Discussion on Multi-level Individualized Training Mode for Engineering Postgraduate—Taking Railway Engineering as an Example

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Abstract. Firstly, some existing problems in the course of postgraduate education in engineering are described. Based on requirement of society, some multi-level individualized training mode for engineering postgraduate are provided. Taking railway engineering of Tongji University as example, some multi-level individualized training cases and methods are discussed. Some results show that in current period, this multi-level individualized training mode for engineering postgraduate is important mode suitably for the development of higher education and social needs and for improvement of training quality. Some key problems are described such as the construction of the tutor teams themselves, collaborative communication between tutors and students and among the students, operation relation between research project and student’s training. The education effect and social recognition for the proposed multi-level individualized training mode are displayed.

Introduction

Postgraduate education is a crucial part of the national innovation system, and the essential task is to cultivate senior specialized personnel equipped with innovation spirit, innovation consciousness, innovation foundation, innovation ability and social practice ability. The quality of postgraduate education is a significant factor in the science and technology and cultural competitiveness of a country, and the postgraduate cultivating mode directly affect the quality of postgraduate education.

The Existing Problem in Engineering Postgraduate Education

The cultivation mode in our country depends on the social demand. As society’s requirement for innovative and applied talents enhancing constantly, a single cultivating method can no longer meet the demand of scientific research institutions and enterprises. However, colleges and universities still use the inherent mode to cultivate engineering postgraduates, causing many problems in present engineering postgraduate education to be solved:

Single Training Objective and Patterned Training Mode. Along with the advance of engineering technology and the continuous development of enterprises, social demand for engineering talent has increasingly developed towards a comprehensive, practical, and innovative target. In contrast, the current training mode for engineering postgraduates in our country has a relatively single objective. Patterned training mode has caused a deficiency in high-level compound talents in society, applied talents are severely deficient [1-2].

Simple Teaching Mode and Standardized Evaluation Criterion. Regarding teaching methods, a teaching mode of repeating what the book says and sticking to the appearance exists. Rather than teaching each student "according to their aptitude", the same teaching method is applied to all the students. Formalities that can encourage knowledge application, such as case discussion, are missing in this mode. In terms of the cultivation objective for postgraduates, papers and research achievements are the sole evaluation criterion; the social standard which is measured by the demands of practice is ignored [3].

As to the graduate supervising mode, only graduate admission and graduation reply are attached great importance to, and the intermediate process of graduate education, such as thesis proposal and medium-term inspection, are often overlooked. In this case, it is difficult to ensure the quality of the postgraduate cultivation and to eradicate academic misconducts during the cultivation of postgraduates.

Student Teacher Ratio over Capacity, Instructional Resources Unbalanced.

Many colleges and universities are facing the problem of student-teacher ratio overcapacity, tutors can’t provide one-on-one guidance for postgraduates, which causes difficulties to systematic instruction, and affects the academic level advance of the postgraduates to a great extent [4, 5]. Taking a certain research group of railway engineering at Tongji University as an example, in 2000 the teacher-student ratio in the research group is 1:1, in 2015 the teacher-student ratio reached 1:4, the number of graduate students has increased many times, but the number of the instructors increased very slowly.

Lack of Innovation Training, Weak Executive Force in Team Collaboration.

In the process of the postgraduate education scale hyper normal development, most graduate students are lack of skepticism and independent opinion, and unable to think actively. Meanwhile, as an essential ability in engineering enterprise, collaborative ability is often neglected in the postgraduate cultivation plan designed for individuals. The graduates lack the abilities of expression, organizing, socializing and collaborative, and can’t meet the enterprises’ requirement for an innovative team [6-8].

Academic Research Confined to, Lack of International Communication.

Postgraduate education should be geared to international standard in talents cultivation, scientific research and communication and cooperation, etc. However, in the process of postgraduate cultivation internationalization, problems like unclear degree standard, maladjusted cultivating mode, unsound quality guarantee system, etc. [9,10]. Thus in order to further promote the internationalization process of graduate education, postgraduate training mode also have to be reformed.

To cultivate graduate students with innovation and application ability, the single teaching mode for postgraduate education must be broken, multi-level individualized training of graduate students is introduced to adapt to the diverse needs of talent market. This requires emphasizing differences, to train students according to their aptitude, and to promote individualized cultivation in the process of graduate cultivation and management.

Multi-Level Individualized Training Mode for Postgraduates Based on Social Demands

Aiming at the existing problems in postgraduate education mentioned above, especially the single cultivating mode, the training orientation for engineering postgraduates is refined. Aside from the professional training for professional ability and quality, individualized trainings are enacted for students with different profession interests and specialties. This way, the cultivation would be diverse.

