Eng Educ Rev 2024;2(1): 16-18

Engineering Education Review

STRATEGY AND POLICY

School education and engineering practices: Dual pathways to cultivating excellent engineers

Zhenyuan Qu*

The China Association of Higher Education, Beijing 100191, China

Engineering education is aimed at cultivating outstanding engineers with extensive knowledge, innovative thinking, problem-solving abilities, and practical skills through theoretical learning and practical training. However, achieving this goal is no mean feat. On the one hand, school education is required to provide a theoretical foundation and academic support. On the other hand, engineering practices are needed to help students improve their capabilities and cultivate their problem-solving ability. Both are of great importance, but there are conflicting aspects between them. This article aims to explore the complementary and interactive relationship between school education and engineering practices in cultivating such outstanding engineers.

SCHOOLING STAGES OF AND SCIENCE-BASED REQUIREMENTS FOR ENGINEERING EDUCATION

Schooling stages of engineering education span vocational, undergraduate, master and doctoral education. School education across these stages jointly bears the important task of cultivating excellent engineers and high-caliber technical talents. Therefore, it is of great significance to figure out how to handle the relationship between theoretical education and practical education across various schooling stages and towards different training objectives.

In the mid-20th century, basic science courses garnered greater attention in engineering education as the development and broader application of science and technology increased the demand for engineers with scientific knowledge. In the second half of the 20th century, the reform in engineering education was directed towards emphasizing basic science courses. Against such a background, many higher education institutions reexamined their curriculum and improved the teaching content and quality of mathematics, physics, chemistry, *etc.*, cultivating higher-quality engineering and technical talents.

Although progress has been made in engineering education, practical education tends to be overlooked. This "engineering education that tilts towards science courses" has faced considerable criticism for multiple reasons. Like a pendulum movement, there is no complete balance in engineering education. Therefore, educators need to strike a balance between theoretical learning and practical training, considering the limited learning time of students. In this process, one important factor to consider is that requirements for theoretical and practical education are significantly different across various schooling stages. According to *Higher Education Law of the People's Republic of China*, vocational education, which focuses on the training of practical skills, aims to equip students with necessary basic theory, professional knowledge, as well as basic skills and preliminary ability to engage in practical work; general undergraduate education enables students to systematically learn necessary basic theory, knowledge, skills and methods involved in their major, so that they possess rudimentary abilities for actual work and research; master education makes students master solid basic theory, acquire systematic professional knowledge, and grasp relevant skills and methods in their major, making them capable of engaging in actual work and scientific research; doctoral education enables students to master solid,

*Corresponding Author:
Zhenyuan Qu, The China Association of Higher Education, Beijing 100191, China. Email: quzhenyuan2016@163.com. https://orcid.org/0009-0002-0098-1999
Received: 1 January 2024; Revised: 2 January 2024; Accepted: 6 January 2024
https://doi.org/10.54844/eer.2024.0517

extensive basic theory and acquire systematic, in-depth professional knowledge, corresponding skills and methods in their major, and equips them with the ability to independently engage in creative scientific research and practical work. Therefore, the breadth and depth of curriculum content across different schooling stages of engineering education should be arranged based on the distinctive features of each stage. This is done to avoid the tendency of weak theoretical foundation and insufficient development momentum, or weak practical ability and long pre-job training. The goal is to cultivate high-caliber talents that meet the needs of society.

THE IMPORTANCE OF ENGINEERING PRACTICES

Engineering practices are an indispensable part in the cultivation of excellent engineers. By participating in actual projects and internships, students can apply theoretical knowledge they have learned to real situations and acquire practical skills and experience. Through engineering practices, they can also understand the complexity, challenges and changes in the engineering field, and acquire abilities related to problem-solving, teamwork and innovation.

Technically, education without engineering practices cannot be seen as true engineering education. Virtual reality allows us to see scenes we have never seen before, but these scenes are still virtual, based on reasoning and imagination, rather than direct experience. It is common sense that a successful engineer must accumulate direct experience.

