

Exploration and Practice of "Three-Dimensional Integration" Training Model for Professional Degree Postgraduates

Yi Zhang*, Xiaobo Wang, Jisheng Ma, Fang Xie

School of Mechanical Engineering, Xijing University, Xi'an, Shaanxi, China

*Corresponding Author

Abstract:

In the current training process of professional degree postgraduates, the three elements of scientific research project, discipline competition and dissertation are not integrated, and the related teaching, research and teaching reform research is mostly limited to the relationship between the two. This paper takes the cultivation of innovation ability and engineering practice ability as the core. Guided by scientific research projects and discipline competitions, it breaks down the barriers to explore the mechanism of how to connect the three elements, studies and constructs a "three-dimensional integration" innovative training model to form an efficient cultivation model for professional degree postgraduates.

Keywords: *Postgraduate, Training model, Scientific research project, Discipline competition, Dissertation.*

I. INTRODUCTION

Scientific research is the logical starting point for postgraduate education. High-level scientific research is an important guarantee for the cultivation of postgraduate students' innovative ability, and also the core and key to improving postgraduate training quality. There is an interdependence and mutual promotion between them. Regarding how to use scientific research projects to more effectively improve the innovative ability cultivation of postgraduates, many scholars have carried out fruitful research in terms of postgraduate training model, scientific research project management system, and implementation of comprehensive incentive measures.

Liu Guoyu[1] believes that innovation is a process of continuous practice and re-understanding. Scientific research projects can let students embrace the forefront of subject research, experience the exploration of scientific problems, develop innovative inspiration, form innovative thinking, master innovative methods, and improve creativity. Yang Jing [2] combines "cultivation of postgraduate innovative ability" with "specific scientific research process", and proposes a postgraduate training mechanism that combines scientific research and teaching based on big platforms, big teams, and big projects. On this basis, Hangzhou Dianzi University cultivates a large number of rigorous high-level

talents with strong innovation ability, good overall quality, who are good at creatively solving problems in scientific research projects. Luo Zhizeng et al.[3] explore the engineering postgraduate training model with "research-practice-competition-innovation" as the main line, requiring students to participate in the whole process of scientific research, closely combine basic theoretical study with scientific research practice, learn and explore in research, and effectively solve the problem of the disconnection between theoretical study and practice, which indeed improves the scientific research level and innovation ability of postgraduates. The lack of research learning training for most postgraduates at the undergraduate level, and their fewer opportunities to participate in scientific and technological innovation practice activities result in low innovation awareness, insufficient innovative thinking, and weak innovative practical ability. In view of this, Lei Caihong et al.[4] propose a series of coherent scientific research practice training such as intensive training of experimental skills for postgraduate freshmen, implementation of scientific project research in the laboratory after school enrollment, and setting of postgraduate innovation fund to cultivate the scientific research and innovation ability of postgraduates. Li Pengjun[5] analyzes the problems in the scientific research and innovation cultivation of postgraduates, and believes that the postgraduate training system fails to pay sufficient attention to scientific innovation research, and postgraduates have poor initiative and continuity in scientific innovation research. In order to make up for the shortcomings in the traditional postgraduate training model, Jinan University, the author's unit, introduces the project management concepts and methods into the cultivation of postgraduate scientific research innovation capabilities. Zhai Pei[6] conducted an investigation and analysis on the status quo of innovation ability cultivation among postgraduates majoring in finance and economics, and found that postgraduates do not participate in scientific research projects enough, receive less necessary innovative practice training, have insufficient innovative knowledge reserves, and lack sufficient innovative thinking and independent learning ability. The author takes training concept, training objectives, training process and training results as the main elements, and constructs an innovative ability training model for financial postgraduates. The model emphasizes the fundamental role of curriculum teaching and scientific research practice in innovative ability cultivation. The Massachusetts Institute of Technology[7] takes the strong scientific research strength of universities as an important driving force, and establishes a platform for industry-university-research cooperation with high-tech companies, uses scientific research and engineering projects as a bridge, takes a good operation management mechanism and a clear division of responsibilities and cooperation among multiple parties as the basis of interaction, provides high-quality software and hardware resources for the cultivation of postgraduates' innovative ability. British universities[8] rely on education companies and knowledge partner programs in the cultivation of postgraduates, focus on promoting learning with use, and emphasize the cultivation of students' innovative practice ability. Through projects in which both partners can obtain benefits, it provides postgraduates with training in an industrial practice environment, combines the needs of enterprise development with talent training in universities, implements the training path of "learning by doing", and effectively implements the training of innovative talents.

