

Research on Mechanism and Path of Cultivating Innovative Ability of Postgraduate Students in Energy Colleges and Universities

Liudan He, Yujia Chen and Xiaoxue Zheng

School of Southwest Petroleum University, Chengdu 610000, China

Abstract

Deepening innovation and entrepreneurship education reform is a breakthrough in the current national reform of higher education, and an important breakthrough in the new era of "comprehensive implementation of quality education" in colleges and universities. Under the background of "dual-carbon" goal, talent strong country and other major national strategies, energy colleges and universities should take the responsibility of serving the national energy strategy demand, and undertake a special mission in helping to realize the "dual-carbon" goal. However, at present, there are insufficient investment in innovative thinking and practice, lack of interdisciplinary cross and deep integration, and ineffective quality management work in energy colleges and universities, which seriously constrain the ability of postgraduates' scientific research and innovation. This paper explores the mechanism and path of cultivation of innovation ability of graduate students in energy colleges and universities as the core research content, and clarifies the difficult problems in the current cultivation, which not only helps to put forward an important way to cultivate top innovative talents, but also can become one of the important grasps to promote the construction of energy colleges and universities in the construction of the new engineering discipline, and also can consolidate the internal development of comprehensive reform of education and the transformation of scientific and technological achievements of the universities.

Keywords

Graduate students; innovation ability; cultivation status; development paths.

1. Introduction

The report of the 20th Party Congress emphasizes the imperative to uphold that science and technology constitute the primary productive force, talent stands as the foremost resource, and innovation serves as the paramount driving force. The cultivation of innovative consciousness and abilities among postgraduates is deemed the wellspring of scientific and technological advancement. Particularly, energy-focused colleges and universities are urged to align themselves with national strategies and stay attuned to contemporary demands. It is only through the nurturing of innovative postgraduates that the continual advancement of scientific research fields and the infusion of fresh vigor into societal development can be achieved. As the vanguards of future society, postgraduates are expected to possess strategic vision and foresight. It is through the cultivation of innovative capabilities that they can emerge as pivotal forces steering future development [1].

China's postgraduate education has seen significant growth, with the current scale of postgraduate training surpassing ten million. However, the challenge remains to develop human resources in line with the country's energy development. Hence, there is an urgent call to explore effective methods and approaches for enhancing the innovation capacity of postgraduates. This entails bolstering their innovation literacy and skills to propel scientific

and technological advancements, address societal issues, foster industrial development, and contribute positively to the nation's sustainable growth.

Through investigating the mechanisms for cultivating innovation among postgraduates in Energy universities, we aim to glean insights from existing models and practices. By synthesizing lessons learned and identifying effective pathways and mechanisms within the realm of practical application, the dissertation seeks to complement and enhance existing findings. This endeavor will serve to enrich and refine the current body of research on postgraduate innovation training in energy-related fields.

2. Factors Affecting The Innovation Capacity of Graduate Students in Energy Colleges and Universities

Innovative ability pertains to the capacity of individuals or organizations to think independently, adapt flexibly, take bold initiatives, and ultimately generate creative solutions when confronted with novel problems and challenges. The factors influencing the innovation ability of graduate students in colleges and universities are multifaceted. These include individual factors such as the learning psychology of graduate students, their motivation to innovate, practical skills, autonomy in theoretical knowledge acquisition, and enthusiasm for social engagement. Additionally, exogenous factors such as the scientific research environment, curriculum design, teaching methodologies, evaluation techniques, social milieu, and innovative educational models also play significant roles[2].

Regarding individual factors, students' personal qualities such as a strong work ethic, innovative thinking skills, teamwork capabilities, and other inherent traits play a pivotal role in fostering innovation ability, exerting the greatest influence on the assessment criteria for graduate students' research and innovation prowess. Proficiency in fundamental knowledge and theories, coupled with personal drive for learning, enthusiasm for research, and a zest for innovation, significantly shape the development of postgraduate students' innovation capabilities in academic settings. The ability of postgraduates to engage in continuous and self-directed learning directly correlates with the depth of their knowledge and competency, with ongoing improvement in these areas serving as a cornerstone for nurturing innovation ability. A well-rounded and comprehensive knowledge base serves as the bedrock and sustenance for cultivating innovation prowess. Individual factors positively correlate with innovation outcomes, with graduate students serving as primary agents in innovation endeavors. Through sustained and deep engagement in scientific research practices driven by internal motivation, postgraduates gradually cultivate advanced levels of innovation ability through frequent and rigorous practice.

