Improving the Ability of Undergraduates’ Innovation by Reforming Experiment of Electrotechnics

Wen-Dong WANG\textsuperscript{a,*}, Xiao-Qing YUAN\textsuperscript{b}, Yi-Kai SHI\textsuperscript{c}, Zhi-Yu LI, Hua ZHANG

School of Mechanical Engineering, Northwestern Polytechnical University, Xi’an, Shaanxi, China
\textsuperscript{a}wdwang@nwpu.edu.cn, \textsuperscript{b}yuan@nwpu.edu.cn, \textsuperscript{c}ykshi@nwpu.edu.cn
\textsuperscript{*}Corresponding author

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Abstract. Experiment is a significant section in training the innovation ability and practical skills of undergraduates. Analyzed the necessity of reforming electrician experiment teaching and combined with the experience in our experiment teaching center, the article proposed some specific measures which were described as following: reforming experimental teaching method to discover a new way for training innovation ability; designing innovative experiments to stimulate students’ consciousness of creation and innovation; opening the labs to cultivate independent students; completing the system of experiment examination, encouraging students to participant in science and technology contests or research projects; changing the traditional teaching concept for modern experiment teaching goals, improving the innovation ability of teachers.

Introduction

Innovation education is the crucial part for the development of a country, and aims to cultivate the innovation spirit and ability [1-3]. To keep improving constantly, it requires high education to educate a large quantity of excellent people with creative consciousness and abilities. Experiment teaching is a significant section in developing manipulative ability and resolve ability. Therefore, it plays a significant role in innovation education.

Electronics is one of the most important basic courses for undergraduates of non-electrical majors, which provides necessary knowledge for following courses and technological works. So it plays a role as a bridge to combine the theories with practice. Also, the electronics experiment teaching can help students strengthen the understanding of theoretical knowledge and conduct them to practice in engineering application. With the growth of technology and the change of modern education ideas, these new experiment teaching system and the electrotechnics experiment contents are required to improve the innovation and creativity of undergraduates.

The Necessity of Electrotechnics Experiment Teaching Reform

The laboratory is an important base for universities to implement quality education and cultivate students’ innovative spirit and practical abilities. The laboratory is not only open to all students, but also provides students with all-round experimental practice conditions. It is a main concern for teaching reform. Besides, the open lab is also the objective demand of cultivating innovative talents and quality education. It has always been a vital issue in teaching that how to improve the experimental teaching and strengthen the experimental operation meanwhile cultivate students’ practical ability. The purpose of electrical and electronic experiment teaching is not only to use experiments to verify theoretical knowledge, but also enable students to master the basic electrical and electronic practice skills through experiments. It helps students observe the phenomenon and problems, furthermore they can solve the real problems using the electrical theory and analysis.

The problems which traditional electrical experiment teaching has are as follow.

The experimental time is limited. If the experiment is too difficult or too much content to be completed in a limited course time, teachers can only simplify the experiment or choose another relatively easy experiment to do, which is not beneficial for students to obtain and understand the knowledge.
The verification experiment is made mainly. Most of the colleges mainly carry out the verification experiment in order to ensure the experiment smoothly. Although it will help students understand the knowledge, the experiment steps are determined. Lacking of experimental design part is unprofitable for students to analysis and solve problems.

Experimental items and content fixed. Because the traditional experimental teaching has been based on the theoretical courses, the experimental projects are selected by the teachers which result in the student's subjective initiative cannot be made full use of.

Experimental conditions are limited. The experimental conditions vary widely between different colleges, lots of schools cannot complete experiment due to lack of experimental equipment. Also students usually work in a group so they can’t choose the experiment which they are really interested in.

In addition, only a few institutions began to implement the open practice teaching method and the degree of implementation varied widely. This condition hinders the cultivation of innovative and practical abilities. In order to satisfy the needs of new situation, reforming the experimental teaching of electrical engineering is extremely urgent, which can also stimulate students to learn by themselves, cultivate students' innovative ability, connect the theory and practice closely, especially improve the cultivation of innovative spirit and practical ability [4].

Exploration on the Reform of Electrical Experimental Teaching Approach

Reform the experimental teaching methods to explore the cultivation of innovation ability. The teaching method must be changed to be open due to the problem of imitation and dependence of students in traditional experimental teaching. Student-centered, teacher-led self-learning model is implemented. Northwestern Polytechnical University Electrotechnics Experimental Teaching Center (hereinafter called the Center) has taken the following three experimental teaching reform methods.

First of all, the use of heuristic teaching, paying attention to mobilize the students' subjective initiative. Teachers only talk about matters need attention, the use of new instrumentation methods, and the expansion of questions raised by students in experiments. Teachers inspire and encourage students to think independently and overcome difficulties, so that students improve the practical ability to solve problems through the experiments.

Secondly, the use of hierarchical teaching, training students' innovative thinking and ability. Regular school-wide electrical and electronic experimental skills competitions are held every academic year, for the enthusiastic students with outstanding academic performance. During the experimental skills competition, students describe it as "both tension and interest", "to improve both the practical design ability and the innovative thinking ability."

Finally, to carry out research teaching, to explore the cultivation of students' scientific and technical innovation ability. Electrotechnics advanced experiments and scientific and technical innovation experiments mainly use the form of scientific research teaching. Teachers make full use of students' spare time and holidays to set up seminars, such as the Forefront of Electrotechnics, Scientific Research Methodology, the Coordination of the Research Team, Electric and Electronic Competition, which develops students' research awareness, team spirit, practical ability and innovation ability step by step.