Cultivating postgraduates' innovative ability is one of the core goals of postgraduate education. Discipline competitions are carried out among college students. It is a scientific and technological activity in which students use multiple courses or subject knowledge to solve the engineering and technical

problems in the specified theme, which is an important means to cultivate the innovative ability of postgraduates and improve their comprehensive quality.

Liu Yang et al. [9] adopted the form of questionnaires and individual interviews to investigate and analyze 331 postgraduates regarding the question: "the role of discipline competitions in the cultivation of postgraduate ability", and believed that discipline competitions can exercise students' language expression skills and on-the-spot adaptability, improve the academic ability and academic quality of postgraduates. Chen Qiping et al.[10] believe that discipline competition is an important means to improve postgraduates' innovation and entrepreneurship capabilities. Discipline competitions can create an atmosphere and interest for innovation and entrepreneurship, and enable students to combine their professional knowledge, scientific research direction with practical engineering problems, broaden students' horizons, train innovative thinking, enhance innovation capabilities, and develop entrepreneurial inspiration. Huang Kexin et al.[11] analyze the comprehensive qualities that postgraduates should have to adapt to future development, as well as the division of discipline competition categories, and uses the questionnaire method to establish the correspondence between various discipline competitions and the comprehensive quality of postgraduates. Basic discipline competitions such as the National Post-Graduate Mathematical Contest in Modeling and the National College English Contest can enhance the learning ability of postgraduates and enable them to form certain independent thinking and self-learning ability in the course of the competition. Engineering machinery competitions provide a platform for postgraduates to meet practical engineering problems, which can mobilize students' enthusiasm for exploring scientific and technical issues, deepen their understanding of basic theoretical knowledge, stimulate their desire and potential for learning, and cultivate their teamwork ability, innovation awareness and communication skills. Liu Dezhi et al.[12] thoroughly analyze the guiding role of the National Post-Graduate Mathematical Contest in Modeling in the cultivation of students' innovative ability. The National Post-Graduate Mathematical Contest in Modeling enables students to link the learned theoretical knowledge with the surrounding real world, use mathematical knowledge and mathematical software to analyze and solve practical problems, thus cultivating the insight, creativity and scientific research capabilities required to solve complex engineering problems. Shi Yaoyuan et al.[13] believe that discipline competition effectively combines the scientific research ability of postgraduates with practical problems, which can stimulate the postgraduates' interest in innovation and entrepreneurship. Through discipline competitions, students can be trained to explore new fields, new methods, and solve complex engineering problems. Discipline competitions have high requirements for the ability to transform and apply professional knowledge. Completion of an excellent competition work requires cooperation, trust and understanding between members, which are also excellent qualities required for innovative talents. Ren Qing-Dao-Er-Ji et al.[14] elaborate on the role of postgraduate innovation & practice series competitions in the cultivation of computer science postgraduate' innovative ability. It is believed that the series of competitions can cultivate students' comprehensive application ability, improve students' scientific and psychological quality, and train students' self-learning ability, hands-on ability and teamwork awareness.

Dissertation is a display of the main research results of professional degree postgraduates, which can be used to judge whether the postgraduate has mastered the basic theoretical knowledge of the professional

field and whether he has the ability to engage in the research of practical scientific and engineering problems. Dissertation quality refers to the degree to which the dissertation meets the potential requirements. The Ministry of Education's Degree and Graduate Education Development Center regards dissertation quality as an important indicator for evaluating the postgraduate training quality.