In terms of exogenous factors, graduate students, as an important component of the general environment, will inevitably be affected by the surrounding environment in the process of development and movement, resulting in different learning concepts and behaviors, especially in the academic atmosphere. If they cannot fully satisfy the personalized needs of the learners, it will be very difficult to promote the bidirectional flow of information on innovation education. Academic atmosphere mainly includes group behavior, scientific research inheritance, interpersonal communication, etc. The academic atmosphere in colleges and universities should be positive, encouraging students to actively participate in academic exchanges, discussions, and advocating the spirit of innovation, and a positive and open scientific research atmosphere can often give rise to more new ideas and new thinking; Education and training, mainly reflected in the education system and curriculum, tutor and team support, academic resources and research conditions, practice opportunities and innovation programs, and so on. The most basic and key link in the cultivation of innovation ability of graduate students in energy colleges and universities is knowledge education, and the specific education methods

and action strategies will have an important impact on graduate students' learning attitude and motivation. At this time, exogenous factors constrain individual factors, which is not conducive to the effective cultivation of graduate students' innovation ability.

3. Problems Facing the Enhancement of Innovative Capabilities of Graduate Students in Energy Universities

3.1. Inadequate mechanisms for innovative training of graduate students

The innovation training mechanisms in many energy colleges and universities are predominantly designed with a holistic view of students, lacking specific policy directives tailored to the innovative training of postgraduate students. This deficiency impacts the satisfaction levels of some graduate students with the university's postgraduate training mechanisms. The inadequacy is particularly evident in aspects such as the academic research atmosphere, the academic evaluation mechanism, and the incentive system[3]. Specifically, universities often exhibit a weak innovative academic atmosphere, insufficient innovation incentive mechanisms, inadequate policy support, and limited academic exchange activities. These factors constrain the broadening of horizons and stifling of innovative thinking among graduate students. Consequently, the innovation motivation of graduate students gradually wanes, impeding their ability to serve as drivers for learning and innovation motivation, thus hindering the quality of innovation training.

Furthermore, while many energy colleges and universities focus on theoretical teaching and practical training to cultivate graduate students' innovation abilities through innovation education, they often overlook the importance of material and spiritual rewards. Some institutions lack robust scholarship and reward systems for scientific research achievements. Consequently, postgraduates may not receive adequate respect and recognition for their innovation efforts during their learning and growth processes. This gradual erosion of innovation motivation can lead some postgraduates to perceive the costs of innovation as disproportionate to the rewards. Consequently, they may prioritize immediate employment concerns over sustained and in-depth engagement in scientific research and innovation practices.

3.2. Insufficient innovation consciousness and innovation ability of graduate students

Consciousness is the precursor and foundation of individual action, and innovative consciousness is the starting point for carrying out innovative activities. The lack of innovative consciousness seriously hinders the enhancement of innovation ability, and also becomes a bottleneck problem affecting the cultivation of high-quality talents in energy colleges and universities in China . On one hand, many students lack a strong sense of innovation consciousness, and they may not actively pursue innovation goals or demonstrate a willingness to engage in innovative tasks voluntarily[4]. Despite recognizing the importance of innovation, students often exhibit insufficient initiative and enthusiasm to undertake innovative endeavors. Some graduate students adopt a utilitarian mindset and lack genuine interest in academic research, preferring to adhere to conventional practices rather than embracing innovation. While a portion of students may possess some degree of enthusiasm for innovation, their wavering commitment, lack of self-discipline, and unclear study and research plans often lead to abandonment of tasks and unsatisfactory innovation outcomes.

