

## *Original Paper*

# Analysis on Cultivating Graduate Students' Innovation Ability Based on Scientific Research Projects—Taking Experimental Animal Science in Medicine as an Example

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### ***Abstract***

*Experimental animal science in medicine, as an interdisciplinary field, plays a crucial role in biomedical research. This article takes experimental animal science in medicine as an example to explore how to effectively cultivate graduate students' innovation ability through scientific research projects. Combining the disciplinary characteristics of experimental animal science in medicine, this paper elaborates on the role of scientific research projects in cultivating graduate students' innovation ability, analyzes some existing problems in the process of using scientific research projects to cultivate graduate students' innovation ability, and proposes targeted and operable schemes from aspects such as optimizing project topic selection, strengthening mentor guidance, improving scientific research platforms, and innovating evaluation systems. The purpose is to provide a theoretical basis for enhancing the innovation ability of graduate students in experimental animal science in medicine and related disciplines.*

### ***Keywords***

*Scientific research projects, Graduate students, Innovation ability, Experimental animal science in medicine*

In recent years, the number of graduate students admitted in China has been increasing year by year. According to statistics from the Department of Development Planning of the Ministry of Education, in 2023, a total of 1.3017 million graduate students were enrolled nationwide, representing a year-on-year increase of 4.76%. The number of graduate students in school reached 3.8829 million, with a year-on-year growth of 6.28% (Department of Development Planning, Ministry of Education, 2023). Graduate education plays an important role in cultivating innovative talents, improving innovation capabilities, serving economic and social development, and advancing the modernization of the national governance system and governance capacity. In the medical field, innovation ability is a key element in promoting the leapfrog development of medical science, overcoming complex and difficult diseases, and enhancing human health and well-being.

Experimental animal science in medicine is a discipline that studies the biological characteristics, breeding management, disease model construction, and application of experimental animals. It integrates knowledge from multiple disciplines such as biology, medicine, and veterinary medicine, and holds a pivotal position in medical research (Zhang, Tang, Luo et al., 2024). It takes experimental animals as research objects and employs advanced experimental techniques and methods to simulate the occurrence and development processes of human diseases, providing strong support for revealing disease mechanisms, developing new diagnostic methods, and therapeutic approaches. For graduate students majoring in experimental animal science in medicine, participating in scientific research projects is not only an important way to deepen professional knowledge and enhance research capabilities but also a key to cultivating innovative thinking and honing innovative abilities. By engaging in scientific research projects, graduate students can directly face frontier issues in the discipline, stimulate innovative potential in the process of exploring the unknown, and lay a solid foundation for future academic research and medical practice.

## **1. Advantages of Scientific Research Projects in Cultivating Graduate Students' Innovation Ability**

### *1.1 Scientific Research Projects Can Broaden Graduate Students' Innovative Thinking*

Scientific research projects are essentially bold explorations into unknown scientific fields, with their core lying in solving unsolved scientific problems or opening up entirely new research directions (Qin, Li, Ma et al., 2024). Within the scope of experimental animal science in medicine, such as exploring experimental animal models suitable for disease research or animal experimental techniques, these projects require graduate students to break through traditional thinking patterns, free themselves from the constraints of existing research methods, view problems from unique perspectives, and conceive novel research ideas and experimental schemes. In the innovation process, graduate students need to organically integrate multidisciplinary knowledge such as biological principles, medical clinical experience, and animal behavioral characteristics to form an interdisciplinary thinking mode. This collision of interdisciplinary thinking can give birth to innovative inspirations, enabling graduate

students to flexibly apply diverse knowledge systems when facing complex problems, propose solutions, and thus gradually cultivate innovative thinking abilities.

### *1.2 Scientific Research Projects Can Improve Graduate Students' Practical and Hands-on Abilities*

Scientific research projects serve as a platform for cultivating graduate students to combine theory with practice (Zhang, Yang, Ni et al., 2025). In the experimental operation links of experimental animal science in medicine, it covers multiple aspects such as the breeding management of experimental animals, experimental operations, and data collection and analysis. Taking the construction of gene-edited experimental animal models as an example, graduate students not only need to master the theoretical knowledge of gene editing technology proficiently but also precisely control experimental parameters in operations to ensure the accuracy and stability of gene editing. In the long-term practice process, graduate students will inevitably encounter various technical difficulties and unexpected situations, which require them to rely on solid professional knowledge and keen observation to quickly analyze the root causes of problems and, through repeated experiments and adjustments, find the essence of the problems and practical solutions. This process of continuous exploration and summarization of experiences and lessons in practice not only enhances graduate students' professional skill levels but also cultivates their innovative practical spirit, enabling them to calmly respond when facing challenges, solve problems from different directions, and change their thinking.