Luo Xiaodan[15] conducted an empirical analysis on the "blind review" results of dissertations of 1160 postgraduate students in a "211 project" university. The university's postgraduate dissertation adopts the "double-blind review" system, which gives four grades of evaluation: A, B, C, and D for the six indicators, including "comprehensive evaluation", "topic selection and review", and "dissertation innovation", etc. The empirical analysis results show that, except for the average grade of "dissertation innovation", which is C, all other averages are above B. This shows that review experts believe that the school's postgraduate dissertation has the problem of insufficient dissertation innovation. In order to solve the above problem, Luo Xiaodan suggested optimizing the curriculum system, consolidating students' basic theory, strictly selecting tutors, clarifying the guidance rights and responsibilities of tutors, strengthening process supervision, and standardizing the development of dissertation work. Zhou Lingling[16] believes that the problem of inappropriate topic selection among postgraduate dissertation is highlighted in the fact that the dissertation topic selection seldom involves cutting-edge and challenging research topics, failing to reflect the due innovation. In order to improve the professional ability and scientific research quality of postgraduates, it is recommended that when formulating the postgraduate training program, it is necessary to put forward achievement requirements for innovative ability development, such as national awards, invention patents, and essays that meet the graduation requirements, thus actively encouraging students to participate in China postgraduate innovation & practice series competitions. Li Ruijiao[17] selected all 7,115 H University dissertations receiving academic misconduct test in 2014-2016 as the research objects. The results showed that the topic selection of the postgraduates of the same major in the past three years has great similarity and lacks innovation, which directly affects the research value of the dissertation. Li Ruijiao believes that establishment of postgraduate innovation projects can effectively improve the dissertation innovation level. Colleges and universities should combine their professional characteristics and advantages to actively carry out various forms of cooperation with other companies and research institutions. By setting up scientific research innovation projects with a strong engineering practice background, and allowing students' positive participation, it is possible to lay a solid foundation for postgraduates to write high-quality dissertations. Long Zhiqiang et al.[18] believe that dissertation is an important means to exercise the engineering practice ability of professional degree postgraduates. Tutors should combine practice, guide students to extract professional dissertation topics from major projects, so that students can deepen their understanding of professional theoretical knowledge during the process of completing their dissertations, and cultivate certain ability of applying scientific theories, methods and technical means to solve engineering practice. Cao Lei et al.[19] established a model regarding factors influencing professional degree postgraduates' practical ability based on four major factors: curriculum learning, tutor guidance, practical activities, and dissertation. The analysis found that there are some problems in professional dissertations, such as single writing form, widespread academic tendency in topic selection content and research style, and great difficulty in judging the practical value of dissertations. In response to these problems, Cao Lei and Cai Dehao proposed to manage the whole process of the

dissertation in order to improve the practical nature of the dissertation and highlight its ability to solve practical problems in the industry. In the initial process management stage, practical topic selection of dissertation should be strengthened. In the mid-process stage, it is necessary to strengthen the practical communication review and pre-defense of the dissertation. In the final process management stage, there is need to strengthen the practical defense of the dissertation.

In the current practice of professional degree postgraduate training, the three elements of scientific research project, discipline competition and dissertation are not integrated, and the related teaching, research and teaching reform research is mostly limited to the relationship between the two. This paper intends to carry out exploration and practice of professional degree postgraduate training model with "three-dimensional integration" of scientific research projects, discipline competitions, and dissertations, and strives to unify the three around the core goal of "cultivation of innovation ability and engineering practice ability", in order to effectively solve the problem of insufficient innovation and practicality in professional degree postgraduate dissertations, and build an efficient and high-quality talent training system.