One contributing factor is the traditional indoctrination learning mode prevalent during undergraduate studies, which contrasts with the independent inquiry learning mode characteristic of graduate studies. This transition can result in an inadequate knowledge structure, limited breadth of knowledge, and hindered innovation capabilities. Additionally,

some graduate students fail to actively engage in their supervisors' and institutions' projects and rarely participate in academic activities both on and off-campus, thereby missing opportunities to hone their scientific research and innovation abilities. Furthermore, there is a lack of strong social insight among some graduate students.

According to relevant surveys, the Internet penetration rate in China is as high as 70.4% . Despite the abundance of network resources available, some students primarily focus on recreational activities and entertainment, neglecting opportunities to gather information effectively. They often fail to pay sufficient attention to pressing societal issues, hindering their ability to develop a deep understanding of real-world problems and identify their underlying essence. Moreover, a lack of practical ability is evident, exacerbated by imbalanced professional development and inadequate project distribution and financial support within energy colleges and universities. As a result, certain students have limited opportunities to engage in scientific research, competitions, and practical activities. Coupled with a deficiency in dialectical thinking skills and creative problem-solving experience, this situation contributes to the overall level of graduate students' innovation consciousness and abilities.

3.3. Incomplete curriculum system of innovation education for postgraduates

The quality of organization and implementation of theoretical pedagogical activities plays a pivotal role in determining the level and efficacy of postgraduates' innovative abilities. Without a solid theoretical foundation, the efficient development and significant advancement of innovation capabilities become challenging to achieve. Currently, energy colleges and universities have yet to establish a diversified and in-depth theoretical course system. Teaching objectives are primarily focused on the acquisition of professional knowledge and skills. However, some professional courses feature outdated content, lacking the latest research findings and remaining stagnant at the undergraduate level. This deficiency results in a lack of cutting-edge and challenging material for students. Moreover, the teaching format predominantly relies on lecture-style instruction, with knowledge dissemination being prominent. The absence of practical elements creates a gap between theoretical knowledge and its real-world application.

Furthermore, the course offerings tend to be limited in variety, with fewer options for independent innovation and entrepreneurship courses. Most of these courses remain elective, and there is minimal integration of innovative education into professional courses. Additionally, interdisciplinary integration remains largely underdeveloped. As a result, the educational landscape lacks opportunities for cross-disciplinary collaboration and exploration. Therefore, the current curriculum teaching system fails to foster the cultivation of graduate students' innovation abilities and the enhancement of their overall quality. The predominant focus on traditional theoretical teaching results in a lack of diversity and depth, hindering the enrichment of graduate students' knowledge structures and skill levels. Therefore, there is an urgent need to creatively adjust the education system of postgraduate programs and establish a new system that aligns with the innovative development of postgraduates in the new era. This calls for innovative approaches to curriculum design and teaching methodologies that prioritize practical application, interdisciplinary learning, and the cultivation of critical and creative thinking skills. By reimagining the education system for postgraduate programs, universities can better equip students with the necessary competencies to thrive in an increasingly complex and dynamic world.

3.4. Poor integration of innovation and practice platforms for graduate students

The essence of cultivating graduate students' innovative abilities lies in translating innovative thinking and skills into tangible practices that yield new outcomes. Therefore, fostering

graduate students' innovation capabilities entails more than just theoretical learning and the development of thinking styles; it also involves acquiring innovative knowledge, resource utilization, problem-solving, result output, and transformation abilities. However, current challenges exist within energy colleges and universities, as they lack practical platforms to effectively stimulate the innovation potential of postgraduates in their education and training endeavors. This gap is particularly noticeable in liberal arts disciplines. Whether it's laboratories and research centers supporting scientific research or digital environments facilitating innovation education, various factors affect their utilization, significantly diminishing the role and advantages of innovation education.

