

Study on Path of Integrating Science and Education to Improve Training Quality of Professional Degree Postgraduates in Henan Province, China

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Abstract: *With the in-depth advancement of the national innovation-driven development strategy and the urgent demand for regional economic transformation and upgrading in Henan Province, professional degree postgraduate education, as the core carrier for cultivating high-level applied talents, has become a key issue in higher education reform. This study takes the improvement of the training quality of professional degree postgraduates in Henan Province as its core goal. It first analyzes the current situation of professional degree postgraduate training in Henan Province, identifies the problems existing in the integration of science and education, and finally constructs a "trinity" path for improving quality through the integration of science and education.*

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I. Introduction

In the current era, education, science and technology, and talents have become the fundamental and strategic pillars for building a modern socialist country in an all-round way. As the top tier of higher education, postgraduate education undertakes a crucial mission in cultivating high-level innovative talents. The integration of science and education, as an innovative educational concept and model, is gradually becoming an important approach to enhance the quality of postgraduate training.

The concept of integrating science and education can be traced back to the early 19th century when the University of Berlin was founded by Humboldt in Germany. He advocated the idea of "attaining cultivation through science" and integrated scientific study into teaching activities as a special teaching method. Since then, this concept has continued to evolve. For example, the postgraduate training model integrating science and education at Johns Hopkins University in the United States has further promoted the close integration of scientific study and teaching. In China, the integration of science and education has also received increasing attention. The National Medium- and Long-Term Plan for Education Reform and Development (2010-2020) clearly states that efforts should be made to 'promote the interaction between scientific study and teaching, and integrate scientific study with the cultivation of innovative talents'. In 2024, the Chinese Academy of Sciences held a working conference on the integration of science and education, systematically summarizing historical experience and studying and deploying new ideas and measures for further advancing the integration of science and education and accelerating the independent cultivation of top-notch scientific and technological talents in the new era. These series of policies and initiatives fully demonstrate the important position of the integration of science and education in postgraduate training in China.

From the perspective of the international situation, global competition in science and technology is becoming increasingly fierce, and various countries have increased their investment in scientific and technological innovation and talent cultivation. Against this backdrop, the integration of science and education can better integrate educational and scientific study resources, cultivate high-level talents with innovative capabilities and international competitiveness, and help China gain a foothold in the global scientific and technological competition. From the perspective of China's development needs, with the rapid economic and social development, the demand for high-quality professional talents has become increasingly urgent. As representatives of high-level applied talents, the training quality of professional degree postgraduates is directly related to the process of China's industrial upgrading and innovative development. However, there are still some problems in the current training of professional degree postgraduates in China, such as the disconnection between training objectives and market demands, the homogenization and lag of curriculum systems, the superficial implementation of practical teaching, and the insufficient effectiveness of the dual-tutor system. These problems have seriously restricted the improvement of the training quality of professional degree postgraduates and made it difficult to meet the social demand for applied talents.

As a major province in terms of population and education in China, Henan Province has continuously expanded the scale of professional degree postgraduate education, but still faces many challenges in terms of training quality. On the one hand, the training of professional degree postgraduates in some universities lacks characteristics and fails to closely align with the local industrial needs. On the other hand, the application of the integration of science and education in postgraduate training is not in-depth enough, and there is a phenomenon that scientific study and teaching are "separated like two sheets of paper". Against this background, in-depth study on the path of improving the training quality of professional degree postgraduates in Henan Province from the perspective of integrating science and education is of great practical significance. Through this study, it is expected to provide useful references for the education of professional degree postgraduates in Henan Province, promote reforms and innovations in its training model, curriculum setting, practical teaching, etc., improve the training quality, and cultivate more high-quality professional talents for the economic and social development of Henan Province and even the whole country.

In terms of the integration of science and education, study in developed countries in Europe and America mainly focuses on the coordination mechanism between scientific study and teaching, the promoting role of scientific study in teaching, and the organizational model of integrating science and education. For example, study universities in the United States promote the in-depth integration of scientific study and teaching by establishing interdisciplinary study centers and industry-university-study cooperation projects, so as to cultivate students' innovative and practical abilities. Germany emphasizes the close cooperation between universities of applied sciences and enterprises, directly applying scientific study results to teaching and production practices, and cultivating a large number of professional talents who meet market demands. In terms of the training of professional degree postgraduates, study in these developed countries mainly focuses on the clarity of training objectives, the practicality of curriculum settings, the effectiveness of practical teaching, and the improvement of quality assurance systems. For instance, professional degree postgraduate education in the United Kingdom focuses on career orientation, with curriculum content closely integrated with industry needs, and strengthens students' practical abilities through internships, graduation projects, and other links.