After years of preparation and attempt, nearly 500 students successfully passed the school-level electrical and electronic experimental skills competitions, more than 400 undergraduate students participated in research experiments, more than 200 various research topics were achieved under teachers’ guide, a number of outstanding talents are reserved for high-level experiments and scientific and technological innovation research.

Design innovative experiments and improve students' awareness of innovation. "Innovative experimental program for college students" is a necessary part in the construction of "quality engineering" in universities. The program aims to explore and establish the teaching model with the core of problem and topic. Students complete project declaration, implementation and conclusion themselves to stimulate their creative thinking and innovation awareness and also improve
innovation ability. The implementation of the program aims to change the current situation of neglecting practice in higher education and to promote research learning and personalized training methods thus creating a good atmosphere of innovative education. Electrical and electronic are close to daily life, therefore the experimental content can improve students’ professional skills, general engineering quality and innovation ability. If the "innovative experimental plan" integrates with electrical and electronic experiments, we will have more choices of the project, moreover we can monitor and evaluate the implementation process [5]. Students play a main role in this teaching method, while teachers just do guiding and assistant things. Experimental teaching activities are changed from teaching to learning, and the status of teacher is changed from teaching to guiding. The form of educating is flexible and diverse, such as group discussions, teacher-student interaction, innovation and exploration, teaching position exchange, so that experimental teaching activities become vivid with students’ independent activities and exploration. At the same time, teachers organize students to do project speech, presentation and comment for better communication at the end of experimental project, which helps students explore the different solutions with different characteristics and expand the knowledge as well.

**Open the laboratory, build up students’ independent experimental capacity.** In the traditional experimental teaching way, students tend to focus only on the results instead of the process in order to complete the experimental content in the limited time, and the integrated experiments are usually unable to complete in class. Consequently, it is necessary to establish a flexible and diverse running schedule. In recent years, the Center gradually pay more attention to the Open Laboratory construction, and there is an increasing number of students going into the laboratory besides experimental class time and continue to carry out unfinished experimental content, or use laboratory to verify their own innovation experimental programs, or study to be proficient in experimental instrument operation, or accomplish their own science and technology competition projects and so on. It has been proved that open laboratories can provide conditions for students to learn and practice independently. Students’ conception is transformed from "passive" experiment to "active exploration" experiment, which is more conducive to the development of students’ personality and innovative spirit. At the same time, a positive and active laboratory atmosphere is created with more utilization of the laboratory. It is an effective way to cultivate students' independent operation ability and innovative thinking by implementing the comprehensive reform of experimental teaching, opening the laboratory and conduct the integrated experiment with plans.

**Encourage students to participate in scientific & technological competition and research projects, lay the foundation for innovation.** Electric and electronic competition and scientific research activities provide opportunities for students to develop creative thinking and enhance innovative ability. In the course of competition and research, students often encounter some problems beyond their knowledge, which can not only expand the students’ knowledge, but also do spadework for cultivating students' innovative ability. In recent years, the Center actively explores innovative talent training methods and encourages students to participate in science and technology competition during the experimental teaching of electrical engineering, the specific measures are:

1) The Center organizes school-level electronic competition to improve students’ basic knowledge of competition and instrument operation skills;

2) The Center organizes teachers and experimental technician as the science and technology guiding teacher to direct students;

3) The laboratory opens all day to provide the necessary instruments and venues for the competition students.

**Improve teachers’ innovation based on their teach capacity and scientific research capacity.** In 2014, the first National Electrotechnics and Electronic Basic Course Experimental Teaching Case Design Competition was jointly organized by the Ministry of Education, and the National Experimental Teaching Demonstration Center. The aim of the competition is to improve the level of teachers' innovative experiment design, to motivate the innovative spirit and to provide better experimental project for students. In addition, under the background of "public innovation and entrepreneurship", it is the prerequisite to cultivate students’ innovative ability that changing the
experimental teaching philosophy and improving teachers’ innovation and scientific research ability continuously. Therefore, it is necessary to take into account both the teachers’ teaching ability development and the scientific research ability development. Especially in the situation of international, an increasing number of students show a strong interest in foreign teaching conditions, teaching patterns and development tendencies. In response to the above development requirements and the social situation, the Center adopts the following measures:

Encourage teachers to attend international cooperation and exchange visits, meanwhile strengthen communication and cooperation between domestic universities. On the one hand teachers can improve their own scientific research capacity, on the other hand they can acknowledge the advanced teaching ideas at home and abroad, so that they can advance the capacity both teaching and scientific research. Until now, teachers in the Center have established communication and cooperation with lots of world-renowned universities to discuss teaching and research, such as the University of Toronto, University of Queensland, Sydney University of Science and Technology, Seoul National University, Northwestern University, University of Illinois, University of California San Diego and so on. New ideas, new methods and new achievements during the process of scholar visit will be shown to students in different forms in class, in order to stimulate students' innovative spirit and desire. Furthermore it’s positive to achieve the purpose of educating innovative talent.

Conclusion

With the exploration of the electrical experimental series courses, the Center has made some initial results. The most important is that students have a great interest in experiments after several years. During the past 10 years, our center follows the international reform tendency of experimental teaching and constantly intensifies the reform of electrical course and experimental teaching system. Besides, the Center with new educational concept sets up experimental teaching and scientific innovation platform helping students to carry out technical innovation competition effectively. Finally, it achieved gratifying results about excellent course construction and innovative talents development. Under the joint efforts of all members here, we constantly digest the experience, develop new projects and experimental methods, resulting in that students’ enthusiasm for electrical experimental class is greatly improved. And the experimental teaching environment is established, which is beneficial to cultivation of innovation and practical ability.

References


