course of “air conditioning engineering” and “determination of performance coefficient of heat pump unit” in the course of “refrigeration technology”, and the experiment of “determination of air meteorological parameters” in the course of “air conditioning engineering” and the experiment of “determination of indoor air quality” in the course of “building environment”. In Table 1, it can be seen that although there are many experimental courses offered by the major, some theoretical courses are repeated, so it is necessary to integrate corresponding experiments.

Table 1. Experimental course

<i>course</i>	<i>basic course experiment</i>	<i>Professional course experiment</i>
Heat Transfer	✓	
Engineering Thermodynamics	✓	
Fluid Mechanics	✓	
Built Environment	✓	
Pipe-Net for Fluid Transporting	✓	
Theory and Device of Mass and Heat Transfer	✓	
Measurement of Building Environment		✓
Building Equipment Automation		✓
Air-conditioning Engineering		✓
Refrigeration Technology		✓
Ventilation Engineering		✓
Heating Engineering		✓
Boiler and Boiler House Design		✓
Gas Transmission and Distribution		✓

3 Reform of Experimental Teaching

3.1 Setting up Independent Experiment Course

In recent years, the teaching reform in Building Environment and Energy Application Engineering major has been actively carried out. The experimental teaching reform is also an important part in our school. Two independent experimental courses have been set up, one of which has been offered for several years as an elective experimental course of “assembling and maintaining of small refrigeration equipment”. This course mainly focuses on simple assembly and troubleshooting of household air conditioners, such as copper tube cutting, bell mouth making, fluorine filling and vacuum pumping. Students seldom have this opportunity to participate in the experiment which is very practical and closely related to the major during the period of study in school. To combine theory with practice, the development of this experiment can open a window for students. This independent experimental course is set up in the second semester of junior year, because the professional “air conditioning engineering” and “refrigeration technology” two theoretical courses are also set up in this semester. After learning these two theoretical courses, it has theoretical significance for the independent experimental course. There is also a compulsory course of “innovation ability exercise (open independent experiment)” set up from grade 2020. This course mainly focuses on the frontier research hot spots in the

professional field, and guides students to carry out independent innovation experiments and independently set up exploratory research projects as the goal, aiming to fully mobilize students' subjective initiative and cultivate students' innovation consciousness and innovation ability, Improve students' scientific research ability and team cooperation consciousness from many aspects. This independent experimental course is arranged in the first semester of the senior year. At this time, the professional courses are all over. Students can choose their own research direction according to their own interests and hobbies to exercise their scientific research ability [6].

3.2 Open and Innovative Teaching

There are four types of laboratories in this major. The opening of each laboratory is shown in Table 2. In order to get through the opening of various laboratories, the open innovative experimental teaching mode is adopted to make students become the main body of the experiment, which has become the main direction of the experimental teaching reform in Building Environment and Energy Application Engineering major [7]. Using the network platform, the laboratory equipment and its main functions are organized into documents and sent to the network, so that students can understand the laboratory resources in time. The students can enhance their understanding of the frontier research field and the current research hotspots by participating in academic reports, professional novelty search, or based on the innovation and entrepreneurship projects of university students, Internet plus or professional technology competition, so as to realize the topic selection design of autonomous innovation experiment subjects. At the same time, professional teachers in their familiar research direction give guidance and program optimization to the students. Students are able to carry out analysis, research and practice activities for innovative experimental projects of independent design by comprehensively using theoretical knowledge, solve complex problems encountered in independent research projects, apply professional software to complete project practice or design research, master basic methods for writing relevant research reports, and refine and analyze research results, Multimedia production and achievement report. Through the implementation process of innovative experimental projects, we can cultivate the ability of multidisciplinary collaborative development, hands-on ability, assiduous research ability and independent innovation practice ability, and improve students' awareness and ability of team cooperation and lifelong learning from many aspects. The open innovation course can enhance students' practical ability. Students can carefully observe the experimental phenomena, constantly find problems, make full use of their creativity and imagination, and complete the whole experiment under team cooperation, which improves students' scientific research innovation ability and practical ability [8–10]. Let the students use the laboratory completely. The experimental instruments and equipment are completely open to students, so that students can become the masters of the laboratory. Through the open laboratory, students applied for a number of college students' innovation and entrepreneurship projects and won awards in a number of national competitions.

