Problems and Solutions for Open Experimental Teaching in College

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Abstract. Open experimental teaching can greatly improve practical innovation abilities of college students. It has been regarded as one of the most important means of creative talents cultivation. Many open laboratories have been set up in different colleges. However, after several years of practice, problems gradually appear, including coexisting problems of equipment redundancy and insufficiency, low updating rate of project, teaching mode reform problems, experiment management problems and etc. In order to make the best use of open experimental resources to improve students’ practical innovation abilities, several solutions to above problems are carried out in our mechatronics innovation experiment center to ensure its sustainable development. The solutions include: full connection training and evaluation system for teachers, construction of resource-share network platform, research emphasis driven projects update mode, and an open and unified management system. After the reform, students’ enthusiasm and interest are significantly improved. Our students achieved great success in a lot of international and national competitions and research projects.

Introduction

“Practice is the key to science treasure.” Experimental teaching is indispensable for improving practical ability of college students. It is an important mean for innovative talents cultivation. Open experimental teaching can make the best use of the instruments, teaching group, experimental condition and environment resources, which makes it a key factor to link theory with practice and a good comprehensive way to cultivate students’ creative and practical abilities. Recent years, a lot of open laboratories are set up in colleges and universities around the world. Electronics laboratory of Southampton University in United Kingdom is a successful example. This laboratory supports not only theoretical teaching and experimental teaching, but also graduation projects, after-school research and related competitions. Teachers can help students to order new equipment and components to satisfy their all kinds of demands and requirements. Most of the domestic open laboratories are still in the early stage. Since there are no fixed operation modes, all the teaching groups are exploring the right way for students of different majors.

Open experimental teaching is a systemic subject, including operation management, teaching team construction, resources planning, and etc. All these factors are mutually dependent. A global and integrating planning is needed to bring all resources into full play. Mechatronics engineering creative experiment center in National University of Defense Technology was set up in 2010 and have played an important role in improving students’ practical ability. However, as time goes on, problems gradually showed up in teaching and management, which became an obstacle of routine teaching process and teaching effect. The main problems are low updating rate of projects, coexisting problems of equipment redundancy and insufficiency, teaching perception reform problems and experiment management problems. Under the efforts of the whole team, several measures are carried out to ensure the sustainable and healthy development of the laboratory. The reform measures include full connection training and evaluation system for tutors, construction of resource-share network platform, research emphasis driven projects update mode, and an open and unified management system. All the methods are not frozen and can be changed with time and situation. Practice result shows that all solutions create a new and active atmosphere in laboratory and good performance is observed.
Problems in Open Experimental Teaching

There are no general standards and modes for the construction and operation of open laboratories. There is also not any experience to quote. During the first two years, mechanical engineering creative experiment center provided students a new learning and practice pattern. Students' interest was greatly improved. However, a series of problems appeared gradually over time, some of which became obstacles for routine teaching. Taking master experiment course “Comprehensive Practice on Mechanical Systems” as an example, we will list the main problems appeared, and then discuss the strategies and methods that can keep the laboratory running smoothly and successfully.

Experiment Instruction Problem. With time goes on, instruction problems became more and more serious, among which technical ability and teaching conception of the teacher team are of the most important. On one hand, the average level of experiment teachers was not enough for creative project design and experimental research. Most of them cannot follow lasted developments in related fields, therefore, students’ creative thinking cannot be inspired properly. On the other hand, the teacher team did not build a clear vision on purpose and conception of open experimental teaching. When problems aroused, the team could not give proper solutions, so some problems cannot be solved timely and effectively. Insufficient understand of students’ knowledge system and incomplete information about the development of mechanical field result in low update rate of the experimental projects and decrease of the illuminating level of the experiment. How to improve teachers’ professional skills and teaching ability as well as good moral quality is a big problem in face.

Equipment Configuration Problem. For equipment configuration, the main problem is coexisting of equipment redundancy and insufficiency. In the early stage, all the equipment platforms were consistent with student training program and educational purpose at that time. Several years later, great development have been achieved in related research fields, but equipment remain the same. The initial experimental projects can only be regarded as basic training for present students. In order to keep pace with fast development of engineering applications and improve students’ innovative ability efficiently, more advanced and extensible instrument and equipment are needed. However, with the limitation of construction funds and laboratory space, only some urgent requirements can be met. That is why the problem of coexisting of equipment redundancy and insufficiency is unavoidable for most laboratories.

Management Problem. Incompatibility between experimental management mechanism and open conception is the main reason for management problem. In actual operation, except for classroom teaching and experimental teaching, no enough manpower and material were provided to guarantee graduation projects, extracurricular competitions and independent research, which was not compatible with the idea of ‘open’. There were also some problems in the specific management process. For example, the problem of lack of supervision for some of the evening and weekend reservations exists; imperfect examination and evaluation system results in cut-and-pasting problem.