In recent years, China has also made significant progress in study on the integration of science and education and the training of professional degree postgraduates. In terms of the integration of science and education, scholars have mainly discussed the connotation, significance, implementation path, and existing problems and countermeasures of integrating science and education. For example, Zhang Feilong and others proposed a conceptual system of integrating science and education with two dimensions (broad sense and narrow sense) and three levels (conceptual level, institutional level, and operational level), which provides a theoretical framework for in-depth understanding of the integration of science and education. In terms of the training of professional degree postgraduates, study in China mainly focuses on the reform of training models, the optimization of curriculum systems, the strengthening of practical teaching, and the improvement of the dual-tutor system. For example, through empirical study on the training of professional degree postgraduates in Chinese universities, some scholars have proposed that it is necessary to strengthen cooperation with enterprises, establish an industry-university-study collaborative education mechanism, and improve students' practical and innovative abilities.

However, there are still some shortcomings in the existing study. On the one hand, there are relatively few systematic studies on the training of professional degree postgraduates from the perspective of integrating science and education, and there is a lack of in-depth discussion on the path of improving training quality from a holistic perspective. On the other hand, study on the training of professional degree postgraduates in Henan Province is not sufficient, and it fails to fully combine the local characteristics and industrial needs of Henan Province to put forward targeted and operable suggestions. Therefore, based on existing study, this study takes professional degree postgraduates in Henan Province as the study object, and in-depth explores the effective path of improving training quality from the perspective of integrating science and education.

II. Problem Analysis

The education of professional degree postgraduates in Henan Province started relatively late but has achieved remarkable development in recent years. In the 1990s, as China gradually launched professional degree postgraduate education, some universities in Henan Province began to pilot the enrollment of professional degree postgraduates. Since then, supported by educational policies and driven by growing social demand, the scale of professional degree postgraduate education in Henan Province has continued to expand.

At present, many universities in Henan Province offer professional degree postgraduate programs, covering multiple fields such as engineering, agriculture, medicine, education, and management. According to relevant data, by 2024, the enrollment number of professional degree postgraduates in Henan Province has accounted for a certain proportion of the total postgraduate enrollment, showing a year-on-year growth trend. In terms of discipline distribution, the enrollment scale of engineering-related professional degree postgraduates is relatively large, mainly focusing on popular fields such as computer technology, electronics and communication

engineering, and mechanical engineering; agricultural professional degree postgraduates are closely aligned with Henan's characteristics as a major agricultural province, with a wide distribution in fields such as crop science, horticulture, and agricultural resource utilization; medical professional degree postgraduates also have a certain enrollment scale in majors like clinical medicine, stomatology, and public health.

In terms of training models, universities in Henan Province have actively explored innovations and continuously promoted industry-university-study cooperation and practical teaching reform. Some universities have established off-campus practice bases and collaborated with enterprises, study institutions, and other entities to carry out postgraduate training, providing students with abundant practical opportunities and project resources. For example, Henan University of Technology has built a 'Three-Link and Three-Promotion' postgraduate training system. Guided by major national projects and key industrial projects, it has conducted in-depth cooperation with enterprises to achieve "three integrations"—integration of discipline resources and enterprise resources, integration of university teachers and enterprise experts, and integration of theoretical study and engineering practice. This system promotes the improvement of talent training quality, the transformation of scientific study achievements, and the transformation and upgrading of curriculum systems. Meanwhile, the university has innovatively implemented a "1+4+1" teaching model, allowing postgraduates to conduct study and practice in enterprises, accumulate engineering experience, and enhance their ability to solve complex engineering problems. In addition, some universities have implemented the dual-tutor system: on-campus tutors are responsible for theoretical guidance, while off-campus tutors focus on practical guidance, jointly cultivating postgraduates' comprehensive quality and professional capabilities. For instance, Anyang Normal University has implemented the strategy of "inviting in and going out" in the training of postgraduates majoring in Teaching Chinese to Speakers of Other Languages (TCSOL). It has recruited experts, scholars, and professionals with practical experience in the TCSOL field as part-time tutors, forming a dual-tutor system where on-campus tutors play a leading role and off-campus tutors participate in professional practice and thesis guidance. This system has improved the construction level of professional degree programs and ensured the quality of postgraduate training.

