Reform and Practice of Teaching Method of "Process Parameter Measurement and Instrument" Aiming at Training Excellent Engineers

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Keywords: Excellent Engineers; Process Parameter Measurement and Instrument; Education Reform.

Abstract. Based on the Excellent Engineer Education and Training Program, aiming at the problems existing in the teaching method of "process parameter measurement and instrumentation" at present, focusing on the train of engineering practicing ability and innovation ability, this paper and around the train of thought of engineering practice ability and innovation ability, this paper puts forward the reform measures of classroom teaching methods including teachers' engineering practice knowledge, utilization of open laboratories and practice bases, and methods of cultivating students' continuous learning ability, so as to lay a solid theoretical and practical foundation for training excellent engineers. The award-winning data proves that these measures are in line with the excellent engineers training target and meet the requirements for students' engineering practice ability and innovation ability.

Introduction

Excellent Engineer Education and Training Program of the Ministry of Education was officially launched in June 2010, requiring the universities selected for the Excellent Engineer Education and Training Program to train professionals who meet the quality requirements of excellent engineers according to certain standards\cite{1}. This plan is a major measure to promote China from a big country to a power country of engineering education. The central issue of the Excellent Engineer Education and Training Program is the cultivation of engineering and innovation capabilities, requiring professional training programs, curriculum systems, and curriculum teaching to be developed and implemented around it.

Automation specialty is the key construction specialty of our university, which has been built according to the standard of excellent engineer. The course of Process Parameter Measurement and Instrument has a history of more than 40 years. It is a compulsory professional course for undergraduates majoring in automation with strong theoretical and practical characteristics. The content of the course is the necessary professional knowledge for engineers and technicians engaged in automatic detection of process parameters, automation of production process, measurement and testing, etc.

Problems and Deficiencies in Teaching

Insufficient Motivation for Students’ Independent Learning

The course of Process Parameter Measurement and Instrumentation introduces the measurement principle and method of temperature, pressure, flow, liquid level, component quantity, mechanical quantity and other parameters, involving some basic principles in several other courses. On one hand, relatively abstract theory, much content which are not closely related are the main obstacles to learning this course. For example, when learning temperature measurement using thermal resistance, it is necessary to master the basic principle of the bridge to convert the resistance into electrical signal output; when learning the piezo resistive pressure transmitter, students need to master the basic
principle of the piezo resistive effect; Faraday's law of electromagnetic induction as well as the principle and calculation method of induced potential should be mastered when learning electromagnetic flowmeter.

On the other hand, the internal structure of the instrumentation involved in Process Parameter Measurement and Instrumentation is relatively complicated. Studying and learning only through the pictures in the teaching materials and multimedia courseware will cause students to have an intuitive understanding of the internal structure and basic principles of the instrument.

Because the links between the chapters are not close, when students learn this course, they may learn the latter chapters but forget what they’ve learned in the previous ones, leading to little enthusiasm in course and lack of motivation for independent learning.

Serious Insufficient of Experimental Course with Small Proportion of Comprehensive and Design Experiments

Few experimental class hours. The course of Process Parameter Measurement and Instrumentation has a total of 64 hours, of which only 8 hours of experiments are arranged which is not enough. Students passively accept knowledge in the experiment making it almost impossible to solve problems themselves in limited experimental classes.

Simplified and programmatic experimental content and lack of systematic and hierarchical experimentation. Currently, based on the existing experimental instructions, students complete the whole process of the experiment according to the given equipment and experimental content within a specified time limit. With the help of the experimental instruction book, the students may not think deeply about the content, principle, and experimental purpose of the experiment. After the experiment, students' cognition of the experimental content is rather vague, and the understanding of knowledge principle is still stuck in the textbook. They still feel that some concepts and conclusions are quite abstract and lack perceptual understanding.

Many demonstrative and confirmatory experiments with few comprehensive and design experiments which is not conducive to the cultivation of students' innovative ability. Basically the experimental content is just a simple process of verifying some theories or familiarizing students with some basic experimental skills [2]. Due to the limitation of experimental equipment during the experiment, most of the experimental steps are clear, which limits the expansion and training of students' thought space making it difficult for students to innovate.

