Researhes and Practices of Experimental Teaching Methods of Mechanical Specialty Adapted to Maker Education

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Abstract. The opening of the laboratory is the main driving force behind maker-oriented cultivation of talents. At the same time, the maker-oriented cultivation of talents also makes higher demands on the experimental teaching. To accommodate the goal of maker education of cultivating talents, the experimental teaching center innovates and makes full use of various pedagogical methodologies and modernized teaching methods. Many comprehensive, designed and creative experimental projects have been developing actively. Professors put more emphasis on student-oriented, interactive and research-and-discussion teaching which is based on problems, projects and cases and independent, cooperative and exploratory learning. We have made some achievements by putting those methods in practice.

Introduction

Focusing on promoting “mass entrepreneurship and innovation”, the general office of the state council of China issued the guiding opinions on the development of maker space and promotion of mass innovation and entrepreneurship on March 11. It also put forward eight key tasks, including speeding up to build the maker space, reducing barriers of innovation, encouraging scientists and students to start up business, supporting innovation public service, strengthening the guidance of financial fund, improving the venture investment and financing mechanism, enriching innovative entrepreneurial activities and building innovative entrepreneurial culture atmosphere.

The launch of a series of policies by the Chinese government to support innovation and entrepreneurship reflects a strong signal of global industrial change. The premier Keqiang proposed the “maker space” policy and measures to encourage mass innovation and entrepreneurship and promote industrial upgrading and transformation. It is a significant development opportunity for Chinese maker movement and maker groups, and it is also a potential challenge for colleges and universities. The theme of the challenge: will colleges and universities be replaced by micro-schools like maker space?

In order to adapt to the development of maker education, the mechanical experimental teaching demonstration center (hereinafter referred to as “center”) of East China Jiaotong University constantly innovates and uses diversified and modern teaching methods, and actively develops comprehensive, designed and innovative experimental projects. Professors put more emphasis on student-oriented, interactive and research-and-discussion teaching which is based on problems, projects and cases and independent, cooperative and exploratory learning. They promote students’ diversification, focusing on the combination of foundation and frontier, classic and modern, virtual simulation and real experience, basic norms cultivation, basic ability training and innovation ability cultivation.

The Realization of the Process of “Four-Step” Progressive Experimental Teaching

The process of adopting “four-step” progressive practical teaching (as shown in figure 1). The first step is introductions of practice and professional importations; The second step is the combination of theory and practice. We pay great attention to three links such as professional experiments, course designs and extracurricular practice innovation platforms; The third step is to participate in the
research and development of enterprises’ products and frontier scientific researches, cultivating students' ability of solving practical problems and comprehensive innovation ability; The fourth step is to comprehensively improve engineering practice ability. In the process of conventional teaching, experimental teaching methods and assessment methods with obvious characteristics are further formed, which improves students' engineering practice ability and scientific and technological innovation ability.

The Experimental Teaching Method Adapted to Maker Education

Introducing the Scientific Research Achievements into Experimental Teaching

Relying on the advantages of the subject, the results of researches will be introduced into experimental teaching, enriching experimental teaching projects. The center reanalyzes and sorts out the content of teachers’ research projects from the perspective of the experimental teaching to find out the combining site and the breakthrough point of this course’s contents. In accordance with the principle of moderate difficulty, the center combines the knowledge of each course with the project’s content to form an innovative experimental project which covers all knowledge points of the course.

In accordance with the progress of students’ courses, the center timely organizes and implements corresponding experimental projects based on scientific research results. In the project implementation process, the center adopts the mode of “1 + 4” (namely 1 professor + 4 students to conduct a research) and uses the method of “active teachers’ guidance and independent students' inquiry” instead of the teacher-oriented inculcating education to cultivate students' ability of analyzing and solving practical problems, to expand students' knowledge, horizons and ways of thinking. Besides, it will largely stimulate students' interests of learning course content autonomously and carrying out the related experiments actively. The process of transforming scientific research achievements into experimental teaching projects is shown in figure 2.

