

Engineering Experience of College Teachers in China: Recent Situation and Improvement Strategies

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Abstract: The engineering practice ability, as the core of engineering professional talents, is under direct influence of college teachers by their practical engineering qualities. Thus, how to improve the practical engineering qualities of college teachers is an active topic deserving full attention. The paper firstly investigates the role of teachers' engineering experience through a questionnaire among 108 undergraduate students in a university, whose finding indicates that overwhelming majority of the interviewees hold a favourable view towards teachers with engineering experience. We then review researches on the engineering experience of Chinese university teachers in recent years to elucidate the situation: over the past decade, progress has been made, yet there is still much to be improved in terms of teachers' practical engineering ability. Such a state may be attributed to young teacher's direct role shift from students without any hands-on experience and the recruitment criteria blocking up the experienced engineers' entry to universities. To solve the issue, endeavours are to be made in rule and regulation perfection, team coaching and training, constructing experiment teaching resources based on modern information technology as well as the industry-university-research cooperation.

1. Introduction

The engineering practice ability of the graduates, as the core of engineering professional talents, is the key to evaluating the quality of higher engineering education. It is widely accepted that the engineering ability of the students is largely dependent on the engineering experience of college teachers. Therefore, college teachers should possess sufficient engineering experience and the capability to conduct research on engineering problems according to the general standards for Engineering Education Accreditation of China [1]. The current situation in China reveals a lack of creativity and the ability to solve practical problems from the graduates. Although students have gained rich theoretical knowledge, the lack of practical experience makes it impossible for them to integrate theoretical knowledge to engineering practice, which is far from satisfying. The solution lies in improving the quality of higher education and cultivating high-quality practical talents, which requires professional teachers with solid practical ability in the first place [2].

This paper firstly presents the importance of teachers' engineering experience through a questionnaire among some students in China. We then review the recent development of the engineering experience of Chinese college teachers to clarify the situation, followed by a discussion of the possible reasons for college teachers' lacking engineering experience. Finally, some initiatives to improve the engineering experience of college teachers are proposed.

2. Role of Engineering Experience on Teaching

To crystallize the role of engineering education for teaching, we performed a questionnaire

survey on the students' needs and perceptions of teachers' engineering experience. Undergraduate students majoring in Water Supply and Sewage Engineering from University X in China were chosen as the sample. The total number of participants in the survey were 108, and the survey questions were as follows.

Q1: Do you think it is necessary for teachers to have engineering experience?

Q2: Do you have teachers with engineering practice experience?

Q3: Will a teacher with engineering practice introduce his experience as a complement to the textbook in classes?

Q4: Can you understand the routine work of an engineer based on the explanation of a teacher with extensive engineering experience?

Q5: Can a teacher with engineering experience impart practical skills besides theoretical knowledge in the class?

Q6: Can teachers with engineering experience offer solutions to practical problems beyond the reference books?

Q7: Are teachers with engineering experience open to new ideas from students when discussing solutions to a given problem?

Q8: What are the advantages of a teacher with hands-on engineering experience versus a teacher without?

The results for questions Q1-Q7 are shown in Figure 1. It is obvious that most of the students think positively about teachers with engineering experience, holding the view that these teachers can be very helpful and necessary for students' understanding and mastery of knowledge, as well as for the improvement of the problem-solving ability. The feedback of Q8 shows that students generally believe teachers with engineering experience know how to connect problems with actual engineering practice because they have a deeper understanding of the key issues in engineering design and construction. Furthermore, they can often bring vividness, profundity, and comprehensibility to lectures via employing actual engineering cases and discussing problems from practical angles. The above survey results highlight the vital role of teachers' engineering experience in students' mastery of theoretical knowledge.