Although there are a number of relevant disciplinary competitions, technical competitions, practical training courses, social participation and industry-university-research cooperation aimed at improving students' practical skills, there are problems in terms of integration, consistency and participation rates. These challenges hinder graduate students' intrinsic motivation to innovate and hinder their ability to practice and innovate effectively. Furthermore, there are limited opportunities for high-level academic exchanges, and postgraduates lack platforms to showcase their research abilities and findings. These factors collectively impede the creation of a conducive innovation atmosphere and limit postgraduates' exposure to diverse innovative perspectives.

4. Suggestions to Enhance The Innovation Ability of Graduate Students in Energy Colleges and Universities

4.1. Improve the innovation training mechanism of energy characteristics and form synergistic educating synergy

The current situation and emerging tasks underscore the urgent need for policy support to guide higher education management levels, particularly in service of the "double carbon" goal. Relevant areas should be strategically aligned within the overall framework, utilizing coordinated disciplines and specialties, implementing special enrollment plans and reinforcing traditional professional strengths. This entails integrating high-level educational resources, meeting national development talent demands, and enhancing the capacity to supply skilled individuals.

Energy colleges and universities must delineate the direction for postgraduate innovation and cultivation, employing systematic thinking and robust top-level design. Prioritizing core issues, colleges and universities should establish and refine postgraduate education and training systems, leveraging the postgraduate students responsibilities in management and nurturing. Enhancements across education, cultivation, academic achievements, and degree conferment mechanisms are crucial for bolstering innovation and cultivation systems. Improving scholarship and loan policies, along with incentivizing individual postgraduates, is essential[5]. Formulating academic evaluation mechanisms tailored to postgraduates' realities can better stimulate internal motivation for innovation, facilitate high-level research endeavors, and yield superior research outcomes.

Utilizing the nurturing role of synergistic education. Energy colleges and universities, particularly those specializing in petroleum studies, have historically fostered strong partnerships with enterprises, establishing a solid foundation for industry-academia integration and international collaboration [5]. Through collaborative innovation initiatives, such as the "three synergies" cultivation mechanism encompassing university-enterprise-government collaboration, university-research collaboration, and international cooperation, these institutions have propelled the integration and advancement of industry-academia-government-research sectors.

The establishment of collaborative innovation communities provides distinctive innovation topics, practical platforms, and academic exchange opportunities for graduate students in energy colleges and universities. This environment nurtures students' understanding of research methodologies, cultivates innovative thinking, and enhances their practical innovation capabilities. Leveraging external social resources, can foster a collaborative education model both within and outside the university. This approach encourages postgraduates to participate in domestic and international conferences and collaborate with leading enterprises across various industries, facilitating platform creation, resource sharing, and synergistic development.

By strengthening the links between industrial, innovation, value, and talent chains, we not only provide ample financial support, venues, facilities, and technology for joint postgraduate innovation and practical training but also bolster students' enthusiasm for innovation and practice. This collaborative approach enhances the capacity for innovative collaboration and ultimately bridges the gap to effectively nurture innovation capabilities and enhance innovation quality, thus achieving the last-mile delivery of innovation education.

4.2. Create an excellent innovation atmosphere and cultivate the perception of innovation atmosphere in colleges and universities

The cultivation of innovation abilities among graduate students in energy colleges and universities necessitates a focus on fostering creative thinking, nurturing innovative personalities, and creating a high-quality "ecological" environment. A university's innovation culture plays a vital role in shaping graduate students' perceptions and behaviors towards innovation. A positive innovation atmosphere, perceived by students, provides stimuli and support for innovation, fostering stronger psychological expectations and beliefs in innovation, thereby encouraging more innovative behaviors.

To achieve this, energy colleges and universities should integrate ideological and political education, development concepts, innovative thinking, and academic ethics throughout all stages of graduate education. Graduate party members can play a pivotal role in modeling and guiding students towards embracing socialist core values and fostering positive energy. Teachers need to change the traditional education model of knowledge indoctrination, guide students to independent thinking, carry out the "flipped classroom", multimedia interactive education model. Emphasizing the autonomy and leadership of postgraduates, institutions can mobilize their enthusiasm for self-management, self-education, and self-development, aligning with personal development goals. At the same time build good teacher-student relationships, as well as interpersonal relationships among fellow students[6].