Figure 1. “Four-step guidance” progressive teaching process.

Figure 2. Transformation of scientific research results into experimental teaching project process.
**Introducing the Engineering Practice into Experimental Teaching**

Facing the engineering practice, the practical problems are introduced into the experimental teaching to expand the professional experimental contents. The center actively encourages professors to lead students to participate in actual engineering projects and students’ ability of solving practical problems and the awareness of responsibility, quality and safety will be trained in the engineering practice. Professors will guide students to actively participate in the design and development of new products of enterprises which enable that the basic knowledge and experimental skills which students mastered can lead them to gain valid experience in practice so as to improve students’ overall engineering quality. The practical experimental teaching flow chart is shown in figure 3.

The center will invite off-campus experts as experimental teaching instructors and sent outstanding students to off-campus engineering practice base for engineering practice and off-campus graduation design. The cooperation unit will invite the center’s professors to serve as technical consultants and sent engineering technicians to the center to receive professional technical training. The experimental teaching adopts the method of “the combination of practicing and learning”, which is conducive to stimulating students’ learning potential and interests. This method is in line with the law of cultivating applied innovative talents.

![Figure 3. Practical experimental teaching flow chart.](image)

**Facing Science and Technology Competitions, Integrating Innovative Ideas into Experimental Teaching, and Stimulating Students’ Interests in Science and Technology Innovations**

Science and technology competitions require students to have strong ability of independent design and innovation, and their project themes are increasingly novel and interdisciplinary. Students can further deepen their understanding of knowledge and improve their competitive awareness and innovation ability by completing relevant contest contents through hands-on design.

To this end, the center, relying on various scientific and technological competitions at the university, provincial and national level, takes the open laboratory and university students' scientific and technological innovation experiment base as the vehicle to incorporate the scientific and technological competition projects into experimental teaching projects. Under the guidance of professors, students will complete the project design and development according to the requirements of science and technology competition; The center then evaluates the design works of students, and the outstanding ones will be recommend to take part in the science and technology competitions and offered further funding. The process is shown in figure 4.

![Figure 4. Schematic diagram of open innovation experimental teaching project.](image)
Based on Interest and Specialty, the Independent Inquiry Is Introduced into Experimental Teaching to Cultivate Students' Exploring Spirit

In the process of learning, students often have a strong curiosity. When they encounter problems, they always try to find answers through various methods. In the process of experiments, professors can help students to find answers by guiding them to solve the problems by themselves. The innovative experimental teaching method which based on independence, cooperation and exploration is the method to perform students' autonomy and creativity and cultivate their creative thinking.

According to their own interests and specialties, students will turn the problems that found in their study into experimental projects and apply to the center, and then the center will organize experts for evaluation, and provide funding for feasible and innovative projects. During the implementation of the project, independently, students will design the experiment content, prepare the experiment, complete the experiment operation and the experiment summary and paper, make the report materials and communicate with each other. In the entire experiment process, the teacher's role is the project director, the judge, and the student is the whole participant, the practitioner. In this way, students will not only master the initiative of learning, but also be given the space to exert their ability. The process of self-exploring experimental project is shown in figure 5.

Summary

Through the intuitional experimental teaching process, the center will realize the integration of classroom teaching and experimental teaching, tamp the theoretical foundation of students, and cultivate and improve students' scientific experimental ability, hands-on ability, analytical and problem-solving ability and teamwork ability; Through opening of open and innovative research experiments, the integration of experimental teaching and scientific and technological innovation can be realized to cultivate students' scientific thinking and improve their scientific and technological innovation ability and scientific research ability; Through the entrepreneurial extension of experimental projects and the integration and utilization of platform resources inside and outside the university, the integration of scientific and technological innovation and engineering practice can be realized. The innovation awareness of students can be cultivated, and the ability of students to comprehensively use knowledge to carry out practical activities and solve practical engineering problems can be improved.

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References