### *1.3 Scientific Research Projects Can Cultivate Graduate Students' Collaboration and Communication Abilities*

Scientific research projects generally have complexity and comprehensiveness, requiring collaborative cooperation from multidisciplinary professionals to proceed smoothly. In scientific research projects of experimental animal science in medicine, graduate students collaborate with team members from different disciplinary backgrounds. For instance, veterinary experts are responsible for the welfare ethics, health assurance, and disease diagnosis of experimental animals; biology experts solve problems in the application of molecular biology techniques; and medical experts evaluate the fit between animal disease models and clinical diseases. In such an interdisciplinary team research environment, graduate students need to actively communicate and exchange with team members, clearly and accurately express their research ideas and views, while seriously listening to others' opinions and suggestions. Through frequent collisions of ideas and information sharing, graduate students can broaden their academic horizons, learn to view problems from different disciplinary perspectives, and achieve complementarity and integration of knowledge (Sun, 2024). This interdisciplinary team collaboration not only helps cultivate graduate students' team spirit and communication coordination abilities but also stimulates innovative inspirations and promotes the generation of innovative results. Members from different disciplinary backgrounds bring their respective different thinking modes and research methods, providing entirely new ideas and methods for solving complex scientific research problems through mutual exchange and cooperation.

## **2. Deficiencies in Cultivating Graduate Students' Innovation Ability Based on Scientific Research Projects**

### *2.1 Topic Selection of Scientific Research Projects Is Key to Cultivating Graduate Students' Innovation Ability*

The rationality of topic selection for scientific research projects is a key factor in ensuring that graduate students can receive effective training and growth in scientific research projects. However, in the actual topic selection process, there exists a phenomenon where the difficulty of topics does not match the graduate students' professional foundation and ability levels. On one hand, some topics are too simple, with research content lacking sufficient challenge, allowing graduate students to complete them easily without investing much effort, which not only fails to fully mobilize their innovative enthusiasm but also makes it difficult to enhance their research capabilities and innovative literacy. On the other hand, some topics are too difficult, exceeding the graduate students' current knowledge reserves and ability scopes, leading to numerous difficulties in the research process, stalled progress, frustrated confidence, and even possible fear of research, seriously affecting the cultivation of innovation abilities. Additionally, some scientific research project topics fail to closely track the frontier dynamics and development trends in the field of experimental animal science in medicine, lacking keen insight and forward-looking layout for emerging research directions. Some topics are merely limited to simple repetitions or minor extensions of traditional research content, failing to fully excavate deep-level problems and potential innovation points in disciplinary development, making it difficult to stimulate graduate students' exploratory desires and innovative enthusiasm.

### *2.2 Mentors Have a Profound Impact on Cultivating Graduate Students' Innovation Abilities*

Mentors, as guides on the scientific research path of graduate students, their guidance is crucial for cultivating graduate students' innovation abilities (Gao, Xu, & Chen, 2024). In reality, many mentors bear heavy scientific research tasks and administrative work pressures, making it difficult to invest sufficient time and energy in providing comprehensive and in-depth guidance to graduate students. This results in graduate students being unable to obtain timely professional advice and guidance from mentors when encountering problems in advancing scientific research projects, leading to slow research progress and even possible deviation from the correct direction. Some mentors, when guiding graduate students, overly emphasize research results and paper publications while relatively neglecting the systematic cultivation of graduate students' innovative thinking, research methods, and academic literacy. In the guidance process, there is a lack of encouragement and guidance for graduate students' independent thinking abilities and innovative spirits, with a habit of directly providing solutions rather than inspiring graduate students to explore and solve problems autonomously. Moreover, with the increasingly intensified trend of interdisciplinary integration, some mentors' knowledge structures gradually fail to meet the needs of graduate students' interdisciplinary research. When facing complex scientific research problems involving multiple disciplinary fields, they cannot provide comprehensive

guidance to graduate students, limiting the expansion of graduate students' innovative visions and the enhancement of innovation abilities.

### *2.3 A Sound Scientific Research Platform Is the Basic Guarantee for Cultivating Graduate Students' Innovation Abilities*

The scientific research work in experimental animal science in medicine highly depends on advanced experimental equipment and techniques. However, due to limited funding investments in some universities and research institutions, the updating and replacement of experimental equipment are not timely, resulting in problems such as equipment aging and outdated performance. For example, in research fields like gene sequencing and proteomics analysis, outdated equipment cannot meet the needs of high-precision and high-throughput experiments, leading to issues such as low data accuracy and inefficient experiments in the process, seriously restricting the development of innovative experimental research.