According to the training objective for postgraduate high-level talent in our country, postgraduates are positioned at several different levels. Nowadays postgraduates in our country are mainly divided into the following levels:

- Academic master graduate
- Engineering master graduate (full-time)
- Engineering master graduate (incumbency)
- Doctoral student directly selected from undergraduates
- Master-doctor continuous study
- Doctoral student (full-time)
- Doctoral student (incumbency)
Different types of postgraduates’ ability at the time of entrance and educational background are diverse. Therefore, the tutor should have a comprehensive understanding of the postgraduates, and cultivate the students to the key directions specifically aimed at their personality characteristics.

Hence the training directions for engineering postgraduates are subdivided as: engineering technology talent cultivation, engineering management talent cultivation, academic talent cultivation, and international academic talent cultivation.

The Implementation of the Training Mode

Considering all the steps in the training system at present, developing a research training mode characterized by research project operations has become an essential link in the reform of postgraduate training system. This mode should be developed from the inside of the postgraduate research team and from the personal level of the tutor and the postgraduate. This work requires following steps:

**Tutor Team Construction.** Firstly, the construction and optimization of teaching staff plays an important role in the multi-level individualized postgraduate cultivation model, the formation of multi-level individualized training mode relies on the reasonable gradient and diversified characteristics of teacher's own professional knowledge. During the establishment of the tutor team, overall consideration for subject construction is needed, and the tutor team should be managed as a whole. Use the reasonable allocation of profession and research direction in the tutor team to drive the training mode, and to optimize the teaching resources, in order to solve the problems of student -teacher ratio overcapacity, imbalance of resources, and single teaching mode etc. The construction is carried out in the following aspects:

1. The Status of Research and Innovation in the Team;
2. Stable and Reasonable Construction of Tutor Echelon;
3. Socialized Tutor Team;
4. Internationalized Tutor Team.

**The Construction of the Postgraduate Team.** After managing teachers as a team and assigning students as groups, the reform implements in engineering practice based on projects. The many-to-many training mode between tutors and students is realized by the engineering-academy integrated group training system. At the same time, the common ways of project management in society are introduced into the engineering postgraduate education to help students adapt to the social work environment, and the single system of measuring students' ability with quantitative indicators is broken. Under the circumstances of graduate student enrollment expansion, not being constrained to a one-to-many model between teachers and students can utilize the maximum potential of the teachers’ team. In addition, the engineering – academy integration helps to realize the combination of study and research. Combining technical reform, innovation and scientific research projects with regular academic study, students’ innovation spirit is stimulated, their practice ability is improved.

This proved to have excellent training results for postgraduates of all different levels. Meanwhile, the training process of engineering project and academic research for postgraduates requires a strong ability to independently design and carry out the research plan. Completing the project application by students themselves can not only exercise the postgraduates’ ability to design and carry out the research plan systematically, but also urge the graduate students to consider every detail and steps in the research seriously, consequently save budget. The promotion of the team training mode can also help engineering graduate students to establish the knowledge system of the subject. Taking the postgraduate teaching of railway engineering at Tongji University as an example, driven by the team training mode, postgraduates have formed a complete subject knowledge system. In teaching, graduate students are encouraged to consider all the research objects of railway engineering as a whole, to study rail transit system with the thoughts of equivalent and coupling, and to consider problems macroscopically from the perspective of generalized railway. Using mathematics as a common means, study emerging problems with the aid of mechanics and its theoretical method, consider static and dynamic problems within the context of each other, and view the engineering
academic problem comprehensively. Using the large amount of railway and subway projects’ experience and data accumulated over the years, the team has formed an ample database for teaching and research, ensuring a constant domestic leading position for the team’s research results. This not only conforms to the requirements of the postgraduate training of this subject, but also allows the exportation of compound talent with comprehensive quality to society.

**Communication between Tutors and Postgraduates.**

1. Organize teacher-student communication before postgraduates choose their tutors;
2. Formulate master degree pursuit plan agreed upon by the tutor as a part of the cultivating scheme after enrollment;
3. Convene research coordinating meetings inside the group regularly;
4. Construct a vital and efficient environment for scientific research communication.

**Strengthen Knowledge Management, Transform Individuals’ Experience Into Team’s Knowledge, and Establish a Platform for Knowledge Sharing and Utilizing.** On account of the frequent changes in team members, the accumulation and sharing of the knowledge are strongly needed. Postgraduates should pass their experiences and lessons in research, study notes, and the daily work routines to the junior postgraduates before they leave school. This can help the junior students to adapt to the research and study environment in the group and fit into the team. This work can be carried out by the forms of communication meetings, related work procedure documents, template formation, and summary of research process in written form.

