An Innovative Teaching Solution of Undergraduates’ Graduation Design (Thesis) Education in the System of “Plan for Educating and Training Outstanding Engineers” in Engineering Education

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Abstract: The “plan for educating and training outstanding engineers (PETOE)” implemented by the ministry of education and other relevant departments jointly to help engineering higher education cultivate talents that meet the enterprises’ needs and to improve engineering education talent training quality has an important guiding role. Teaching practices show that the proposed preliminary solution would make the student to complete well engineering designs that conform to the common standards and industry goal in future and it will strengthen the cultivation of engineering ability and innovation ability.

Introduction

In China, the "plan for educating and training outstanding engineers (PETOE)" was started by 61 universities in June 2010. Since then, second and third groups of colleges and universities have launched the implementation; "PETOE" has been injected new vitality for the engineering education of talents in colleges and universities. "PETOE" is a reform plan for talent cultivation in university that allows university, enterprise and industry to be deeply involved in student training processes, which pays more attention to students’ engineering practice and innovative ability. "PETOE" is also a major reform project that follows up to the implementation of the National Outline for Medium-and Long-Term Educational Reform and Development (2010-2020) and the National Medium - and Long-Term Plan for Human Resource Development (2010-2020). It’s a significant action that promotes our country to evolve from a big engineering education country to a powerful engineering education country, and it’s aimed at foster a large number of various types of high quality engineering and technical personnel with strong innovative ability who can meet the needs of economic and social development. In recent years, some universities dominated by science and engineering has carried out a large number of studies related to engineering education combined with the authoritative CDIO (Conceive, Design, Implement, Operate) concept under the framework of “PETOE” [1-5].

Graduation design (thesis) is a comprehensive inspection and enhancement of the expertise, overall quality, practical ability and creative quality of the graduate. Graduation design (thesis) as an important part of the practice teaching of undergraduate engineering education, it’s teaching philosophy, goals and methods of teaching must be reformed synchronously with the implementation of "PETOE", it is necessary to carry out innovative reforms so as to give better play to the graduation design (thesis) teaching in the successful implementation of "PETOE".

Analysis of the Teaching Adaptability of Graduation Design (Thesis) Under the New Situation

Problems and Deficiencies

Although many efforts for the graduation design (thesis) on practice teaching are paid, and many positive and useful explorations have been made and many remarkable achievements have been
gotten, there still exist many problems and shortcomings inevitably in graduation design (thesis) teaching. Some general and representative problems are described as follows:

(1) For students
Firstly, since the popularization of higher education and the increase of employment pressure, some students spend less time and effort on the graduate design (thesis), which results in the quality decline of graduation design (thesis) [5]. Many senior students are busy looking for jobs and internships, or preparing for the postgraduate entrance examination as well as applying for foreign schools, thus they have not spent much time and effort on the graduate design (thesis) and understood the graduation design (thesis) problems thoroughly. Secondly, many students have poor abilities of analyzing and solving problems by the synthesized use of knowledge, as well as the ability of considering problems independently. Although students have learned the basic knowledge for over three years, how to think independently and how to use the knowledge to solve practical problems still are students' common weaknesses. Thirdly, some students have a poor ability of retrieving the literatures, so they do not make full use of rich academic resources in library. In addition, some students' attitude to graduation design (thesis) is not serious, and their attention paid to graduation design (thesis) is not enough.

(2) For selecting subjects
Parts of the subjects are not original and profound enough, and which do not connect to the reality tightly. Some subjects are too broad, too wide and needing a large workload [5]. Besides, only a little student selects their subjects by themselves, most of the subjects are chosen by instructors how to determine original and realistic subjects with an appropriate difficulty provokes people to consider.

(3) For teachers
Some engineering teachers in college may be busy with their own research so that they spend less energy and time on guiding students' graduation design (thesis). In addition, some instructors' guidance methods needs to be improved at the graduation design (thesis), such as taking measures to fully mobilize the initiative of independent learning, inspiring teaching and so on.

(4) For management
Universities have established a unified censorship of graduation design (thesis) and have developed a grading standard, but the task requirements, research programs and results of the graduation design (thesis) are not identical with each other, therefore the system and the standard should be more subdivided in order to treat the graduation design (thesis) differently. In addition, the censorship and grading standard are strictly executed and be standardized to ensure the quality of graduation design (thesis).

**Tasks and Challenges**

Graduation design is the last major comprehensive practice teaching in college undergraduate education and teaching, which is the students' comprehensive inspection, review and improvement of what they learned at school, as well as a convergence point for students to walk from school to society in reality [5]. It has great significance to do a good job of graduation design (thesis) for improving the teaching quality of engineering education.

