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Reform of Innovative Practice Training Mode for Postgraduates in Oil & Gas Engineering Field

Zhihua Wang*

Guangsheng Cao

Daiyin Yin

PhD. Asst. Prof. College of Petroleum Engineering, Northeast Petroleum University, Daqing, China

PhD. Prof. College of Petroleum Engineering, Northeast Petroleum University, Daqing, China

PhD. Prof. College of Petroleum Engineering, Northeast Petroleum University, Daqing, China

Abstract: The strategic position of postgraduate education has gradually become a heated issue and the urgency of quality improvement has become increasingly prominent. Under the background of the strategy of "Innovation-driven Development", this thesis analyzes the importance of education in practice link to training of engineering postgraduates in view of the postgraduate training in oil and gas engineering fields, reforms the practical training mode which has taken the scientific research activities as main forms all the time, researches the construction measures and characteristics of diversified innovative practice training mode for postgraduates in oil and gas engineering fields by taking the development of innovative practice platform and innovative practice academic competitions as breakthrough, and mainly starting from the construction of stratified, integrated and modularized practical teaching projects, as well as that of practical courses in engineering plan design under the guidance of discipline direction, forms the comprehensive practical course system integrating the practical teaching, engineering design and scientific research activities, and offers some recommendations for the operation mechanism of innovative practice training mode for postgraduates.

Keywords: Experiment teaching; Engineering practice; Innovation-driven; Postgraduate training; Teaching reform.

1. Introduction

As the professional education on the basis of second-level disciplines, postgraduate education is a kind of education training the abilities of learners in innovation research and practice, the overall purpose of postgraduate education in China is to train the postgraduates to let them master solid basic theories and systematical specialized knowledge, and further possess certain abilities in scientific research and creation (Zhu and Ma, 2011). In this way, especially for engineering postgraduates, the training mode including the practice link is to provide a series of professional learning opportunities with the purpose of training abilities in scientific research, innovation and practice to postgraduates, and its connotation and characteristics lie in its exploration, innovation, specialty and dynamic (McNabola and O'Farrell, 2015). Therefore, the assurance of construction hierarchy of innovative practice training mode based on the construction of course groups, and its comprehensive reform, as well as the final construction quality directly decides the training level of engineering innovative talents. Under the background of in-depth advancing of reform of postgraduate training mechanism, and all-round improvement of higher education quality, as for engineering postgraduates, it has important significance to the training and improvement of postgraduate abilities in innovation and engineering practice, as well as a wide application prospect to break through the traditional form, reform the practical training mode which has taken the scientific research activities as main forms all the time, set and reform practical courses and teaching methods in stratification and modularization, and construct the special and comprehensive practical course system and training mode integrating the engineering plan design, practical teaching, and scientific research activities with the overall objective of diversified course construction and comprehensive reform and practice (Christie, 2015; Lisa and Maura, 2015; Tamano and Guimba, 2016).

2. Construction and Implementation of Practical Teaching Projects for Postgraduates

In the research of training of engineering practice abilities, the enlightenment of research status at home and abroad to us lies in that the engineering education is becoming a special research field, and continuously exploring the combination of engineering and education, and the micro-level course and teaching of engineering education, namely "engineering learning system" is attracting more and more attention and concern (Soraya *et al.*, 2010). Seen from the aspect of society, especially the requirements of industrial community on engineering education, the

*Corresponding Author

research on engineering education model and course construction reflects the demands of persons related to the engineering education benefits, and the research contents will be more involved with the differences in various aspects of different engineering specialties, industries, areas, student genders and nationalities, as well as school types and levels, so as to form an academic community intercrossing specialties and disciplines. Therefore, it has become a new trend in deepening the engineering education of engineering students at different levels to reform the training mode from the perspective of engineering.