Insufficient Combination of Teaching Content and Engineering Practice

At present, the course mainly adopts the teaching method of multimedia and blackboard writing, and analyzes the working principle of various instruments according to the teaching materials and outline. This teaching method can indeed lay a solid theoretical foundation for students [3]. However, due to the lack of one-to-one correspondence between the equipment at the work site and theoretical knowledge, students may not be able to form a specific and intuitive impression of the knowledge points they learn. For example, when it comes to the installation of the instrument, if students do not actually go to the site, it is difficult for them to imagine and remember the key issues when installing. There may be a lack of methods and ideas when dealing with practical problems. Although multimedia can be used to play live pictures in the classroom, it is incomparable with the information obtained by direct contact with the instrument.

The current teaching is obviously far from the requirement of strengthening the engineering ability and innovation ability of students in the Excellent Engineer Education and Training Program, and does not reflect the training mode of engineering ability and innovation required in the Excellent Engineer Education and Training Program. Referring to the training objectives of the Excellent Engineer Education and Training Program as well as the training target of ‘training research, development and design talents with strong foundation, analytical and problem-solving ability, high comprehensive quality, “big engineering” concept and international vision, making them to become high-end engineering and technical talents in the future energy and power field’, we have reformed the teaching process of the Process Parameters Measurement and Instrumentation course.
Teaching Reform and Implementation with the Goal of Training Excellent Engineers

Training on Engineering Capabilities

Strengthen the reserve of teachers' engineering practice knowledge. Improving the teacher's engineering practice knowledge reserve is an important and key part of the teaching reform with the goal of training excellent engineers. Many of the current teachers directly start to teach students after their doctoral graduation, leading to lack of production and practical experience for their courses. In order to strengthen the training of teachers, on the one hand, teachers in this course should be encouraged to take students to relevant enterprises for production internships; on the other hand, it should be strengthened that the cooperation between schools and enterprises such as letting teachers to participate in the scientific and technological research of enterprises, which not only solves problems for enterprises, but also enhances the teachers' own knowledge of engineering, from which they learn the latest developments of related industries and pass them on to students, so that students can keep pace with the times. Besides, those senior engineers who not only master the teaching methods and laws of higher education, but also have power production and engineering experience should be employed to teach students and develop their practical ability.

Teach in a practice base. The school should construct a practice base, make full use of the existing resources and cultivate engineers and technicians with innovative capabilities. In order to let students to deepen their perceptual knowledge of the instruments they have learned, they have been organized to visit the power plant in the previous time. This approach has some drawbacks. First, the visit time is limited. The specific visit time is determined by the operation of the power plant. Besides, the visiting time and the influence of the on-site environment makes the visit's effort unsatisfactory. In addition, it takes a chartered car to go to the power plant, which takes a long time. The current practice is to organize students to visit the heat exchange station in the school. The temperature, pressure, flow, and liquid level instruments installed in the heat exchange station are used to explain the relevant knowledge. Students are asked to take photos of the instruments and review relevant information after class to expand their knowledge. They make PPT about what they've learned and communicate during class. In order to display the results of their visits in the class better, the students carefully observe the instruments and access the materials, which stimulates students' interest and enthusiasm for learning.

Make full use of students' internship. Make full use of various internships (such as production internships), so that students can directly contact the actual production process and instruments used by the company. During the internship, the company's instrumentation and control technology engineers will explain the application scope, installation and use precautions of the instrument on the spot, letting students analyze and discuss the instrument selection and recognize the difference between what they learn in class and practical working environment.

Training for innovation ability

The students' innovative ability is mainly cultivated from the aspects of intensive experiment and practical teaching.

Firstly, teachers should explain deeply the selecting and working principle of various instruments in the experiment, and lead students to disassemble and reassemble the instruments under their guidance to make them fully understand the requirements and rules of instruments installation during this process. After the experiment, the students are required to broaden their thinking and give improvement ideas and implementation methods of the functions completed by the instruments in the experiment.