Despite the certain achievements made in the training of professional degree postgraduates in Henan Province, from the perspective of integrating science and education, there are still some problems that restrict the further improvement of training quality.

In terms of policy support, although the state and Henan Province have issued a series of policy documents encouraging the integration of science and education, there are issues of inadequate policy implementation in actual practice. Some universities and study institutions have an inaccurate understanding and grasp of the policies, lacking specific implementation rules and supporting measures, which makes it difficult for the policies to take root. For example, in terms of scientific study project cooperation, although policies encourage universities and study institutions to jointly apply for projects, there are many obstacles in project approval, fund allocation, and other links, which affect the enthusiasm of both parties for cooperation. In addition, the incentive mechanism for the integration of science and education in policies is not perfect. There is insufficient reward and support for units and individuals that have made outstanding contributions to the integration of science and education, which also hinders the in-depth advancement of the integration of science and education to a certain extent.

In terms of cooperation between universities and study institutions, there are problems of insufficient depth and breadth of cooperation. The cooperation between some universities and study institutions only stays on the surface, lacking substantive cooperation projects and collaborative innovation mechanisms. There are barriers between the two sides in the sharing of scientific study resources and talent training, making it difficult to achieve complementary advantages. For example, although some universities have established cooperative relationships with study institutions, in the process of postgraduate training, the high-quality scientific study resources of study institutions have not been fully opened to universities. Students have limited opportunities to participate in scientific study projects and cannot truly benefit from the integration of science and education. In addition, the communication and coordination mechanism between universities and study institutions is not perfect, which easily leads to problems such as information asymmetry and unclear responsibilities during cooperation, affecting the efficiency and effectiveness of cooperation.

In terms of the teaching staff, there is a phenomenon of disconnection between teachers' scientific study and teaching. Some teachers invest a lot of energy in scientific study but fail to transform the latest scientific study achievements into teaching content during teaching, resulting in outdated teaching content that cannot meet students' needs for cutting-edge knowledge. At the same time, some teachers lack practical experience and find it difficult to provide effective guidance and help when guiding students in practical work and scientific study projects. For example, in the teaching of some professional degree postgraduate courses, teachers still adopt the traditional method of theoretical lectures, lacking case analysis and practical teaching links, which makes it difficult for students to apply the knowledge they have learned to practice. In addition, the implementation effectiveness of the dual-tutor system is insufficient, and the role of off-campus tutors has not been fully exerted.

Due to busy work, some off-campus tutors have limited time and energy to participate in postgraduate training, and their guidance to students is not in-depth or systematic.

In terms of student participation, some postgraduates have an insufficient understanding of the integration of science and education and lack enthusiasm for participating in scientific study projects. Some students believe that scientific study projects are difficult and demanding, and they are worried that participating in these projects will affect their academic performance and graduation, so they are unwilling to take the initiative to participate. At the same time, students lack autonomy and creativity in scientific study projects; they often passively accept the arrangements of tutors and lack the ability to think independently and solve problems. For example, in some scientific study projects, students only conduct experimental operations and data collection according to the requirements of tutors, lacking overall planning and thinking about the project, and cannot give full play to their potential. In addition, the guarantee mechanism for students to participate in scientific study projects is not perfect, and there are deficiencies in scientific study funds, experimental equipment, and other aspects, which also limits the enthusiasm and effectiveness of students' participation in scientific study projects.

III. Study Methods

This study comprehensively adopts multiple study methods to explore the path of improving the training quality of professional degree postgraduates in Henan Province from the perspective of integrating science and education in a comprehensive and in-depth manner.