As an engineering field researching the oil and gas exploration, evaluation, production, gas-oil separation, transportation theories and technologies, the oil and gas engineering focuses on the training of high-level talents engaging in scientific problem tackling, technology development, engineering design and construction, project planning and management in oil and gas well engineering, oil-gas field development engineering, oil and gas storage and transportation engineering which is subordinate to the oil and gas engineering field (Hadjamberdiev, 2004). As a university with the construction of national "Characteristic Key Discipline Project", Northeast Petroleum University (NEPU) has the first-grade national key disciplines of oil and gas engineering, and establishes the second-grade national key disciplines of oil and gas well engineering, oil-gas field development engineering and oil and gas storage and transportation engineering, and recruits and trains full-time professional degree postgraduates in the first-grade disciplines, and academic degree postgraduates in the three second-grade disciplines. Since 2010, the scale of full-time professional degree postgraduates of Northeast Petroleum University in this field has been 100~120 persons each year on average, and that of academic degree postgraduates has been 80~100 persons each year on average, and the scientific research activities have been the training form in the practice link which has always been used by the University. In order to accommodate the situation of innovative construction of postgraduate education system, the University has incorporated the practical teaching into the training plan for postgraduates according to the training goal for academic and professional degree postgraduates in the oil and gas engineering field through the two years of research and exploration under the background of highlighting the training on innovation spirits and practical abilities of postgraduates.

2.1. Construction of Innovative Practice Platform

Positioning itself in the open, innovative practice platform for training on comprehensive abilities of postgraduates, the University establishes the "innovative practice platform for oil and gas engineering postgraduates" through the integration and optimization of relative idle software and hardware resources in scientific research of disciplines, scientific combing of process and objectives, uniform compaction of characteristics and standards, design of open operation mode and mechanism, and coverage of professional directions of oil and gas well engineering, oil-gas field development engineering and oil and gas storage and transportation engineering. The platform construction involves scientific experiment contents related to analysis and test of characteristics of chemical flooding drilling fluid, displacing fluid and produced fluid in the tertiary oil recovery, fully reflects the comprehensiveness, innovation and interdisciplinary, and resolves the problems that some precise and precious instrument equipment is hard to realize the large-scale opening and practice application to postgraduates. As the symbolic achievement of construction of postgraduate practice base in Northeast Petroleum University, this platform provides a superior environment and condition for such practical activities as establishing experiment teaching projects, carrying out training on innovative abilities and discipline competitions for postgraduates in the oil and gas engineering field.

2.2. Setting of Practical Teaching Contents

Considering that practical teaching is an important link of training the scientific quality, hands-on abilities and innovation abilities of students, the University positions itself into the facilitation of positive interaction between growth and success of postgraduates in the oil and gas engineering field through practical teaching activities, and for full-time professional degree postgraduates, it covers the reservoir engineering, oil production engineering, oil and gas well engineering and oil and gas storage and transportation engineering discipline directions, constructs the practical teaching projects in integration, places stress on and reflects the training on engineering practice abilities of postgraduates; for academic degree postgraduates, it constructs the practical teaching projects in modularization according to the oil-gas field development engineering, oil and gas well engineering, oil and gas storage and transportation engineering discipline directions, and places stress on and reflects the training on innovation abilities of postgraduates. Furthermore, the University focuses on comprehensive design, independent exploration and guidance and realization of opening and innovation, sets practical teaching projects according to the professional degree level, academic degree level and integration and modularization characteristics, and carries out the experiment teaching in stratification and modularization for postgraduates in this field.

Generally, the University sets the practical teaching projects according to the professional degree level and academic degree level in view of the training on innovative practice abilities of postgraduates in the oil and gas engineering field based on the starting point of being completely higher than specialty experiment teaching of undergraduates. And the University sets 32-hour practical teaching projects according to the integration characteristics in the professional degree level, and 16-hour practical teaching projects according to the modularization characteristics in the academic degree level. Two courses of *Oil and Gas Engineering Experiment* and *Oil and Gas Engineering Exploration and Innovation Experiment* are established for these practical teaching projects, as elective courses for the degree, the two courses break through the training mode in the practice link

which traditionally takes the scientific research activities as the main form, so as to further increase and realize quantification of weight of training on practical skills of postgraduates, and meanwhile further highlight the strengthening training on engineering practice and innovation abilities of professional degree postgraduates. Up to now, the teaching implementation for two sessions of postgraduates has shown a good operation and feedback.