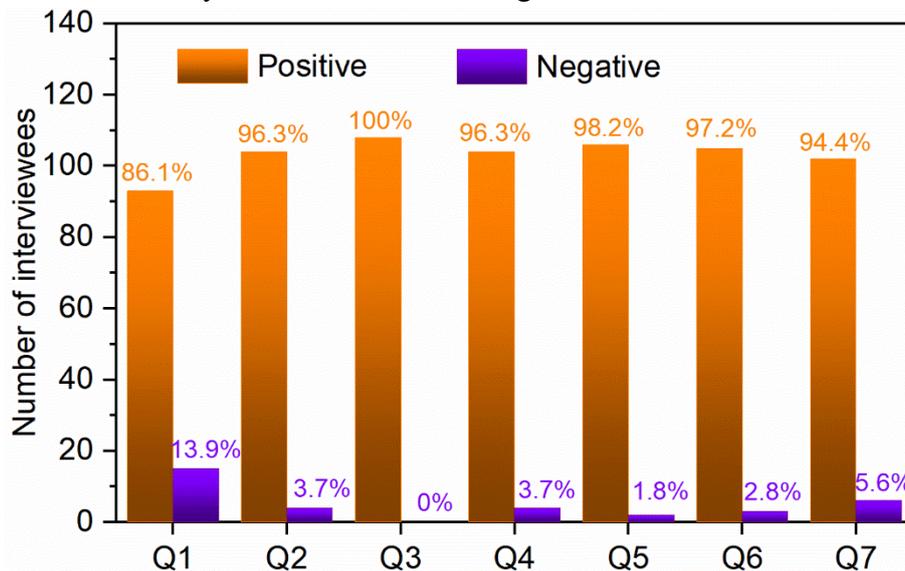


Figure 1 Role of engineering experience on teaching from students' perspective. 108 undergraduate students majoring in Water Supply and Sewage Engineering from University X in China were chosen as the sample in the survey.

3. Recent Situation of College Teachers' Engineering Experience

In 2010, the Chinese Ministry of Education launched the "Excellent Engineer Education and Training Program", aiming to cultivating a huge army of innovative, adaptive engineering talents

for the needs of economic and social development. In 2012, Li [3] conducted a survey on the engineering quality of college engineering teachers in 25 Chinese provinces, cities, or autonomous regions, with 600 questionnaires distributed and 580 collected. The findings (Figure 2a) indicated that from the viewpoints of teachers and administrative staff in colleges, the engineering quality of college teachers was more often commented as “average”, “not high” and “very low”, accounting for 70.9% of the total, while “high” quality or above making up only 29.1%. Further investigation revealed that 17.5% of engineering teachers had less-than-one-year’s engineering experience, 25% had no engineering experience at all, while 63.9% were occasionally involved in major engineering projects [3]. Indications were that engineering teachers generally lacked the practical experience which they should have had ten years ago.

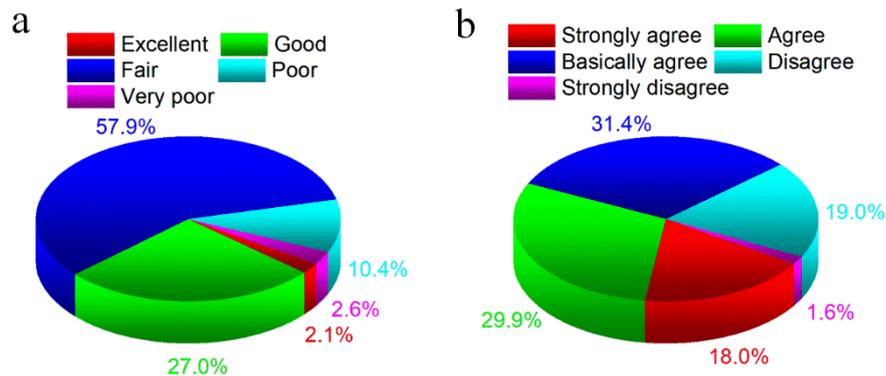


Figure 2 Survey of satisfaction with engineering experience of college teachers in (a) 2012 and (b)2020. The data for part (a) and part (b) were obtained from Ref. [3] and [4], respectively.

