Reform of mechanical manufacturing experiment teaching based on Excellence in Engineer Program

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Abstract. This paper will expound the new demand of talent training based on Excellent engineer education and the significance of experimental teaching, as well as analyze the current situation of experimental teaching. Then, the reform countermeasures of mechanical manufacturing experimental teaching based on ”Excellent Engineer Education” have been put forward, so as to provide reliable reference for relevant teachers.

1. Introduction

Engineering education and training programs of excellence (Excellent Project) is a major reform project to implement the Outline of National Medium and Long Term Education Reform and Development Plan (2010-2020), and also a major measure to promote China from a country of engineering education to a country of engineering education education [1]. Since the Excellence Plan was launched in 2010. Colleges and universities have taken various measures to continuously promote the reform of engineering education, comprehensively improve the quality of engineering education personnel training, and provide talent support for China to take a new road of industrialization development and build an innovative country. The new industrial revolution and Strategy of innovation-driven development as well as the Belt and Road have set new and higher requirements on the knowledge system, theoretical level, multi-aspect ability and comprehensive quality of engineering talents trained by us. It is suggested to implement the strategic initiative INDUSTRIE 4.0, Industrial Internet, Made in China 2025 and other three new industrial models, and redefine the very direct demand for the transformation of engineering education paradigm proposed by the project. For a more diverse talents training mode, diversified teaching mode, the demand for professional assessment as well as certification of new more urgent than ever before, and these are the Excellent Plan can carry [2-3]. Therefore, excellence Plan 2.0, the upgraded version of Excellence Plan, is in the air. With the implementation of the upgraded version of Excellence Plan 2.0, it will play a positive role in deepening the reform of higher engineering education.

The major of mechanical manufacturing is popular in our country's engineering colleges and universities, which has trained many high-level talents for our country's manufacturing industry. However, compared with developed countries, China's mechanical manufacturing professional education foundation is relatively weak, knowledge update speed is slow, experimental equipment is not advanced, practical engineering and theoretical foundation has a certain disconnect, making China's manufacturing industry development restricted. The implementation of Excellence Plan 2.0
will certainly promote the engineering teaching reform of machinery manufacturing major in colleges and universities as well as further improve the level of China's machinery manufacturing industry.

2. New demand for talent training based on the Excellence in Engineering Program
At present, the scale of Excellent engineer education and training programs in China continues to expand. Combined with China's development needs in the new period, it can be seen that schools should cultivate more and more engineering talents who are adaptable to social and economic development and have strong innovation ability in the field of engineering. This requires relevant majors to be able to analyze and solve problems and translate reasonable concepts and ideas into reality when they leave campus and enter the society. At present, there are still many deficiencies in the personnel training of the teaching and education mode, so we should continue to reform the education mode and content [4].

3. The significance of experimental teaching reform based on Excellence in Engineer Program
Nowadays, after most college students graduate and enter the society, many problems have been exposed, mainly because of their poor comprehensive quality and low level of practical operation. Therefore, in recent years, colleges and universities have been increasing opportunities to cultivate students' practical ability, such as reasonably adjusting the content of course design, providing more internship opportunities for students, and at the same time, ensuring that students can improve their overall level in the practice of graduation design. For all universities, experimental teaching is the core teaching to cultivate students' comprehensive practical ability, while laboratory is one of the important resources that can be reasonably used and comprehensively grasped by the school [5]. When students exercise their practical ability, experimental teaching is a key way to lay a solid foundation. However, nowadays, many students do not move, do not ask, do not listen, do not look at the problems in the experimental class, which is not only difficult to verify the textbook knowledge, but also unable to fully combine theory and practice. In this way, in addition to failing to achieve the overall goal of experimental teaching, it can't get good results, and then the value of experimental teaching in cultivating students' comprehensive ability will be greatly weakened.

4. Current situation of mechanical manufacturing experiment teaching

4.1. Teaching content does not have good flexibility, and the model has obvious hysteresis
Due to the limitations of equipment and conditions used in mechanical manufacturing experiments, many students can’t successfully complete the corresponding objectives of experimental teaching, and many experimental teaching methods only one. Once encounter new theory, new knowledge, will even lack of supporting experiments.

4.2. Less supporting teaching materials and backward experimental equipment
With the comprehensive development of science and technology, the equipment and technology of manufacturing industry have achieved extremely rapid development. However, major schools did not increase investment in a targeted way, and professional equipment of machinery manufacturing has a relatively high price, leading to the disconnection between experimental equipment and industry development. In addition, due to the increasing diversity of manufacturing technologies, the equipment used in experiments cannot meet the development requirements of the industry [6-7]. Facts have proved that experimental equipment will directly determine the final result of experimental teaching, but the national schools are unable to achieve uniform equipment, at the same time, matching textbooks are unable to unify the compilation standards, old textbooks, and the lack of high-quality teaching materials, greatly affecting experimental teaching. However, the instruction prepared by the teacher alone is easy to appear many unreasonable, and then affect the experimental results.
4.3. Limited ability of teachers
In many science and engineering colleges, experimental teachers have lower educational level and
knowledge level than theoretical teachers. Although some theoretical teachers will be involved in
experimental teaching, experimental instructors are still the core force for organizing experimental
teaching.