3. Construction and Practice of Practical Courses in Engineering Plan Design

As a kind of ability in engaging in engineering design, the engineering design ability is substantially the concentrated reflection of designer quality, and the engineering design in a general sense is a kind of planning activities, as well as specific measures and means which are proposed to solve problems according to certain engineering purposes (Pericles and Panagiotis, 2014). The engineering design is a kind of creative labor by taking the goal of transforming the objective world, and the design process is a decision made under some restraint conditions to reach a certain goal. This decision is closely related to the personal morality quality, knowledge quality, technical capability, physical quality, etc. of the designer, and good engineering design abilities are within the background of solid basic theoretical knowledge and professional engineering technologies, and based on information acquisition capability and application skills. Therefore, engineering postgraduates may obtain a considerable amount of basic skills in engaging production practice, and fully reserve scientific achievement transformation capabilities through the effective combination with the actual engineering field in the design ability training. This provides some ideas for expanding the channels of training practical abilities of postgraduates, constructing the practical courses in professional engineering plan design, and forming implementation specifications for engineering plan design under the guidance of discipline direction.

3.1. Development Background of Practical Courses in Engineering Plan Design

With the improvement of the scientific and technical level in the global oil industry, the development design of oilfield engineering in the oil industry has become a kind of work changing from focusing on satisfaction of the use function into comprehensive consideration of requirements in multiple aspect such as the use function, use value, economic factor of structure, as well as the effect on overall function and planning of oilfield, and raises higher requirements on the multidisciplinary collaboration of exploration, development, drilling, storage and transportation, as well as the expertise level, overall design philosophy, scientific research level and creative thinking of designers. It is undoubtedly a vital element for facilitating the training on innovative practice abilities of postgraduates in the oil and gas engineering field to forge a platform integrating learning, competition and research, and grasp the dialectical relation in "learning, competition, competition" - "learning for competition, competition for research promotion" (Cunningham and Higgins, 2015; Qiang, 2012).

As one of six competitions of "National Postgraduate Innovative Practice Activities" recognized by the China Academic Degrees and Graduate Education Development Center, "China Petroleum Engineering Design Competition" is an academic competition which is organized by China Academic Degrees and Graduate Education Development Center, Chinese National Committee for World Petroleum Council, Chinese Petroleum Society, China Petroleum Education Society under the overall background of "Plan for Training Outstanding Engineers" suggested by the Ministry of Education, with the main purpose of training on practice and innovation abilities of university students. In order to expand the competition range, become an international competition, and attract foreign players to compete, enhance the competition's international fame, this academic competition changed its name into "China Petroleum Engineering Design Competition" from "National Petroleum Engineering Design Competition" in 2015. This competition is widely involved with each field in the oil professional research, especially the design and management of oil engineering, and increases more innovation contents on the basis of traditional exploration, development, drilling, storage and transportation by combining the non-conventional oil and gas resources, and provides a typical turning point to exercise, promote and train students' overall quality and abilities in comprehensive application of specialized knowledge. The competition completes preliminary examination and review in each division, and then selects the outstanding teams who will join the on-site defense in the final.

