Exploration of Open Experiment Teaching Model-Based on the Practice and Investigation in the Optoelectronic Laboratory Course of EE Dept. Tsinghua University

Hui LV¹, Hui TANG² and Xiao-hong MA¹

¹Electronic Engineering Department, Tsinghua University, Haidian, Beijing 100084, China
²School of journalism and communication, Tsinghua University, Haidian, Beijing 100084, China

Keywords: Open experiment, Teaching reform, Optoelectronic experiment, Practical investigation.

Abstracts. This paper presents a new experimental teaching model for lab course in colleges and universities. It is named open experiment teaching model in this paper. The optoelectronic laboratory course in Electronic Engineering Department of Tsinghua University has explored and implemented the open experimental teaching model for five years, and made a preliminary progress through continuous reflection and improvement. The course also did a survey annually. Through the summary of years operation of open experiment teaching model and the last curriculum survey in 2016, the paper introduces the main points of implementation and improvement in the future, which can be used as reference for other science and technology lab courses.

Introduction

Cultivating students' innovation ability is an important goal of talent training in higher education nowadays. The classroom teaching is the main battlefield that carries out education for all-round development [1]. As a significant part of higher education, experimental teaching plays an irreplaceable role in improving students' practical ability, innovation ability and scientific quality. However, in the traditional experimental teaching mode, the fixed time and the uniformed solidified contents restrict developments of students’ initiative and personality without thinking of particularity of individual student [2]. In order to meet the needs of modern education and personal training, it is imperative to reform the traditional experimental teaching mode.

The optoelectronic laboratory course in EE Dept. in Tsinghua University is the earliest laboratory engaging in laser and optoelectronic technology laboratory teaching. Opened in the early 80s of last century, the course has always upheld the teaching philosophy to cultivate comprehensive quality talents, improve the innovation ability and independence of students in the past thirty years of development history. The course has achieved good results through continual reform and exploration of the teaching model.

In recent years, based on the exploration and practice of the open experimental teaching model in the course, the laboratory has summarized the key points in the open experimental teaching. Meanwhile, we conducted a questionnaire survey and in-depth interviews to the students in the course of the 2016 fall semester, the data analysis of 93 valid questionnaires reflects the effectiveness and future direction of lab teaching reform, which can provide reference for the development of other laboratory courses.

Exploration and Practice of Open Experimental Teaching Mode

The optoelectronic laboratory course in Electronic Engineering department of Tsinghua University is a comprehensive professional experimental course, which has been trying and exploring opening experiment teaching mode over the past 5 years, and has formed the existing curriculum construction scheme after summarizing and rethinking the practice. As each experiment in this course is a comprehensive experiment involving optics mechanical and electricity, the teaching model in the course can be prompted in the majority of science and engineering laboratory teaching.
Setting up Experiments that Can Stimulate Students’ Interest

Through years of observation of the students’ performance in the lab class, we have found that interest and curiosity are the cornerstones of effective learning activities in doing experiments, there will be interested in investment, there will be input to harvest. Since the beginning of the open experiments’ establishment, we have been developing new experiments for students to choose every year, which shows that the experiments involving the professional frontier and possessing practical application value can inspire students’ interesting more. In the course, experiment contents like "quantum information basic experiment", "visible light communication experiment", "surface plasmon resonance sensing experiment", "measurement of particles concentration in the air using laser scattering " or others possessing the characters above can greatly stimulate the enthusiasm of students, where students can expand professional vision and learn the corresponding research methods as well.

Open Platform and Experimental Content

"Openness" of open experiment is mainly reflected in two aspects, one is the students can do research and design program based on their own interests, the other is the hardware platform is completely opened, students can use the discrete components to recombine the system. The open experiments of the course encourage students choose and develop freely as much as possible. The class environment is created close to the real scientific research mostly.

Giving Students Plenty of Time

In order to cope with the high degree of freedom of the open experiments, the time for each open experiment is set to be two times of that in traditional comprehensive experiment, which means the course experiments number is deduced in case of the same total hours. At the beginning of the implementation, there are concerns that this will reduce students’ harvest, but the class effect shows that completing one experiment deeply and quality-highly is far greater than doing two experiments urgently. In the case of limited time, students tend to divide the experiment content into several tasks, they pay attention to how to get the required data without further innovating or thinking. But if the time is accompanied well students will pay more attention to more significant activities for the open requirements of the opening experiments, such as observing experimental phenomena, analyzing results, reflecting setting conditions and so on.

Interaction among Students and Teachers: Argument Teaching and Curriculum Report

The class of open experimental teaching must be students-centered, where students are able to play the subjective initiative, which not only requires the construction of the hardware platform, but also soft class environment, referring to the class atmosphere created by the interaction among teachers and students. Practice shows that positive relaxed and active class atmosphere can greatly stimulate students' learning enthusiasm and creative potential. Argument teaching method is applied in the course, which means the teachers don’t provide answers or obvious guidance to the students’ questions, but by the way of giving them guidance through asking questions or discussing with them. On the other hand, we found that the interaction between peers is also important for their study, so we ask two students to be a group doing experiments and discussing their work among groups both in the mid-term and final of the course. Students can effectively sort out their research thoughts by expressing their own work and deepen the existing understanding by the following questions and discussions.