The “Excellent Engineer Education and Training Program 2.0” started in 2018 made an explicit requirement on teachers’ practical engineering ability: they must possess industrial background and practical experience. In 2020, Zhu et al. [4] conducted a survey on whether the practical engineering ability of college teachers could meet the requirements of schools from the perspective of college administrative staff in China, with a sample size of 542. As can be perceived in Figure 2b, if “agree” and “strongly agree” were deemed as an approval of teachers’ practical engineering ability, 48% of the teachers could satisfy the requirements of schools, while more than half of teachers’ engineering ability were still in need of further improvement. They further assessed teachers’ practical engineering ability on different indicators of the engagement in engineering-based projects, frequency of participation in various stages of engineering projects, and engineering experience, which also offered proof of a relatively weak ability in engineering practice [4]. Therefore, despite the over-10-years’ implementation of “Excellent Engineer Education and Training Program” in China, the study in 2020 indicated that there was still much to be improved in terms of teachers’ practical engineering ability.

4. Why Are the College Teachers in Lack of Engineering Experience?

Teachers of engineering majors in colleges and universities, especially young teachers, despite their excellent academic achievements and solid professional knowledge, lack engineering practice experience because most of them directly become teachers upon graduation, which is reflected in their less than satisfactory performance in teaching. For example, some young teachers are not competent in solving practical engineering problems due to the poor hands-on ability; some lack the ability to transform theoretical knowledge and practical experience into teaching content; some are unable to offer in-depth guidance to students in solving practical problems [5].

In the recruitment process, the policy of “theory over practice” [6] lays emphasis on educational background and academic achievements of a candidate, assessing one’s theoretical knowledge and research ability, rather than the engineering experience, which leads to an abnormal phenomenon, i.e., many college teachers, with profound theoretical knowledge and excellent research ability, are

not competent in engineering teaching [5]. On the other hand, many senior technicians from enterprises, even with great practical ability, find it almost impossible to be recruited to key universities, limited by their educational background and research level [5]. Moreover, the assessment in colleges, with research achievements like paper and book publication as the criteria for teachers' promotion, brings about much more willingness to be devoted to paper writing and scientific projects, while practical teaching is not given due attention.

It has become a consensus that teachers of engineering majors should possess profound theoretical knowledge as well as certain engineering experience in order to cultivate qualified professional talents. At present, the young teachers haven't formed a clear idea of engineering because most of them also go without exposure to engineering practice, not to mention a consciousness or ability in practice, thus making an incompetent supervisor in engineering practice classes, and compromising the effects of theoretical classes. Therefore, it has become an urgent problem in the construction of teaching faculty as well as in engineering talent cultivation to enrich the engineering experience and cultivate the engineering ability of young teachers very shortly.

5. Strategies to Enhance Teachers' Engineering Experience Ability

To improve the engineering experience of university faculty, efforts should be made in the following four aspects, i.e., rules & regulations, mentoring & training, construction of experiment teaching, and industry-university-research cooperation (Figure 3).