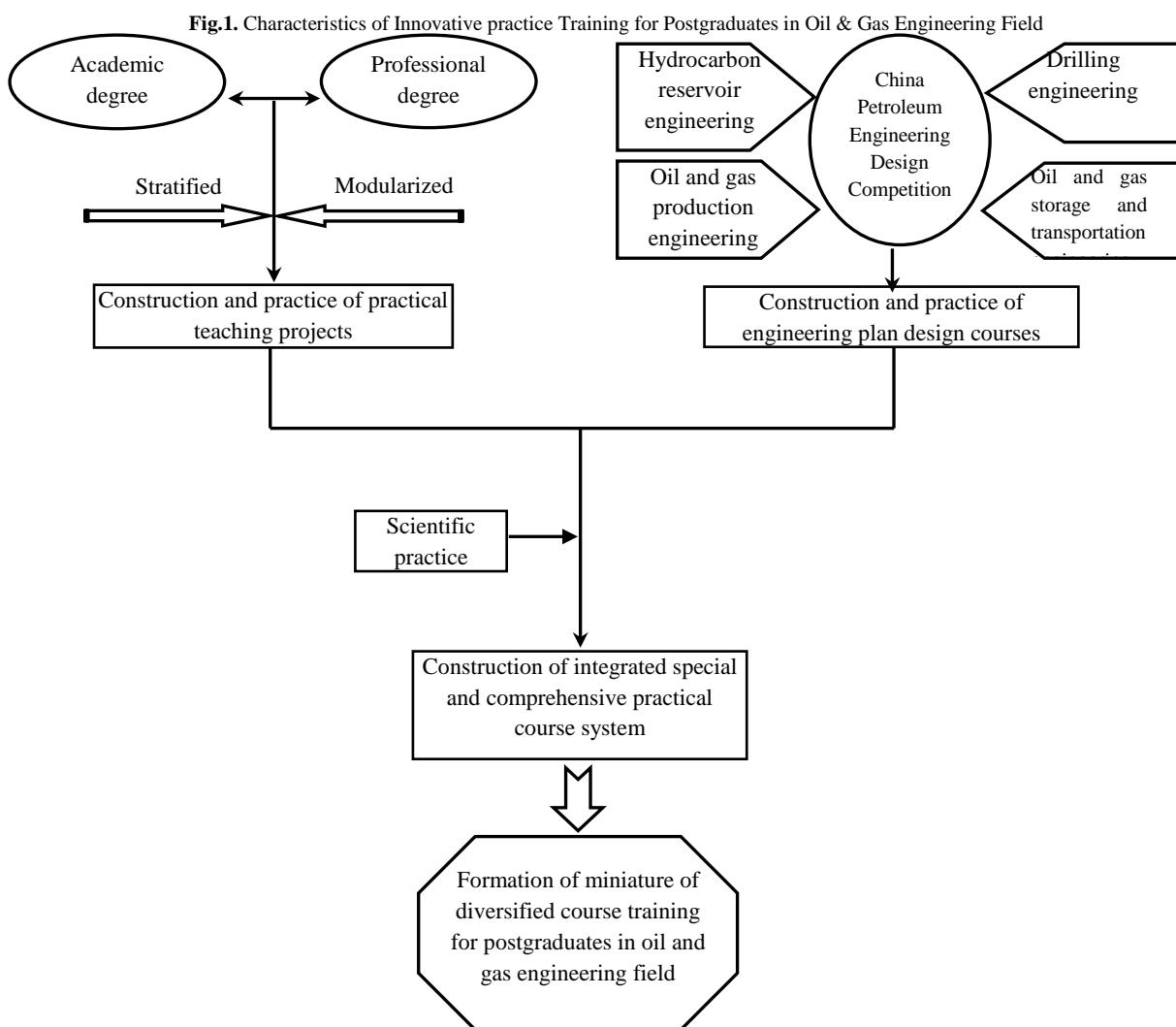
3.2. Construction and Practice of Oil Engineering Plan Design Courses

Under the guide of this academic competition involving with innovative practice, we plan and construct practical courses of Oil Engineering Plan Design, and set the contents separately in hydrocarbon reservoir engineering plan design, drilling engineering plan design, oil and gas production engineering plan design, oil and gas storage and transportation engineering plan design under the guidance of discipline direction. Postgraduates take corresponding practical courses in engineering plan design electively according to the research direction, and during the implementation process, and complete such courses by taking "China Petroleum Engineering Design Competition" as background and turning point in two terms: in the spring term of the first-year postgraduates, instructors guide the postgraduates to complete the plan design task of competition problems of China Petroleum Engineering Design Competition in the previous year, which trains the postgraduates' abilities in applying theory to reality, comprehensively solving the actual production problems, and makes the postgraduates establish the basic ideas in developing the engineering plan design, including the design principles, methods and steps, etc.; in the fall term of the second year, instructors organize postgraduates to join and independently complete the competition problems of China Petroleum Engineering Design Competition in the current year, and make a comprehensive and

systematical plan design for a single item or all items, and finally comprehensively evaluate the results of the practical courses in combination of the works submitted to the competition.