Investigation Based on Open Experiment Course

In order to reflect the effects and problems of open experiment teaching model intuitively, we conducted a questionnaire survey and in-depth interviews to the students in the course of the 2016 fall semester, questionnaire involves experiment time, argument teaching method, experimental difficulty, experiment content, degree of openness, supporting resources, laboratory management, teaching faculty and so on. After analyzing 93 valid questionnaire data, we found the open
experimental teaching in recent years gained full recognition of students, with helping students to improve the ability to do experiments independently, but we also found that the model needs further reform.

Open Experimental Teaching Has Achieved Remarkable Results, Most Students Prefer Open Experiment
In the survey, students give a positive evaluation to experimental class set, experimental difficulty, experimental content, and teaching faculty, more than half of students favored the open experiment mode than traditional experiments; 94% of students can complete open experiment smoothly through accessing information dependently and discussing with peers and teachers; students’ evaluation about curriculum system, innovation, openness and application have reached more than 4 points (out of 5); 96.7% of students think teachers can greatly help them study and research by explaining properly; 75.3% of students think that teaching assistants are helpful and most students are satisfied with the numbers of teachers and assistants.

However, the results also reflect the problems about laboratory management and teaching materials.

Degree of Laboratory Management Openness is Limited, Teaching Resources Need to Be Further Opened
The open laboratory has become the basic requirements of experiment teach reform and modern laboratory management [3]. On the one hand, open laboratory can effectively extend the limited experimental resources space and time, which fully utilizes the experimental resources of institutions, institutes and enterprises [4], providing necessary conditions for opening experimental teaching and students' autonomous learning, on the other hand, it also encourages students to participate in the experiment and innovate actively, meeting the personalized development need of students. To enhance the overall level of experiment teaching through the open laboratory construction is the main direction of the reform experiment teaching at the present stage [5]. In the open experimental environment, students can choose the experimental time and experimental content according to their ability, interest and style and enjoy the experiments. This is not only open of time and space, but open of the philosophy of people-oriented and talents-oriented. In the meanwhile, laboratory opening not only includes teaching laboratory, but also develop "second classroom" such as curriculum design competition, graduate design competition and Undergraduate Electronic Design Contest, helping students establish a concept of "laboratory is everywhere “.

In the investigation of laboratory management mode, 66.7% of students think that "the current laboratory management is relatively strict, I am in favor of the management"; 33.3% of people think that "I tend to open laboratory management mode for personal needs, which I can apply for it when I need". Obviously, limited by the resources, the current laboratory management has not yet reached the requirements of students to choose based on their own time freely, there is a certain distance to satisfy most students’ needs of laboratory resources.

Providing Adequate Teaching Information to Help Students Explore Effectively
In open experimental teaching mode, the students take leading role while the teachers for secondary status. We learned that in the experimental process, apart from seeking help from teachers directly, students tend to seek help from information provided by teachers including books, experimental guidance and predecessors’ experience. The survey found that students hope experiment materials would be improved in many aspects. According to students’ opinions, improvement suggestions can be ranked as "detailing guidance on experimental steps" (52.69%), "enhancing the professional frontier content and developing realistic application" (39.78%), "explaining more about principles" (35.48%), "enhancing system of professional content" (34.41%). As to the predecessors’ experience, more than 80% of people believe that they need previous image or text data for intuitive reference.

Indeed, in the era of Internet, students can find the required information through the network, but to improve learning efficiency and improve the curriculum configuration, teachers should provide enough resources for students to have more comprehensive reference and index, and promote students’ resource utilization capacity, optimizing the opening teaching effect.
Summary

In recent years, opening experimental teaching model of Optoelectronic laboratory course in EE Dept. Tsinghua University has made remarkable achievements through continuous exploration and improvement, which can stimulate students' interest in learning and improve the innovation ability of students, promote students to participate in the experiment actively, create innovative experiment design, enhance students' interest in experiment, improve their comprehensive quality, getting recognition among students and teachers.

In the open experiments, by organizing actively, participating in subject selection, accessing to literature, conducting research plan, writing experimental report or scientific research papers, students can get a comprehensive scientific research training, which improves their ability to analyze problems, solve problems, make use of resources, and cultivate their practical ability. At the same time, designing experimental content and teaching method with considering students' personality characteristics is conducive to develop personal talent and stimulate the potential of different levels of students, so that each student can make progress, the course can reach the goal of experimental teaching and fully realize the talents cultivation.

Meanwhile, there are still some problems in the open teaching model after investigation, in the future reform, open experimental teaching model needs to be more effectively and create more open environment for students to do experiments dependently, expand experimental contents while improving the teaching methods, The course is also supposed to provide reference and experience for other laboratory courses by trying and deepening the teaching practice continually.

The open experimental teaching model can increase rate of utilizing laboratory resources and experimental data and improve students' comprehensive experimental ability effectively, it makes up the disadvantages of traditional teaching, and it is a teaching mode that conforms to the law of talent development. It is a necessary choice under the goal of cultivating comprehensive-quality talents. As well, the open experimental teaching mode is a comprehensive system conduction, which needs constant exploration and research. There will be more systematic practice experience and research results in the future.

Acknowledgement

This research was financially supported by Tsinghua University Undergraduate Teaching Reform Foundation.

References