The first method is the literature study method. By extensively reviewing relevant domestic and foreign literature, including academic journals, dissertations, and study reports, this study sorts out the theoretical foundation, study status, and development trends of the integration of science and education and professional degree postgraduate training, so as to provide a solid theoretical support for the study. During the sorting process, it not only focuses on classic theories and the latest study results but also conducts comparative analysis of different viewpoints to accurately grasp the study dynamics.

The second method is the case study method. Representative universities in Henan Province are selected as cases to conduct in-depth analysis of their practical experience and existing problems in the training of professional degree postgraduates from the perspective of integrating science and education. Through detailed analysis of these cases, successful experiences are summarized and common problems are identified, providing practical basis for proposing targeted improvement paths. In the selection of cases, factors such as university type, discipline characteristics, and training scale are fully considered to ensure the diversity and representativeness of the cases.

The third method is the survey study method. Questionnaires and interview outlines are designed to conduct surveys among professional degree postgraduates, tutors, and relevant management personnel in Henan's universities. These surveys aim to understand their cognition, attitudes, and practical situations regarding the integration of science and education, as well as collect their opinions and suggestions on improving training quality. Through statistical analysis of survey data, the current situation is deeply understood, problems are identified, and empirical support is provided for the study. During the survey process, attention is paid to the randomness and comprehensiveness of samples to improve the credibility of survey results.

The innovations of this study are mainly reflected in the following aspects:

In terms of study perspective, starting from the unique perspective of integrating science and education, it conducts a comprehensive and systematic study on the path of improving the training quality of professional degree postgraduates in Henan Province. This makes up for the limitations of previous studies in perspective and helps to more deeply reveal the internal connection between the integration of science and education and postgraduate training quality.

In terms of study content, it closely combines the local characteristics and industrial needs of Henan Province, and proposes targeted and operable strategies for improving training quality. These strategies provide practical suggestions for the reform and development of professional degree postgraduate education in Henan Province, enhancing the practicality and application value of the study results.

In terms of study methods, it comprehensively applies the literature study method, case study method, and survey study method. These methods mutually confirm and complement each other, making the study results more comprehensive, accurate, and reliable, and providing new methodological ideas for related study.

IV. Exploration of Paths to Improve Training Quality of Professional Degree Postgraduates in Henan Province

4.1 Policy Support and Institutional Guarantee

The government plays a key role in improving the training quality of professional degree postgraduates in Henan Province and should provide strong support for the integration of science and education in postgraduate training in terms of policy formulation, fund investment, and resource allocation.

In policy formulation, the government needs to issue more specific, detailed, and operable policy documents. For example, it should clarify the responsibilities and rights of universities and study institutions in the integration of science and education, and formulate detailed cooperation processes and standards to reduce uncertainties and disputes during cooperation. At the same time, it should establish a supervision mechanism for policy implementation, conduct regular inspections and evaluations on the implementation of policies by universities and study institutions, and ensure that policies are truly implemented.

Fund investment is an important material basis for guaranteeing postgraduate training under the integration of science and education. The government should increase financial support for professional degree postgraduate education and set up special funds to support the development of science-education integration projects. These funds can be used to subsidize postgraduates' participation in scientific study projects, purchase scientific study equipment, and carry out academic exchange activities. In addition, through policy measures such as tax incentives and financial subsidies, enterprises and social forces should be encouraged to participate in professional degree postgraduate education to expand funding sources. For instance, enterprises participating in the joint training of postgraduates can be given tax reductions, and social institutions donating to postgraduate education can be provided with financial subsidies.

In resource allocation, the government should play a role in macro-control and optimize the allocation of educational and scientific study resources. On the one hand, it should strengthen resource sharing between universities and study institutions, promote the opening and sharing of scientific study equipment, laboratories, and data resources, and improve resource utilization efficiency. On the other hand, it should guide resources to tilt toward advantageous disciplines and key fields, and concentrate efforts to build a number of characteristic and advantageous professional degree postgraduate training bases. For example, combined with the industrial characteristics of Henan Province, more resources should be invested in fields such as equipment manufacturing, agricultural modernization, and biomedicine to build high-level science-education integration training bases and improve the training quality of professional degree postgraduates in related fields.