II. EXPLANATION OF THE CONCEPT OF "THREE-DIMENSIONAL INTEGRATION"

2.1 Scientific Research Project

"Scientific research project" is an important carrier for postgraduate training. In the process of solving the inherent scientific or engineering problems, the innovative and practical abilities of postgraduates can be effectively improved, which helps cultivate top-notch innovative talents. The scientific research projects involved in this paper mainly refer to applied scientific research projects suitable for professional degree postgraduates and mainly cultivating their engineering practice capabilities, or fund projects established by universities to cultivate postgraduates' innovative practical capabilities. These projects display the following characteristics: (1) have a strong engineering practice background and high practical value; (2) have a certain degree of innovation and cutting-edge attributes; (3) Show the characteristics of interdisciplinary integration and demand knowledge and technology of multiple fields for completion; (4) its scientific research results can be transformed into competition works, thus allowing participation in discipline competitions; (5) its theoretical depth and practical complexity meet the basic requirements for writing dissertations.

2.2 Discipline Competition

"Discipline competition", a scientific and technological practice activity, is an effective means and an important carrier for cultivating postgraduates' innovative thinking and enhancing their engineering practice capabilities. In this paper, discipline competition refers to the "China Postgraduate Innovation & Practice Series Competitions" (hereinafter referred to as series competitions) jointly organized by the Ministry of Education's Degree and Graduate Education Development Center and the Youth Science and Technology Center of the China Association for Science and Technology. The series competitions focus

on improving postgraduates' innovative practice ability. With the goal of improving postgraduate training quality, it creates an innovation platform for industry-university-research cooperation, uses social resources to collaboratively promote the reform and development of postgraduate education, and promotes the overall improvement in China's postgraduate education development level and service support capabilities. The series competitions set up 11 themed events, including smart city construction, mobile Internet, aerospace, integrated circuits, professional degree case construction, etc. (as shown in Table I). The series competitions have become a platform for postgraduates to cultivate their innovative spirit and awareness, and improve their practical ability, which become a powerful starting point for postgraduate training units to improve postgraduate training quality, create a postgraduate innovation atmosphere, and promote the reform of postgraduate innovation and entrepreneurship education.

TABLE I. China postgraduate innovation & practice series competitions (8 themed events)

Event theme	Event purpose and content	Sponsor
China Postgraduate Electronic Design Competition	The competition is divided into seven competition directions, consisting of two parts: technical competition and business plan special competition	<ul style="list-style-type: none"> • Ministry of Education's Degree and Graduate Education Development Center • Youth Science and Technology Center of the China Association for Science and Technology • Chinese Institute of Electronics • Chinese Society of Artificial
China Postgraduate Robot Innovation Design Contest	Enhance postgraduates' awareness of innovation and entrepreneurship, cultivate innovative design capabilities, and promote the innovative development of robotics technology and industry.	
China Postgraduate Smart City Technology and Creative Design Competition	Based on the concept of "creative enlightenment of wisdom and innovation-driven development", stimulate postgraduates' awareness of innovation and improve postgraduates' innovative and practical capabilities.	
China Postgraduate Future Aircraft Innovation Competition	Based on the concept of "innovation changes the future", focus on aircraft technology innovation to enhance the independent innovation and comprehensive practical capabilities of the majority of postgraduates.	

National Post-Graduate Mathematical Contest in Modeling	Stimulate postgraduates' innovative vitality, improve their comprehensive ability to establish mathematical models and solve practical problems, and cultivate the spirit of innovation and teamwork.	Intelligence •International Astronautical Federation • China Petroleum Society • China University of Petroleum
China Postgraduate Innovation "Core" Contest	Contribute to the development strategy of the national integrated circuit industry, effectively improve the innovative and practical capabilities of postgraduates, and promote the cultivation of outstanding talents in the field of integrated circuits.	
China Postgraduate Artificial Intelligence Innovation Competition	Focus on the theme of artificial intelligence innovation, stimulate postgraduates' innovative consciousness, improve postgraduates' innovative and practical capabilities, and cultivate innovative and applied high-end talents.	
China Graduate Energy Equipment Innovation Design Competition	Stimulate postgraduates' enthusiasm for innovation, cultivate innovative thinking, improve innovative practice capabilities, and promote the innovative development of the national energy equipment industry.	