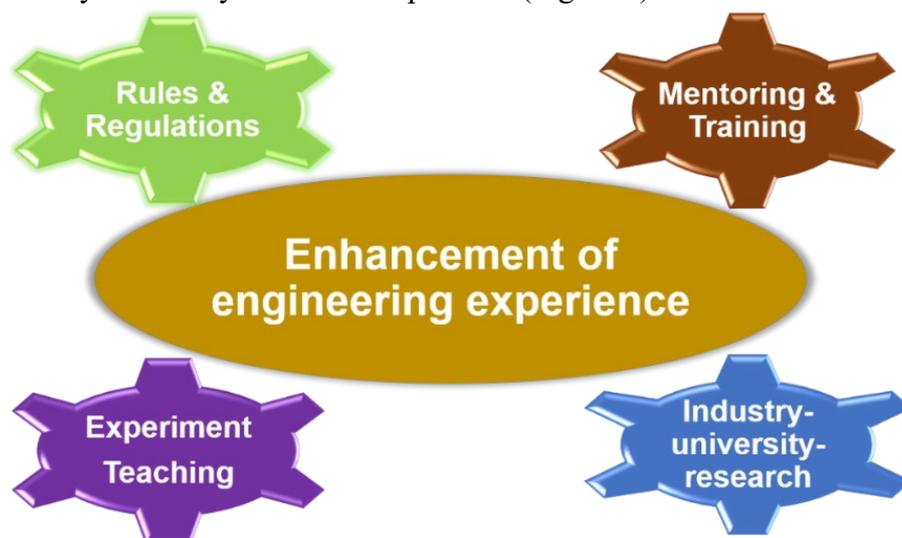


Figure 3 General strategies to enhance engineering experience of college teachers.

5.1. Perfecting Rules and Regulations to Direct Teachers' Attention to Their Engineering Capabilities

Institutional construction and policy measures play a crucial role in teachers' engineering capability development [7]. Colleges can require and encourage young teachers to improve their engineering capability as soon as possible through emphasizing the top-level design for young teachers' engineering capability cultivation and formulating relevant policies. For example, colleges can require new teachers, in addition to the established pre-service training, to complete a certain hours of engineering practice learning, or even to have internships in enterprises as a prerequisite for a qualified engineering teacher. Besides, practical engineering ability can also be taken as one criterion in the annual assessment and title appointment of teachers.

5.2. Stressing Team Coaching and Trainings to Develop Teachers' Engineering Design Skills

To improve the engineering design capability of young teachers, efforts can be made through exchanging and mentoring among team members, participating in design training on and off campus, as well as teaching and instructing courses or practical designs. In this process, team work can never be overlooked. For instance, young teachers can follow design-experienced teachers

throughout the courses as teaching assistants; engineering-experienced teachers can offer guidance and help in course design and teaching; regular teaching activities can be carried out, including team discussion, seminar in teaching plan and collective observation of classes. These measures may exert positive influence on young teachers' engineering teaching ability and bring out its gradual improvement.

5.3. Constructing Experiment Teaching Resources Based on Modern Information Technology

The development of information technology has greatly facilitated modern education. A diversity of simulation experiment platforms can be introduced to engineering majors. For instance, such multi-dimensional, visual, or interactive information technology means as Kinect somatosensory technology, unity 3D and unity 3D + Kinect, make it possible to explore the evolution and change in the complicated engineering environment. These simulation platforms not only enrich the experiment teaching resources, but also provide teachers a concrete understanding of modern information technology and a deeper insight into engineering practice.

5.4. Transferring Scientific-Research Results to Productive Forces to Cultivate Teachers' Engineering Application Ability

Given the fact that most of the scientific-research projects in engineering come with apparent industrial application back-ground, teachers can, through investigation, project study and exchange with enterprise personnel, understand the needs and technical challenges in the industry, work out solutions to problems and bring benefits to enterprises with improved technology. While hosting or participating in such enterprise cooperative research projects, young teachers can develop their capabilities in engineering research and engineering application, making the most of the industry-university-research cooperation.

6. Conclusion

Engineering ability are playing an increasingly important role in satisfying human needs and promoting social progress in modern society. Through a questionnaire among 108 undergraduate students in a Chinese university, it is found that most of the interviewees hold a favourable view towards teachers with engineering experience, believing these teachers are more enlightening with deeper insight into engineering, and are thus more beneficial to students' assimilation of theoretical knowledge.

A concise review of the surveys in 2012 and 2020 show that despite the progress that has been made, there is still much to be improved regarding teachers' engineering ability. Such a phenomenon may be attributed to two factors: young teacher's direct role shift from students without any hands-on experience and the recruitment criteria blocking up the experienced engineers' entry to universities.

To solve the tough issue, endeavours are to be made in rule and regulation perfection, team coaching and multiple training, constructing experiment teaching resources based on modern information technology as well as the industry-university-research cooperation, in the hope of facilitating the development of college teachers' practical engineering qualities to the full.

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