4.2 Deepening the Cooperation Mechanism Between Universities and study Institutions

Establishing a long-term and stable cooperative relationship is the foundation for deepening cooperation between universities and study institutions. Both parties should, from a strategic perspective, fully recognize the importance of the integration of science and education for talent training and scientific and technological innovation. They should sign long-term cooperation agreements to clarify cooperation goals, tasks, and responsibilities, and provide institutional guarantees for cooperation. For example, universities and study institutions can formulate a 5-10-year long-term cooperation plan around common scientific study directions and talent training needs, and clarify the cooperation priorities and expected results of each stage in the plan.

In curriculum development, universities and study institutions should strengthen cooperation and jointly formulate the curriculum system for professional degree postgraduates. study institutions can integrate the latest scientific study results and practical experience into the curriculum content to make the curriculum more cutting-edge and practical. At the same time, the two parties can jointly offer interdisciplinary courses to cultivate students' interdisciplinary thinking and comprehensive abilities. For example, in the interdisciplinary field of artificial intelligence and medicine, universities and study institutions can jointly develop courses such as "Application of Artificial Intelligence in Medical Image Diagnosis", and invite experts from both sides to teach together, allowing students to access knowledge and study methods in different fields.

Practical teaching is an important part of professional degree postgraduate training. Universities and study institutions should jointly build practical teaching bases to provide students with rich practical opportunities. study institutions can provide students with platforms to participate in actual scientific study projects, allowing students to exercise their scientific study capabilities and problem-solving abilities in practice. Universities, on the other hand, should strengthen the management and guidance of practical teaching to ensure the quality of practical teaching. For example, Henan University has cooperated with Henan Academy of Agricultural Sciences to establish a practical teaching base for agricultural professional degree postgraduates. Students participate in the study and promotion of agricultural scientific study projects at the base, achieving good practical results.

Tutor mutual appointment is an effective way to promote talent exchange and knowledge sharing between universities and study institutions. Universities can hire experts from study institutions as part-time tutors to participate in postgraduate guidance and pass on the scientific study experience and practical skills of study institutions to students. study institutions can also hire teachers from universities as part-time studyers to participate in scientific study projects and promote the interaction between scientific study and teaching. For example, Zhengzhou University has hired a number of experts from the Zhengzhou Institute of Physics and Engineering of the Chinese Academy of Sciences as part-time tutors. These experts have provided professional guidance in the aspects of postgraduate thesis proposal and thesis writing, improving the training quality of postgraduates.

4.3 Strengthening the Construction of Teaching Staff

Cultivating a tutor team with both teaching and scientific study capabilities is the key to improving the training quality of professional degree postgraduates. Universities should strengthen the training and development of teachers, provide more scientific study opportunities and academic exchange platforms, encourage teachers to participate in scientific study projects, and improve their scientific study level. At the same time, they should carry out teaching ability training to help teachers master advanced teaching methods and concepts and improve teaching quality. For example, teachers can be regularly organized to participate in domestic and foreign academic conferences and training courses, and educational experts can be invited to provide training and guidance on teaching methods.

Establishing a scientific and reasonable incentive mechanism is an important means to improve the enthusiasm of tutors in guiding professional degree postgraduates. Universities should incorporate tutors' work in guiding postgraduates into the performance evaluation system, and commend and reward tutors who have performed well in postgraduate training. In terms of professional title evaluation and position promotion, preference should be given to tutors who actively participate in professional degree postgraduate training and have achieved good results. For example, an "Excellent Postgraduate Tutor" award can be set up, and the winning tutors can be given certain material rewards and spiritual rewards, as well as bonus points in professional title evaluation.

In addition, the management and assessment of dual tutors should be strengthened. The responsibilities and division of labor between on-campus tutors and off-campus tutors should be clarified, a communication and coordination mechanism for dual tutors should be established, and the guidance work of dual tutors should be regularly evaluated and fed back. For tutors who do not perform their duties seriously, corresponding punitive measures should be taken, such as reducing the number of students they can enroll or revoking their tutor qualifications, to ensure the effective implementation of the dual-tutor system. For example, a detailed dual-tutor assessment index system can be formulated to assess dual tutors from multiple aspects such as guidance time, guidance effect, and student satisfaction, and rewards and punishments can be given based on the assessment results.