Experimental animals, as the main objects of research in experimental animal science in medicine, their types, quantities, and quality directly affect the depth and breadth of research. Some units have relatively scarce experimental animal resources, unable to provide experimental animal varieties and strains that meet diverse research needs. In addition, the breeding management conditions for experimental animals are not standardized enough, lacking standardized animal breeding facilities and strict quality control systems, leading to unstable health conditions of experimental animals and questionable reliability and reproducibility of experimental results. This not only increases the difficulty for graduate students to conduct experimental research but also limits their space for in experimental design and innovation.

### *2.4 A Comprehensive Evaluation System Is the Driving Force for Cultivating Graduate Students' Innovation Abilities*

Currently, the evaluation system for graduate students' scientific research achievements still largely uses the number of papers published and the impact factors of journals as the main measurement indicators. This single evaluation standard overly emphasizes the quantitative presentation of scientific research results while ignoring the comprehensive consideration of graduate students' innovation processes, innovative thinking, and innovation abilities. Under this evaluation orientation, graduate students often concentrate a lot of energy on pursuing paper publications while ignoring the in-depth exploration of scientific research problems, which is not conducive to the cultivation of graduate students' innovation abilities. In addition, the existing evaluation system has certain one-sidedness in indicator settings, failing to fully cover various aspects of graduate students' performance in scientific research projects. For example, there is a lack of specific and clear evaluation indicators for graduate students' innovative contributions in processes such as experimental design, data analysis, team collaboration, and problem-solving, making it difficult to comprehensively and objectively reflect graduate students' comprehensive qualities and innovation abilities. This one-sided evaluation method

not only fails to provide accurate feedback and incentives to graduate students but also is not conducive to selecting truly outstanding talents with innovative potential.

### **3. Optimization Strategies for Cultivating Graduate Students' Innovation Abilities Based on Scientific Research Projects**

#### *3.1 Closely Following Disciplinary Frontiers and Practical Needs, Establishing a Scientific and Reasonable Topic Evaluation Mechanism*

In project topic selection, firstly, mentors and graduate students should closely pay attention to the international frontier dynamics and domestic practical needs in the field of experimental animal science in medicine, actively participate in academic conferences, frontier lectures, and other academic activities, and timely grasp the latest trends and hot issues in disciplinary development. Combining national major scientific research strategic deployments and key problems urgently needing solutions in clinical practice, carefully select research topics with innovativeness, foresight, and practicality. For example, in response to the urgent need for animal models in the current field of tumor immunotherapy, carry out research projects on constructing experimental animal models for tumor immunotherapy based on gene editing technology, aiming to provide more reliable models for the development of tumor immunotherapy drugs. Secondly, organize experts to conduct comprehensive evaluations of proposed topics, comprehensively considering graduate students' professional backgrounds, knowledge reserves, research abilities, as well as the research content, expected goals, technical routes, and other factors of the topics, to ensure moderate difficulty. For topics with greater difficulty, mentor teams can adopt joint guidance to provide necessary support and help to graduate students, enabling them to continuously enhance their innovation abilities in challenges. At the same time, encourage graduate students to independently design research topics with certain innovativeness based on their own interests and strengths, and gradually improve topic schemes under mentors' guidance, fully 发挥 graduate students' subjective initiative and innovative spirits.

#### *3.2 Strengthening Mentors' Important Mission and Responsibility in Cultivating Graduate Students' Innovation Abilities*

Advocate mentors to transform guidance concepts, shifting from traditional "indoctrination-style" guidance to "inspirational-style" and "guiding-style" guidance, focusing on cultivating graduate students' independent thinking abilities and innovative thinking (Xie, 2019). In the guidance process, mentors should encourage graduate students to actively raise questions, boldly question existing theories and methods, and guide them to autonomously find solutions through methods such as literature review and survey analysis. At the same time, mentors should continuously update their own knowledge structures, pay attention to the trend of interdisciplinary integration, strengthen interdisciplinary learning and research, and enhance their own comprehensive qualities and guidance abilities. In addition, establish a regular mentor training system, invite well-known experts and scholars from home and abroad to hold frontier academic lectures and scientific research method training

courses, providing mentors with opportunities for continuous learning and knowledge updating, ensuring that mentors can provide high-quality and frontier guidance services to graduate students.