5. Reform measures of mechanical manufacturing experiment Teaching based on Engineering
education and training programs of excellence

5.1. Identify the important features of the reform
Basic experiment reform: From the perspective of the distinguished engineers program, actively
update all contents of experimental teaching [8]. Ensure that the basic experiments conform to the
excellent teaching outline, discard the outdated and old experimental methods and content, and add
new experimental items and content. Reform the methods and methods of experimental teaching, at
the same time with the help of virtual experimental equipment, multimedia and video teaching, so that
the experimental teaching effect has been comprehensively improved.

System planning professional course experiment: The Excellence in Engineer Program course
system changes greatly. It is a comprehensive knowledge structure training method with practice as
the core, and project-driven training of students’ engineering practice ability and innovation ability, as
shown in Figure1 and Figure2 [9]. This is because experimental teaching has been systematically
adapted to fit more closely with the Excellence in Engineer Program. Therefore, it is necessary to set
up various experimental teaching items, such as manufacturing automation, construction of CNC
machine tools, industrial robots and CNC machining, to ensure the full combination of experimental
teaching and theoretical teaching, which can not only enable students to achieve a comprehensive
grasp of the required knowledge, but also significantly improve their knowledge application ability.

Figure 1 Training of comprehensive knowledge structure with practice as the core (example) [9]

Figure 2 Project-driven cultivation of students’ engineering practice ability, engineering quality and
innovation ability (example) [9]
Take students as the main body of experimental teaching: because the school has a larger and larger student scale, but its own personnel system is limited. As a result, most experiments are debugged in advance by teachers, while students can hardly take the initiative to debug. The Excellence in Engineer Program requires students to have strong hands-on ability and adapt to the development of enterprises and society. Therefore, the laboratory should be open to students 24 hours a day [10]. In the new teaching mode, the experimental teacher only needs to sort out the experimental equipment, explain the principles and precautions, and let the students actively participate in the whole experimental process, and consult the teacher when they encounter knowledge points that they cannot understand.

The integration of all teaching and education resources: For the mechanical manufacturing major, its experimental equipment is very expensive. Meanwhile, in recent years, the equipment manufacturing innovation speed is very fast, leading to the inconsistency between experimental equipment and equipment used by enterprises. Schools should work closely with enterprises to improve the experimental base so that students have the opportunity to learn about the latest equipment. Meanwhile, the team of experimental teachers should be strengthened to ensure the high quality of the experimental teaching environment for students.

To promote the overall construction of the laboratory: in order to ensure the effective implementation of experimental teaching, the school should attach importance to the construction of hardware and software. Among them, the hardware construction depends on the effective allocation of current experimental equipment and the purchase of urgently needed experimental instruments. The software construction is mainly completed through the construction of the laboratory management system, in which the overall quality of experimental teachers is improved [11].

5.2. Explore the content of innovative teaching
Cognitive experiment: the key goal of this kind of experiment is to consolidate and understand the content of theoretical teaching and to concretize abstract knowledge. For example, through the correlation analysis of mechanical system and robot composition, students can intuitively understand the architectural features, principles and functions of all modules of the robot through observing and listening in the field, and then they will take the initiative to learn the most in-depth theories.

Analytical experiment: the core task of this kind of experiment is to synthesize and extend the content of theory teaching, and intuitively grasp the relation between various performance parameters and their influence on the results with the data obtained from the experiment. For example, by on-line predicting the surface roughness of machined parts, students can directly obtain the surface roughness of parts by changing the machining parameters.

Design experiment: the important purpose of this kind of experiment is to make up for the deficiency in theory and satisfy the practical needs of research students. Due to the reduction of curriculum design and the compression of classroom teaching hours and the reduction of curriculum design, many students do not have a high level of engineering design, and some modern design methods and concepts cannot be clearly mastered by students. Therefore, teachers should set up such experimental teaching to make up for the above deficiencies, so that students' engineering design ability can be comprehensively improved. For example, the development and analysis of the machine tool spindle dynamic system, so that students can optimize the machine tool spindle, dynamic design theory and vibration concept to further understand and grasp, which is of far-reaching significance for students to improve the ability of computer application.

Development-oriented experiment: this kind of experiment can enable the majority of students to design and develop experimental system actively, and enhance their subjective initiative. In the new century, college students are always the main force of innovative science and technology. The school should pay attention to the comprehensive cultivation of their innovative ability and consciousness, increase corresponding investment, and guide students to design and develop the experimental system spontaneously.
6. Conclusion
The students' practical ability and innovation ability are the most important indexes of the training quality of the students in the mechanical manufacturing major of colleges and universities. Only through effective reform and keeping pace with the development of science and technology of The Times can we effectively improve students' engineering practice ability, innovation ability and comprehensive ability and realize the goal of training excellent engineers. Experimental teaching based on Excellence in Engineer Program needs to ensure the combination of practical engineering and theory to enable students to digest and absorb new equipment and new technology quickly.

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