4.4 Optimizing the Curriculum and Teaching System

Integrating scientific study results into the curriculum is an important part of optimizing the curriculum system. Teachers should timely introduce their own scientific study results and cutting-edge discipline knowledge into classroom teaching to enrich teaching content and improve the innovation and practicality of the curriculum. For example, in the courses of engineering professional degree postgraduates, teachers can use actual cases from the scientific study projects they participate in as teaching materials, allowing students to understand the practical problems and solutions in engineering practice. At the same time, students should be encouraged to participate in scientific study projects, combining scientific study practice with curriculum learning to cultivate their scientific study capabilities and innovative thinking.

Innovating teaching methods is an important way to improve teaching quality. A variety of teaching methods such as case teaching, project-based teaching, and seminar-style teaching should be adopted to stimulate students' learning interest and initiative, and cultivate their ability to analyze and solve problems. For example, in the courses of management professional degree postgraduates, the case teaching method can be used. By analyzing actual management cases, students are guided to use the knowledge they have learned to conduct analysis and make decisions, improving their management practice ability. Modern information technology should be used to carry out online-offline blended teaching, expand teaching space and time, and improve teaching efficiency and quality.

The practical teaching link is the core part of professional degree postgraduate training, and the organization and management of practical teaching should be strengthened. The proportion of practical teaching should be increased to ensure that students have sufficient time to participate in practical activities. For example, it can be stipulated that the practical teaching time of professional degree postgraduates is not less than half a year, and practical teaching is included in the credit system. A sound practical teaching evaluation mechanism should be established to conduct a comprehensive and objective evaluation of students' practical performance, feed back the evaluation results in a timely manner, and help students improve. At the same time, cooperation with practical teaching bases such as enterprises and study institutions should be strengthened to jointly formulate practical teaching plans and ensure the pertinence and effectiveness of practical teaching. For example, internship projects can be carried out in cooperation with enterprises, allowing students to participate in the actual work of enterprises, understand the operation and needs of enterprises, and improve their professional quality and practical ability.

4.5 Improving the Quality Assurance and Evaluation System

Establishing a full-process quality monitoring mechanism is an important means to ensure the training quality of professional degree postgraduates. In the enrollment link, enrollment standards and procedures should be strictly implemented, and the assessment of candidates' comprehensive quality and professional ability should

be strengthened to ensure the selection of excellent students. In the training process, monitoring of various links such as curriculum teaching, practical teaching, thesis proposal, and mid-term assessment should be strengthened, and regular inspections and evaluations should be conducted to timely identify and solve problems. For example, a teaching supervision system can be established to conduct regular supervision and evaluation of classroom teaching; an annual report system on postgraduate training quality can be carried out to conduct a comprehensive summary and analysis of training quality. In the graduation link, the thesis review and defense procedures should be strictly implemented to ensure that the training quality of postgraduates meets the requirements.

Constructing a diversified evaluation index system is the key to scientifically evaluating the training quality of professional degree postgraduates. The evaluation indicators should cover multiple aspects such as postgraduates' academic level, practical ability, innovative ability, and professional quality, so as to fully reflect the comprehensive quality of postgraduates. For example, in terms of academic level, the scientific study achievements and thesis publication of postgraduates can be evaluated; in terms of practical ability, the performance of postgraduates in practical teaching and their ability to solve practical problems can be evaluated; in terms of innovative ability, the innovative thinking and innovative achievements of postgraduates can be evaluated; in terms of professional quality, the professional ethics and team spirit of postgraduates can be evaluated. At the same time, third-party evaluation institutions should be introduced to conduct objective and fair evaluation of the training quality of professional degree postgraduates, providing a reference for improving training work.

V. Conclusion

Under the perspective of the integration of science and education, this study conducts an in-depth exploration on the paths to improve the training quality of professional degree postgraduates in Henan Province. By sorting out the theoretical basis of the integration of science and education and the training of professional degree postgraduates, analyzing the current situation and problems of professional degree postgraduate training in Henan Province, it proposes paths to improve the training quality from multiple aspects. The integration of science and education is of great significance for enhancing the training quality of professional degree postgraduates in Henan Province. Through the collaborative efforts of all parties and the implementation of the aforementioned improvement paths, it is expected to cultivate more high-quality professional degree postgraduates who meet social needs, thereby providing strong talent support for the economic and social development of Henan Province.

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