4. Construction of Integrated Special and Comprehensive Practical Course System

Innovation comes from practice, and the innovative practice training is an important channel to improve the overall quality of postgraduates (Sammel and Waters, 2014). It is important to expand diversified practice training mode in the engineering postgraduate education in the face of talent requirements focusing on design, practice, innovation and competitiveness (Murgor, 2013). Based on the scientific development of training mode for innovative talents, the diversified expansion in practical teaching with scientific research and innovative design as development direction can improve the abilities of postgraduates in comprehensive utilization of knowledge in the practice process, stimulate the creative abilities of postgraduates, and meanwhile trains the scientific and rigorous work style as well as team spirit of mutual cooperation, facilitates the coordinated development between practice and innovation abilities and overall quality of postgraduates, and pays equal attention to the personal development of postgraduates, and has important significance to the realization of training on high-quality and creative first-class talents.



Generally, the stratified and modularized construction of practical teaching projects is explored and implemented according to goal of training academic and professional degree masters during the process of advancing the diversified innovative practice training mode for postgraduates in oil and gas engineering; the orderly establishment of engineering plan design task under the guidance of discipline direction, as well as the effective connection with the discipline top design competitions is realized during conducting the construction of practical courses in engineering plan design. Therefore, the special and comprehensive practical course system in oil and gas engineering integrating practical teaching, oil engineering plan design and scientific research activities through the joint construction and practice of practical teaching projects, oil engineering plan design courses, and in combination of the traditional scientific research activities of postgraduates, which deals with the effective integration of practical teaching, engineering plan design and scientific research activities during the training progress of postgraduates in

this field, and further effectively constructs a set of integrated special and comprehensive practical course system, and forms the characteristics of innovative practice training for postgraduates as shown in Fig.1.

5. Conclusions and Recommendations for Operation Mechanism

It has become an important direction for universities in deepening the reform of postgraduate education and teaching in recent years to continuously optimize and adjust the discipline structure, and explore and build a training mode for innovative talents with high quality and strong ability in multiple channels. This thesis provides the following conclusions and recommendations for the innovative practice training work of postgraduates in oil and gas engineering field of Northeast Petroleum University through the research on construction of innovative practice training mode for postgraduates, as well as the teaching reform research, and tries to demonstrate them to the establishment of innovative practice training mode and operation mechanism for engineering postgraduates in relevant disciplines:

1) For the construction and practice of practical teaching projects, the practical teaching projects are planned and set according to discipline characteristics as well as requirements on talent knowledge system by mainly utilizing the "innovative practice platform for oil and gas engineering postgraduates". Instructors teach the core technology contents, and postgraduates design technical plans, independently complete experiment contents, analyze and solve problems, and research and practice more targeted teaching methods in view of training plans in the practice link established by levels and categories, as well as practical teaching projects designed in modularization.

2) For the construction and practice of practical courses in oil engineering plan design, 4 sections are set under the guidance of discipline direction, the postgraduates' abilities in applying theory to reality, and comprehensively solving the actual production problems by taking China Petroleum Engineering Design Competition as background and turning point are achieved, and the basic ideas in developing the engineering plan design are established.

3) For the involved high-pressure, inflammable and explosive high-risk or extreme environments, unreachable or irreversible operation, as well as engineering practice training projects requiring high costs and consumption, it is suggested to introduce and allocate virtual simulation resources to realize virtual-actual combination, and mutual complementation, and effectively promote the diversification of innovative practice training for postgraduates, which is the further work plan for the innovative practice training for postgraduates in oil and gas engineering

4) An integrated special and comprehensive practical course system is constructed in combination of traditional scientific research activities, and innovation abilities, engineering practical abilities and competitiveness of postgraduates at different levels are increased by focusing on "training on innovation ability, engineering practice ability and overall quality", so as to make postgraduates really become high-level application-oriented talents.

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