2.3 Three-dimensional Integration

"Three-dimensional integration" refers to an innovative talent cultivation mode that efficiently trains professional degree postgraduates with high quality. First of all, it cultivates postgraduates' scientific research literacy and innovation awareness through scientific research projects with strong engineering practice background and interdisciplinary integration, so that students can understand the latest academic frontiers in the discipline development, and master advanced scientific research means and methods to carry out original research and continuously make innovative contributions in the field of engineering application technology. Then, it transforms scientific research results into competition works such as principle prototypes, three-dimensional digital models, products, etc. participating in the China Postgraduate Innovation & Practice Series Competitions, encourages students to apply scientific theoretical knowledge to engineering practice, thus cultivating students' technical practice ability to solve complex engineering problems, teamwork spirit, meticulous logical thinking and accurate language

expression skills. Finally, based on the research results of scientific research projects and the experimental verification of competition works, it guides the dissertation writing. Such training method can effectively integrate scientific research projects, discipline competitions and dissertations, break the barriers between the three to form a three-dimensional integrated and efficient professional degree postgraduate training model.

III. THE CONSTRUCTION OF THE "THREE-DIMENSIONAL INTEGRATION" TRAINING MODEL FOR PROFESSIONAL DEGREE POSTGRADUATES

It is necessary to explore a professional degree postgraduate training model with "three-dimensional integration" of scientific research projects, discipline competitions, and dissertations, integrate the three elements involved in the training process, namely, scientific research projects, discipline competitions and dissertations, break the barriers between the three, and therefore efficiently cultivate applied, compound high-level engineering technology and engineering management talents that not only master solid basic theoretical knowledge and scientific research methods in the professional field, but also can innovatively solve practical engineering problems, and write high-quality dissertations.

1) Scientific research projects undertaken or joined by students should be selected based on the innovative and practical standards of discipline competitions, so that the training of professional degree postgraduates breaks away from the set pattern in academic postgraduate training, restores the standard, and pays more attention to innovation ability and engineering practice ability cultivation.

Professional degree postgraduates belong to applied talents, and their education should be oriented to professional practice and career development, focus on the cultivation of engineering practice ability, and ability to use professional knowledge to analyze and solve practical problems.

China's professional degree system is established on the basis of academic degree system and has inherent shortcomings, which are mainly manifested in the low distinction between the two training modes, the lack of orientation to meet professional needs and the insufficient practical characteristics in training, making it easily develop into a "compressed version", "simplified version", derivative or appendage of academic degree postgraduate education.

With improving innovation and practice ability of postgraduates as the core and improving postgraduate training quality as the goal, China Postgraduate Innovation & Practice Series Competitions are a powerful starting point to promote the reform of postgraduate innovation and entrepreneurship education. It is necessary to give full play to the promotion role of discipline competition, select and allow students to participate in scientific research projects whose scientific research results can be easily transformed into competition works, which can effectively combine practice and theory, ensure that practice finds the research focus for theoretical study, and theoretical study provides theory support for

practice. These scientific research projects are mainly derived from actual engineering or have a clear engineering technical background. Focusing on complex exploratory and creative practices, it can be the research and development of new technologies, new processes, new equipment, new materials, and new products.

2) It is necessary to transform the research results of scientific research projects into discipline competition projects, which can effectively reduce the production cost of competition works and improve the technological content of competition works.

The production, operation or testing of competition works in the form of principle prototypes, three-dimensional data models, products and case libraries can be used as an integral part of the implementation process of scientific research projects, that is, experimental verification work, which can effectively promote the implementation of scientific research work. Such training mode of organically combining scientific research projects and subject competitions can efficiently cultivate the scientific research ability and engineering practice ability of professional degree postgraduates with high quality, thus providing an important way to improve their comprehensive quality.