### *3.3 Establishing a Systematic and Sound Scientific Research Service Sharing Platform*

Universities and research institutions should attach great importance to the construction of practical platforms and increase funding investments in the purchase and updating of experimental equipment. Formulate scientific and reasonable equipment procurement plans, prioritize purchasing a batch of advanced experimental equipment representing disciplinary frontier levels, such as two-photon microscopes, single-cell sequencers, intelligent animal behavior analysis systems, etc., to meet the needs of graduate students in conducting innovative experimental research. At the same time, establish a sound equipment management and maintenance system, equip professional equipment managers, regularly maintain, care for, and perform performance tests on equipment to ensure normal operation and improve equipment usage efficiency. In addition, strengthen the construction of equipment sharing platforms, break down barriers between departments and disciplines, achieve optimal allocation and efficient utilization of equipment resources, and provide more graduate students with opportunities to access advanced equipment.

Strengthen the construction of experimental animal centers, enrich experimental animal varieties and strain resources through introduction, cultivation, and other methods, and establish experimental animal resource libraries covering various types such as common disease model animals and gene-modified animals. Increase the transformation and upgrading efforts of experimental animal breeding facilities, build standardized animal houses according to international standards, equip advanced environmental control equipment, feed nutrition supply systems, and animal welfare facilities to provide comfortable and safe living environments for experimental animals. At the same time, establish strict experimental animal quality monitoring systems, strengthen detection and management of experimental animals' genetic backgrounds, microbial carriage situations, etc., to ensure that experimental animal quality meets scientific research requirements. In addition, strengthen experimental animal ethics education and management, strictly follow experimental animal ethics guidelines to conduct experimental research, protect experimental animal welfare, and enhance graduate students' animal ethics awareness and sense of responsibility.

### *3.4 Implementing Full-Process Dynamic Evaluation and Building a Diversified Evaluation Indicator System*

Establish a full-process dynamic evaluation mechanism, integrating evaluation throughout the entire process of graduate students' scientific research projects. In the project initiation stage, focus on evaluating the innovativeness, feasibility of topic selection, and rationality of research plans; during the project implementation process, regularly check graduate students' research progress, experimental data quality, problems encountered, and resolution situations, etc., and provide timely feedback and guidance; in the project conclusion stage, comprehensively assess graduate students' research achievements, innovative contributions, as well as growth and progress throughout the entire project

process. At the same time, introduce diversified evaluation subjects such as peer evaluation, student self-evaluation, and mutual evaluation, fully listen to opinions from all parties, and ensure the fairness and objectivity of evaluation results. Through full-process dynamic evaluation, timely discover problems and deficiencies in the process of cultivating graduate students' innovation abilities, provide a basis for adjusting cultivation strategies, and motivate graduate students to continuously pursue innovation in the scientific research process and enhance their own innovation abilities.

In the evaluation of scientific research achievements, abandon the single evaluation mode centered on paper publications, and build a diversified evaluation indicator system covering multiple dimensions such as innovative thinking, scientific research abilities, practical achievements, and team collaboration. In terms of innovative thinking, focus on examining graduate students' abilities to propose innovative problems and conceive unique research ideas and methods in scientific research projects; in terms of scientific research abilities, pay attention to graduate students' performance in experimental design, data processing, paper writing, etc.; in terms of practical achievements, not only include paper publications but also incorporate patent applications, scientific research awards, technology transformations, etc., into the evaluation scope; in terms of team collaboration, evaluate graduate students' communication coordination and cooperation contributions in teams. Through diversified evaluation indicators, comprehensively and objectively reflect graduate students' innovation abilities and comprehensive qualities.

#### **4. Conclusion**

Relying on scientific research projects to cultivate graduate students' innovation abilities is a systematic and arduous task, which has profound significance for promoting disciplinary development and enhancing the level of medical research. Through a series of measures such as optimizing project topic selection, strengthening mentor guidance, improving practical platforms, and innovating evaluation systems, it is possible to create a good environment conducive to cultivating innovation abilities for graduate students, stimulate their innovative potentials, enhance their practical abilities and team collaboration spirits, and cultivate a batch of high-quality medical scientific research talents with solid professional knowledge, outstanding innovation abilities, and international visions.

Looking to the future, with the rapid development of medical science and technology and the continuous deepening of interdisciplinary integration, experimental animal science in medicine will face more new opportunities and challenges. We should continue to pay attention to disciplinary frontier dynamics, constantly explore and improve the cultivation mode of graduate students' innovation abilities based on scientific research projects, keep pace with the times, inherit the ancient and open up the new, inject continuous innovative power into the vigorous development of China's medical cause, and make due contributions to the cause of human health.

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