All in all, current undergraduate graduation design (thesis) teaching mainly faces the double tasks and challenges in China:

(1) Facing the challenge of popularization of higher education, some solutions to the existing problems in graduation design (thesis) teaching at a solving way should be developed. With the increase of colleges' enrollment, the resources of teaching teachers are limited, increasing the pressure on employment of graduates, and the time and efforts for graduates who prepared to go abroad to study and for the postgraduate entrance examination are reduced in graduate design, graduation design (thesis) formed a "formality" and quality deterioration trend. How to make graduation design (thesis) teaching adapted to situations of popularization of higher education, and improve the quality of graduation design (thesis), which is the most important problems placed in front of university education to solve at once.
The second problem is the innovation of graduation design (thesis) ideas and methods in the new situation. Under the new situation of engineering education’s promotion ‘PETOE’, college graduation design (thesis) teaching must advance with the times, inherit and carry forward previous successful experience of the premise, reforming the ingredients of teaching which are not meet the requirements in ‘PETOE’. Wheat from the chaff, innovate positively, so as to form a scientific and rational system of teaching methods, to improve the teaching quality of graduation design (thesis), thus promoting the implementation of the "PETOE" successfully.

Improvement and enhancement of the graduation design (Thesis) teaching under new situation

"PETOE" can fully reflects the practice attributes of engineering education, which takes engineering practice as the background and develops talents through deepening the close cooperation between universities and industry enterprises. Not only can students learn the basic knowledge and basic skills on campus, but they can also participate in school-enterprise cooperation to learn more about the practice and practical application of skills, which means that students can get professional skills training in engineering practice before they are out of the campus. In the teaching system of "PETOE" excellence program, undergraduate graduation design (thesis) teaching needs to focus on the training of students' quality, knowledge and ability. Meanwhile, based on engineering practice, schools and enterprises carry out scientific and reasonable teaching work through close cooperation so that students are able to achieve the goal for consolidate knowledge, develop skills, enhance the awareness and improve personal quality. Faced with the dual task of the new situation, undergraduate graduation design (thesis) teaching should do the following several aspects:

1) Reasonable choice of graduation design topic

Topic selection is the most important task of the graduation design (thesis) works which determines research direction and research methods of graduation design (thesis) as well as degree of difficulty and workload of the design and even affect personal future career choice. Therefore, topic selection is the good first step of graduation design [7].

To select the title of graduation design (thesis) is the first step to complete the design. As for topic selection, it is vitally important to emphasize the significance of choosing a topic. Design topic should be suitable which combines with the current economic construction situation, and to some extent, it also should have depth and breadth that can make students consolidate and deepen what they learned within the stipulated time through the comprehensive application of the basic theory and professional knowledge so that they can get enough exercise and improve personal ability. It is brilliant to combine engineering subject with scientific research and engineering practice, which has certain guiding significance to the actual work. Instructors need carefully draw up some graduation design topic of school-enterprise cooperation as well as choosing a few actual problems faced in enterprises, design institutes, construction units or other industry enterprises as the graduation design topic. Topic selection of graduation design should be encouraged innovation and be tried to contact with actual engineering practice, the production and scientific research rather than using topic that lags behind the actual production. Meanwhile, it is significant to guide students to think independently and choose topic by themselves, which means they have to identify, think and refine problems in the practical application.

2) Scientific instruction

Instructor's effective guidance and student's earnest participation is the basic conditions to complete the graduation design. There are two aspects to instruct graduation design (thesis) scientifically. One is to build a team of teaching staff, including college teachers and graduation design (thesis) instructors participated in "Plan for Educating and Training Outstanding Engineers" of the industry enterprises. The second is the need of a reasonable guidance method to raise the level of the teacher's instruction.

Undergraduate graduation design (thesis) involves a wide range of knowledge and teachers should not only have a systematic, solid theoretical knowledge, but also have the experience of
engineering practice. Excellent teachers’ team is a group with reasonable knowledge structure, high professional level, strong practical ability and experience. In order to strengthen the construction of the team of teaching staff, the guidance of teachers' engineering practice and scientific research ability training is enhanced. And opportunities and conditions to encourage young teachers to stand out are created, as well as the level of academic and research capacity which make instructors not only master systematic and solid theoretical knowledge are raised, but also experience of engineering practice and scientific research are accumulated so that instructors can handle easily in practice teaching of graduation design (thesis). At the same time, it is important to strengthen teachers' moral education and ideological education, and control teacher access qualification strictly in the enterprise. In the instruction work, it requires to pay special attention to strengthen teachers' morality as well as improving their ideological and political quality.