One generally needs to spend a long time accumulating experience in engineering practices before they can truly become excellent engineering technicians. A research group from the Chinese Academy of Engineering surveyed 245 academicians on their career growth and conducted statistical analysis in 2006. According to the results, engineering technicians generally began to stand out academically, publish representative papers or achieve marked scientific and technological achievements 10 to 15 years after obtaining the bachelor's degree. They became project leaders and shouldered heavy responsibilities around the age of 40. After another 5 to 10 years of accumulating engineering technological experience, they generally made outstanding achievements in engineering and received ministerial, provincial. or national-level awards when they were aged 41 to 55. Only a few who made prominent contributions and achievements were elected academicians, and most of them had to go through another 10 years before they were recognized by the scientific community and society. Then, they were most likely to be elected academicians at the age of 51 to 60. Therefore, starting from their graduation from university, it generally takes these academicians 25 to 35 years from their growth, experience accumulation to maturity, as revealed in the statistical results of the growth of engineering and technical talents.

Nowadays, when we emphasize school education, especially higher education reform, we must avoid overlooking the decisive role of post-university engineering practices in nurturing engineering and technical talents. While universities should cultivate engineering talents of the future, they cannot be expected to directly nurture outstanding engineers. In the past, Tsinghua University was hailed as the "cradle of engineers", but it can only play the role of a "cradle". After graduating from the "cradle", students still need to go through arduous training or hard work before they become mature. "Talents training at universities + engineer cultivation in workplaces" is a general model for the growth and cultivation of excellent engineering and technical talents.

COMPLEMENTARITY OF SCHOOL EDUCATION AND ENGINEERING PRACTICES

School education and engineering practices are mutually reinforcing. The former can equip students with theoretical knowledge, basic skills and comprehensive quality, including basic engineering training, and help them lay a solid foundation in terms of knowledge and abilities. School education is fundamental to the growth of engineering and technical talents.

Engineering practices in school education provide students with a platform to apply theoretical knowledge to solve practical problems, enhancing their perceptual knowledge and cultivating their practical abilities. By participating in actual projects, internships and industry cooperation, students can apply the knowledge and skills they have learned to real situations, communicate and cooperate with industry professionals, thus cultivating their communication and cooperation abilities. Engineering practices can also stimulate their interest in practical problems and enhance their innovative thinking by drawing on feedback and experience in practices. Such practices can not only strengthen students' practical abilities, but also promote their career development and employment competitiveness.

Theoretical learning and practices are not only interactive, but also run through a person's whole life. During school education, especially during the undergraduate period, systematic theoretical learning is the main task of students, and practices are also necessary for them to cultivate practical abilities.

Students need to cultivate the ability to use both their brains and hands during this period. After their graduation from university, practices will maintain a dominant position. University education represents the starting point of their practices, and working practices are the continuation, development and deepening of university practices. Similarly, learning habits developed at university will still be an integral part of their post-university work and life, and lifelong learning can lead to continuous progress. Excellent engineering and technical talents are those who not only combine theoretical learning with practices but also make innovations on this basis.

ROLE AND RESPONSIBILITY OF THE INDUSTRY

The industry plays an important role in engineer cultivation. During university studies, enterprises and industry organizations provide practice opportunities, tutor guidance and professional training for students, enabling them to participate in actual projects and learn about the real industry. This not only provides students with practice opportunities but also accelerates their career growth and development.

In addition, the industry can also participate in the reform and development of engineering education, and establish cooperation with schools to jointly launch educational programmes and cultivate excellent engineers. The industry can provide guidance and support for school education with its professional knowledge and practical experience, and can also timely incorporate industry needs and technological changes into the design and implementation of engineering education, given its acute sense in this regard.

It is apparent that the industry plays a unique role in cultivating engineering and technical talents. However, its role in advancing education has not been fully leveraged in the past, which is precisely what today's education reform should focus on.

Correspondingly, school education should also extend to the industry by allowing the industry to participate in the reform and development of engineering education. This involves advancing school education and continuing education, and building a new type of engineering education system that runs through a person's life.

CONCLUSION

School education and engineering practices are the mutually reinforcing dual pathways to excellent engineer cultivation. On the one hand, school education provides theoretical knowledge and academic support. On the other hand, engineering practices offer students with a platform to apply their knowledge and skills while acquiring new ones. The industry plays an important role in cultivating engineers. With closer cooperation between school education and engineering practices, more excellent engineers catering to the needs of the times can be cultivated.

DECLARATIONS

Author contributions

Qu ZY developed the concept for the manuscript, reviewed the literature, formulated research questions, collected the data, conducted analyses and interpreted the data. The author read and approved the final manuscript.

Source of funding

None.

Conflict of interest

Qu ZY is an Editorial Board Member of the journal. The article was subject to the journal's standard procedures.

Data availability statement

No additional data.