Reform Strategies for Open Experimental Teaching

Combining the fundamental purpose of experimental teaching and aiming at improving students' innovation ability, our laboratory carried out a series of reform measures, including changes in staff training, experimental projects update, equipment utilization and management.

Improvement of Training and Evaluation System. Open experimental teaching does not have any script. Students will ask various questions. At the same time, new ideas and design scheme of students need immediate guidance and feedback. All of these have put forward higher requirements for the professional quality of teachers. Therefore, we attach great importance to team training. In 2013, the experimental teaching team was reorganized and full range of teacher training plan was developed.

With the rapid updating of scientific knowledge, teachers should constantly update their knowledge structure to keep up with the times. In our lab, teachers and technicians are required to
participate in compulsory and specialized courses about mechanical engineering to understand the basic knowledge and practical ability requirement of students. They should also participate in the equipment training to know how to use and maintain the existing equipment. Industrial visits to Sany Heavy, Zoomlion and other large machinery and equipment manufacturing enterprises are arranged every year, so that they can catch the latest information about use, maintenance of the equipment and research development of key technologies. Evaluation system is also improved. Besides the professional skills, students’ feedback, competition honor and expert opinion will all be considered to access the work of a teacher. After the reform, a skilled, responsible and energetic team is organized, which is the basis for sustainable development of a laboratory.

**Projects Update Mode Driven by Scientific Research.** Infiltrating the scientific research into the experimental teaching is essential to encourage students in active. Most of the lab teachers are required to make thorough investigations on major projects of our university, including 973 project, national major project, national defense study-in-advance project and etc. All these projects represent the most advanced technologies and the latest development of our research. Experiment projects updating with the development of scientific research will bring great benefits to students. On one hand, after course study, students will finally participate in various research projects in research group, so the experiment can lay a good foundation for their latter research work. On the other hand, all research projects have very clear background requirements, which can arouse student's enthusiasm and improve their learning interest. For example, sound silencing and noise control is a main research domain in laboratory of integrated logistics support. In order to cultivate students’ interest in this field, a noise control platform is set up in experiment center, based on which students can intuitively understand the basic theory of noise control and can carry out further research on structure design and adaptive method study for noise reduction. Such projects update mode can guarantee the laboratory act as a good source of knowledge and creativity.

**Construction of Equipment Share Network.** With the fast development of technologies in mechanical engineering field, experimental equipment is also achieving progress. Restricted by construction funds, laboratory cannot update equipment timely. The only way is to make full use of existing equipment and platforms through sharing, restructuring and other methods to achieve the best performance. Firstly, equipment procurement will be fully demonstrated. Utilization and scalability of equipment is regarded as one of the main equipment purchasing criteria so as to avoid funds waste. Secondly, make good use of campus and interschool networks, through which existing general equipment can be made into full play and valuable equipment and scarce equipment in the net can be mutually borrowed and shared. For example, Aerospace Institute in our university has a rocket launch platform. The data from their vibration test is a good resource for our condition monitoring and fault diagnose experiment. For students who choose this project, teachers will encourage them to perform the experiment in Aerospace Institute. In project of complex system modelling and analysis, we can take the maglev train test platform as one object, from which students can learn more real application techniques. Maglev train platform belongs to automation laboratory. We can book this equipment from the campus network. Hunan University and Zhongnan University are on the interschool net. Their vehicle models, large machinery manufacturing equipment can also be used after application.

**An Open and Unified Management System.** The most notable feature of open laboratory is the open management mode. Management system must be consistent with the open conception. In our center, a unified opening experiment teaching platform is constructed on the internet. Students can book equipment, download material and watch teaching video through the network platform. The center opens from 8am to 10pm. As long as there is an appointment that supervision and maintenance is guaranteed. The center reserves part of the funds to support students to participate in various competitions and creative design. New devices and components can be specifically ordered to meet the needs of the students. With this management system, full range of supervision and assessment can put a certain pressure on students, but at the same time flexible experiment and time arrangements can ensure them free and autonomous learning.
Summary
After the reform, the operation effect of the center has been greatly improved, and the students’ enthusiasm and creativity have been improved significantly as well. All above measures are not frozen and can change along with the research direction and management conception, which builds a good foundation for sustainable development of the center. In recent years, the center opened 1200hrs every semester and achieved high utilization rate of equipment and high degree of openness and sharing. Good social benefits are also achieved. Our students participated in international RoboCup and awarded Special Prize, and also won a first prize for National College Students’ Internet of Things Contest and a first prize for National Mechanical Innovation Design Competition.

References