Table 2. Laboratory opening

<i>Laboratory classification</i>	<i>Open form</i>	<i>Laboratory Manager</i>	<i>Experimental project</i>
Undergraduate professional laboratory	Appointment opening	Experimental teacher	Experiments required by the course
Teacher research laboratory	Appointment opening	Professional teacher	Scientific research experiment, science and technology competition and graduation project
Undergraduate Innovation Laboratory	Appointment opening	Experimental teacher	College Students' innovation and entrepreneurship projects, science and technology competitions
School enterprise coconstruction laboratory	Appointment opening	Professional teacher	Scientific research experiment, science and technology competition and graduation project

3.3 School Enterprise Cooperation

The alumni resources of this major are rich, which can carry out school enterprise cooperation to build laboratories and deepen the integration of industry and education. In recent years, thanks for good quality alumni resources, professional laboratory construction has been rapid development. In 2012, alumni invested in the construction of ground source heat pump research base of Lute energy and Wuhan University of science and technology. In 2016, during the evaluation of the Ministry of housing and urban rural development, the alumni transformed the air conditioning system for our department according to the professional norms and standards, and won the unanimous praise and recognition of the evaluation experts during the evaluation period. In 2017, alumni built a large space flexible distributed system. In 2019, the building environment intelligent control system of comfortable Yibai and Wuhan University of science and technology was established. The installation and operation of these systems have produced benefits, provided experimental platform and help for students to set up scientific and technological innovation projects, created good conditions for students to carry out practice and scientific research experiments, and also contributed to the development of the laboratory. Because of the school enterprise cooperation, some of the laboratory's achievements can be fed back to the enterprise, truly achieve a win-win, benign interaction [6].

3.4 Laboratory Manager

Open experiments are generally carried out in extracurricular time. At this time, teachers are not in the office after work, so it is not convenient for students to carry out experiments. If you directly give the keys of the laboratory to students, it will be difficult to explain in case of a safety accident. Therefore, the allocation of laboratory managers is one of the important guarantees for the development of College Students' innovation and entrepreneurship projects and laboratory open innovation. At present, there are no managers specially responsible for open innovation experiments in professional laboratories, which are usually managed by experimental teachers and professional teachers. However, experimental teachers are mainly responsible for the development of undergraduate teaching experiments and the maintenance of equipment, Professional teachers may only be responsible for the relevant management of their innovation projects, and the school or college does not have such relevant jobs and the description of relevant workload. While the country strongly advocates innovation and entrepreneurship, it is hoped to specially allocate laboratory managers who are responsible for the development of open innovation experiments. The managers are best selected from professional experiment teachers. As long as relevant additional workload is given, not only the staffing isn't increased, but also the open innovation experiments are carried out smoothly. At the same time, in order to improve the professional and management level of managers, we should regularly carry out unified technical training for managers, arrange them to exchange and study in domestic excellent universities, learn advanced management experience and practical technology, broaden their horizons, make the level of managers keep pace with the times and improve the comprehensive quality of laboratory managers. In a word, the management level and work enthusiasm of managers play an important role in cultivating college students' innovation competition and the development of open innovation experiment.

4 Conclusions

There are many problems in the traditional experiment teaching. This paper discusses the problems existing in the experiment teaching process, and puts forward a constructive reform plan. It is hoped that through the discussion of setting up independent experimental courses, open innovative teaching, school enterprise cooperation and co-construction of laboratories, allocation of laboratory managers we can provide students a better experimental teaching environment and complete the training task of Building Environment and Energy Application Engineering major. And four aspects of research can train students' practical ability, strengthen their scientific research literacy, and solve the needs of enterprises. However, the research is still insufficient, because the open innovation experiments are generally arranged outside the working hours. How many managers are allocated and how to calculate the workload of managers are issues that need to be studied later.

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