Besides, teachers should make full use of the open laboratory to complete the experimental teaching. For example, the existing sensor laboratory can be used (shown in Figure 1) to conduct open lab teaching. A variety of sensors can be found on the sensor bench of the laboratory. The design task proposed by the teacher is to select one or more sensors, design an electronic scale, and weigh the mass of an object. The quality of the object has been weighed out using a weighing balance. Based on the student's weighing data, the student's design is checked and the student is asked to think about
ways to reduce the error. This experiment is a design experiment and requires multiple experiments in the laboratory to get satisfactory results. Students can experiment in the lab according to their own schedule, which increases the flexibility of students' experiment time.

![Open Sensor Laboratory](image1.jpg)

**Figure 1. Open Sensor Laboratory.**

What’s more, in the process of experimental teaching, the teaching thoughts of “teachers as leaders, students as the main body, training as the main line, and thinking as the core” are fully embodied [4]. The task of the teacher is not only to impart knowledge, but also to establish an experimental environment that can develop students' experimental skills, knowledge transfer ability, and the ability to use knowledge flexibly. It is necessary to adopt the “three not” measures, that is, not limited experimental methods, not fixed experimental steps and not directional experimental induction. Students learn theoretical knowledge according to their needs, changing from passively accepting knowledge to actively seeking knowledge, which cultivates students' ability to learn, analyze problems and solve practical problems independently.

**Stimulate students' interest in learning**

**Enrich teaching methods with multimedia technology.** Combine pictures, videos and animations in teaching may improve students' interest and efficiency in learning. For example, when introducing an electromagnetic flowmeter, the shape and internal structure of it can be displayed using pictures, related videos and animations accompanied by the teacher's blackboard writing. This will not only stimulate students' interest in learning, but also solve the problem of too abstract theoretical knowledge of the curriculum, and deepen students' understanding of the basic principles of instrumentation.

**Introduce mind maps in teaching.** The drawing process of mind mapping utilizes the logical thinking and abstract thinking of the left and right brains of human being, presenting all the information in the tree-like diffusion structure of subject and sub-branches, so that people can quickly grasp the center from the complicated information, sort out the logical relations among different levels, and add visual stimulation of color and image markers, which not only realizes visual learning, but also greatly promotes and explores people's memory, reading, creativity and decision-making ability. Mind mapping can not only improve the efficiency of teaching, but also cultivate and improve students' learning ability.

**Strengthen interaction with students.** On the network resource platform, learning methods can be diversified. Teachers can use online classroom management platform (such as classroom pi) to achieve interaction between teachers and students. By discussing and interacting with the topics published by teachers, students' thinking and skills are developed, and their abilities of analyzing and solving problems are comprehensively exercised. At the same time, teachers will also provide
students with timely answers to questions on the discussion platform, and promptly intervene and correct the problems.

**Conclusion**

Although the classroom teaching of Process Parameter Measurement and Instrumentation is only a small part of the students' training plan, it exerts a subtle influence on the cultivation of students' practical and innovative abilities. The students in the automation experimental class actively participated in various disciplines competitions and scientific and technological innovation practice projects, and they all achieved excellent results. The performance of automated 1201 experimental class (a total of 30 students) is more outstanding. The awards are summarized as shown in Table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Science and Technology Competition Award</th>
<th>Innovation and Entrepreneurship Training Program for College Students</th>
<th>Other Achievements</th>
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<td>Grade</td>
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<td>State-level</td>
<td>Paper Patent and software copyright</td>
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<td></td>
<td>Provincial-ministerial-level</td>
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The reform of teaching methods plays a decisive role in the quality of students' training [6]. The students' comprehensive and innovative ability has been improved. Since the enrollment of engineering practice-oriented pilot classes in 2011, teaching methods have been reformed in six grades. Practice has proved that both teachers and students have benefited a lot. Teachers' teaching level has been improved, and graduates have been recognized and valued by employers. This shows that only by fully understanding the Excellent Engineer Education and Training Program, changing teaching concepts, taking excellent engineer training as the goal-oriented, and reforming existing teaching methods, can we really achieve the training of students' engineering ability and innovation ability.

**References**