**Basic Level Postgraduate Training Unit Should Offer Support for Postgraduate Research Team.** The management quality and method are varied in different postgraduate training responsible institutions of schools and research facilities. The communication and collaboration among the postgraduate managing organization in universities, and basic level postgraduate training unit should be offered by departments and postgraduate tutors. Base level postgraduate training units need to elevate their postgraduate training service function under the guidance of the competent organization for postgraduates in universities, including providing various hardware environment supports, coordinating the conflicts between tutor’s training and base level postgraduate management work.

**Evaluate the Class Quality for Postgraduates.** Class teaching is an important part of postgraduate training at present. However, most of the teaching contents are out of date, the attention teachers pay to class differs greatly between undergraduate phase and postgraduate phase. Meanwhile, class teaching for postgraduates lacks of supervision and evaluation system, to a certain extent result in the slope in the teaching quality. Postgraduate class quality evaluation can raise attention of the teacher, the postgraduates themselves and the base level training unit to the class teaching. It can improve the unsatisfying situation at present to a certain extent. The tutors’ form of teaching should be innovative, directed at the characteristics of students and curriculum. Seminar, discussion case study are all welcomed forms.

**Strengthen the Control of the Medium Process Key Points Such as Midterm Filtration and Thesis Proposal.** Process control is an important part in modern project management, and it can elevate the realization degree of the objective by correction and adjustment. In the process of postgraduate training, the role of key point control should be emphasized. The postgraduate midterm filtration at present is more of a formality than substance, and the thesis proposal don’t draw enough attention either. Without the feasibility analysis and sound midterm inspection, the stated objective can’t be realized at the end of the paper writing. To strengthen the process control, the key steps of postgraduate training should be strictly controlled by all level cultivating institution. The key steps include cultivation plan, thesis proposal, midterm inspection and pioneering lecture evaluation. Relocate several segments of thesis review and oral defense to thesis proposal and midterm inspection. This would raise the paper writing quality and research ability of the postgraduates to a great extent.
Implementation Effect

The railway engineering discipline in Tongji University has adopted the multi-level individualized training mode as a main form for engineering postgraduate training since 1999. The multi-level individualized training mode for engineering post graduates has been improved in the process of teaching reform innovation. A questionnaire survey was conducted among some of the railway engineering graduates graduated between 1999 and 2015, and the effect of multi-level individualized training mode in aspects of social demand satisfaction, graduate destination and career development were inquired in the survey.

According to the survey result, from 1999 to 2015, the graduate destinations of this major agree with the subdivided training orientation based on social demands in the engineering postgraduate team training mode. The training orientations divided by the multi-level individualized training mode accord with the demand of the society and industry. This division has solved the problems of single training objective and patterned training mode in engineering postgraduate training. In addition, the survey result shows that over 95% engineering postgraduates participated directly in actual engineering practices while at school via averagely over 8 months’ in site project practice provided by the multi-level individualized training mode. The graduates generally believe that participating in engineering projects has practical value after employed, especially for graduates who take place in engineering management or construction units. This survey result fully proves that in the multi-level individualized training mode based on projects, introducing the teaching mode of engineering practice and academic research simultaneous development has significant effect on the training of postgraduates, and it can help graduates to meet the needs of society and realize their self-worth. Meanwhile, this mode has broken the single evaluation system for engineering postgraduates by introducing the social standard, and has prompted the diversified development of teaching modes. While focusing on the training of professional skills and thinking mode and satisfying the social demands for postgraduates, the multi-level individualized training mode also emphasizes the training of comprehensive quality such as independent innovation and team collaboration spirit. The elevation of these soft powers can help the graduates to adapt to society in a short time, and to exhibit more excellent professional ability and comprehensive quality than other graduates. According to the survey result, over 67% graduates have been promoted to the person in charge within 3 years of graduation; their ability and quality are widely acknowledged by their work unit and society.

Conclusions

The transformation of national economic model has crucial impact on the training mode and method of postgraduates in our country, the innovation of postgraduate training mode relies on the exploration and practice of multi-level individualization. The multi-level individualized training mode for postgraduate is an essential mode that suits the higher-education development and social demands and elevates the postgraduate training quality. Only if we have the courage to innovate in idea, organization and system, the real knowledge innovation can be realized, and a large quantity of innovation talents can be cultivated.

Postgraduate education is an important source for the science and technology innovation in our country. Only by breaking some existing mode and reforming the fixed concepts and ideas of managers, tutors, and postgraduates, the diversified talents can be cultivated for national economy and social development.

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References