Cultivation of engineering practice ability is an important feature that distinguishes professional degree postgraduate education from academic degree postgraduate education. Discipline competition is an important starting point for cultivating students' ability to comprehensively use theoretical knowledge and scientific methods, and improving their ability to solve practical engineering problems.

China Postgraduate Innovation & Practice Series Competitions provide a wide range of topics for postgraduates, create a good environment for students to carry out professional practice and stimulate inherent creativity, also encourage students to participate in innovative practice. By transforming the results from scientific research projects into competition projects in series competitions, it can effectively combine the cultivation of scientific research ability and engineering practice ability, so that students can apply the learned basic theoretical knowledge to engineering practice in the first time, thus pushing the cultivation of comprehensive quality and innovation ability of professional degree postgraduates to a higher level.

By participating in the series competitions, students can cultivate their scientific research and technological development capabilities, problem-building and problem-solving capabilities. Completing a competition work requires application of professional knowledge in multiple disciplines. This requires students to not only actively expand their knowledge scope and learn knowledge of related disciplines, but also integrate the knowledge and proficiently apply it to engineering practice, which will help improve students' overall quality and core competitiveness.

Competition projects of series competitions generally require more than 3 students to form a competition team for joint completion. The tacit cooperation between team members has a direct impact on competition preparation and competition results. Therefore, series competitions can also train students'

communication and expression skills, as well as teamwork spirit.

3) Scientific research projects meeting the requirements of discipline competitions have distinct industry characteristics and actual engineering background, strong innovation and high engineering practice requirements.

The competition projects transformed from scientific research results have deep theoretical foundation and academic value. By combining scientific research projects and the corresponding discipline competitions effectively, and using them as the preliminary work and foundation of the dissertation, it can effectively solve the problem of insufficient innovation and practicality in professional degree postgraduate dissertations.

Dissertation of professional degree postgraduates should not only maintain the academic dimension of academic degree postgraduate dissertation, but also strengthen its professional dimension. Topic selection of the dissertation must emphasize practicality, which must solve practical engineering problems. The quality evaluation standards should be practice-oriented, focusing on solving practical engineering problems.

At present, the writing of professional degree postgraduates' dissertation has a greater academic tendency in dissertation topic selection and research style. It is common that academic degree postgraduate dissertations, namely, research papers, are followed. Writing style has great similarity with that of academic degree dissertation, which fails to reflect the practicality of professional degree postgraduate dissertations and the goal of solving practical problems. One reason is that the current professional degree dissertations are mostly selected and written under the guidance of college tutors, which is greatly affected by the academic thinking of the tutors, leading to the academic tendency in the dissertation topic selection. Even if the topic is selected from a practical perspective, the content tends to be academic and deviate from practicality in writing.

By constructing a "three-dimensional integration" training model for professional degree postgraduates, closely combining the scientific and systematic nature of scientific research projects with the innovative and practical nature of subject competitions, and writing dissertations based on the scientific research and competition results of the two, it is possible to better meet the innovative and practical requirements of professional degree dissertations.

IV. CONCLUSION

Under the background of double first-class construction, oriented to serving the national development strategy of Made in China 2025, with improving postgraduates' innovative practical ability as the core and improving postgraduate training quality as the goal, this paper adopts the basic methods of higher education research to analyze shortcomings in the existing training process of professional degree

postgraduates, draws on the successful experience of postgraduate education in domestic and foreign universities, explores construction of a professional degree postgraduate training model with "three-dimensional integration" from the three dimensions of scientific research project, discipline competition, and dissertation. Hoping that professional degree postgraduate education pays more attention to the cultivation of innovation ability and engineering practice ability, it provides corresponding countermeasures and suggestions for cultivating high-level applied technology talents. In the later research of this paper, we can further explore effective ways to realize the integration of scientific research projects, discipline competitions and dissertation work, study and establish relevant guarantee mechanisms, examination mechanisms and evaluation mechanisms, and practice professional degree postgraduate training model with "three-dimensional integration" of scientific research project, discipline competition and dissertation.

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