In the graduation design (thesis) work, students are in the dominant position. Teachers should take students' quality, level of knowledge and ability as the center and give students a directional and methodological guidance related to their graduation design (thesis), mainly in the design and topic selection process. In this process, the most important thing is cultivating students' abilities to apply knowledge into practice, to find and solve new problems through independent thinking and to innovate. As a guide, supporter, mentor, supervisor and partner, teachers should not only participate in students’ graduation design (thesis), but also establish good communication channels and friendly relationships based on mutual trust with students.

3) Individualized instruction

Try to ensure an instructor guides less than four students as far as possible in order to guarantee instructor has sufficient time and energy. The basis of individualized instruction is that teacher has enough understanding of students, including their strengths, hobbies and future planning, which means teacher can implement more scientific instructions. After college announces instructors and graduation design topics, two-way choice should be implemented between instructors and students. In this way, it can meet the interests, employment and further education of students as much as possible. Having established topics and instructor, the instructor should take corresponding guide methods to set up project task and job schedule according to student's personal situation.

4) School-enterprise cooperation

A great feature of "PETOE" is the industry guidance and school-enterprise cooperation, which means the industry enterprise will assign an instructor to guide students who finish graduate design in the enterprises. The practical subject of enterprises has a great number of features that the assignment is clear, the requirement is specific and the plan is adequate. Besides, it can stimulate the enthusiasm and initiative of students as well as enhancing students' awareness of engineering practice. At the same time, it is also helpful to students’ transition after graduation. Through the graduation design of real projects or cases, students' abilities of comprehensive design and scientific innovation have been improved greatly, which plays an important role in supporting the cultivation of reserve talents for the excellent engineers. Meanwhile, it is not only useful for graduates to adapt to the engineering practice, but also conducive for students who intend to pursue further education to understand the discipline frontier dynamic and find their research direction and positioning.

5) Ability training

Colleges have to pay more attention to the cultivation of students' abilities during the graduation design process. In the guidance of graduation design, teacher needs to teach students how to seek the solving process of problems and how to apply their knowledge to solve the problem. The more important thing is teaching students the ideas and methods to analyze and solve practice problems. People need to keep learning new things and skills, so it is very important to cultivate students’ learning ability, even more than knowledge itself. Society needs innovation and engineering practice also requires innovation. Practice is the source of innovation and creativity comes from practice. The ability of innovation is fostered during the process of solving practical problems. In the process of graduation design (thesis), it’s important to create a space for students to explore and seek the solution through their own independent thinking.
Management intensification

In view of the quality reduction problem of graduation design (thesis), college has to strengthen the process management of graduation design (thesis). From the topic selection to the oral defense, graduation design lasts for half a year. The accomplished qualities in every stage and every link in graduation design are directly affect the quality of graduation design (thesis) and the improvement of students' comprehensive quality and innovative ability. The school teaching management departments and each academy shall strengthen the process management and do a good in grasping every link of graduation design together.

Teaching Cases and Summary

As an example, undergraduate 2010 Transportation Engineering, the College of Transportation Engineering in Tongji University, is incorporated into the "PETOE" and is also the college's first certified professional engineering education. Rail Transit Engineering Class 40 graduates except one chose research thesis, the other 39 graduates choose graduation design for practice engineering whose topic mainly come from some practical engineering projects, students choose topics mostly combined with their own interests or research direction of postgraduate studies when they choose the subjects. Each instructor guide number of students no more than four and each student have a different subject. The school has established a practice of teaching management system for unified management of graduation design (thesis) at every stage and every aspect of the work, which strengthen the quality of graduation design management. Taking into account some students preparing to postgraduate entrance examination and applying for foreign schools and off-campus internships, courses are all over at the end of the sixth semester and off-campus internships begin at the first six weeks of the seventh semester, so that every student has a personal opportunity to experience engineering practice. The work of choosing graduation design subjects begins to prepare at the latter half 7th semester. This arrangement ensures that the students have ample time to complete the high-quality graduate design (thesis). Each instructor takes different specific methods for different students to guide them to think and analyze the problem independently. Students have successfully finished their graduation design (thesis) with the scientific guidance of teachers, and their overall quality, the abilities of analyzing and solving problems as well as learning abilities have been greatly improved.

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References