On-campus, cultivating an academic culture that encourages bold exploration, personality development, and inclusiveness is crucial. This fosters a subtle yet profound sense of cultural enrichment and innovation enlightenment among both faculty and students. Internally, prioritizing academic exchange activities and promoting cross-disciplinary communication platforms enhance academic integration. Externally, colleges and universities should strengthen academic forums and broaden access to institutions related to their majors. Encouraging graduate students to participate in university-organized academic forums and facilitating visits to key institutions broaden their academic horizons and expand their network. This holistic approach ensures the creation of an environment conducive to innovation and the holistic development of graduate students' innovation abilities[7].

4.3. Constructing distinctive academic programs and building energy-specific knowledge systems

Energy colleges and universities must continue to enrich the essence of disciplines, leveraging the synergies among them to establish an organic unity encompassing core, backbone,

supportive, and distinctive disciplines. This entails enhancing the quality of discipline construction and expediting the development of a first-class discipline system characterized by energy specialization.

Emphasis should be placed on enhancing the foresight and strategic planning of discipline construction, adopting a classification and integration approach to drive advancement in strategic areas and urgently needed national technologies. This includes expanding into the field of green energy and prioritizing the development of disciplines with significant potential impact.

Moreover, there should be a focus on fostering new cross-disciplinary initiatives and leveraging traditional disciplines and technological strengths in emerging energy fields. For instance, techniques from the oil industry, such as drilling technology, can be repurposed for geothermal energy collection. Additionally, efforts should continue to diversify energy supply through initiatives such as expanding unconventional oil and gas exploration, including shale oil and shale gas.

Colleges and universities should design graduate training programs tailored to the unique characteristics of energy education, building a distinctive knowledge and innovation system comprising core degree courses, specialized curriculum, and cutting-edge lectures. This approach strengthens the pivotal role of graduate students within the energy academic landscape, positioning them as leaders in driving innovation and advancement[8]. Through the characterization of the postgraduate curriculum system, including the characterization of the content curriculum, the characterization of the course content and the reform of the teaching and evaluation system, broaden the connotation and extension of the postgraduates' characteristic knowledge system of energy, and form an organically unified and mutually reinforcing mode of postgraduates' innovation ability cultivation.

4.4. Broaden the way of scientific research practice and improve the innovation ability of graduate students

Firstly, colleges and universities should proactively increase the proportion of courses dedicated to scientific research practice as a potent method to cultivate the innovation capabilities of graduate students. Scientific research practice, with postgraduates taking the lead, fosters diverse and innovative research methodologies and ideas. Institutions should progressively enhance and deepen scientific research practice, with a clear emphasis on the central role of graduate students. This approach ensures that students develop a sense of ownership and mastery over specific research projects.

Moreover, colleges and universities should systematically develop innovation platforms and promote the establishment of collaborative practice bases with enterprises. By actively engaging with social enterprises and local entities, colleges and universities can design practice projects that align with the professional direction of each discipline. For instance, finance students could engage in securities investment and fund management practices, while logistics students might participate in supply chain management projects. Similarly, students in oil and gas programs could undertake projects related to oil and gas management and exploration, while accounting students might focus on environmental protection, sustainable development, and ESG initiatives. This tailored approach allows students to enhance their professional practice abilities based on their backgrounds and interests.

Secondly, students should be encouraged to participate in team competitions and collaborative endeavors. By sharing competition information and establishing communication groups, students can integrate personal development with collective practice, thereby enhancing teamwork, communication skills, and group achievements.

Furthermore, the collaborative training model can also provide graduate students with practice platforms and exercise opportunities. Theoretical studies and research projects undertaken by

postgraduates should achieve tangible goals through close cooperation across these sectors. Additionally, research endeavors should be closely linked to various practical application scenarios, enabling students to continuously enhance their innovation, scientific research, and independent thinking capabilities. Energy colleges and universities should leverage diverse and open innovation platforms, strengthening the connection between theoretical research and real-world practice. By promoting industry-university-research cooperation and encouraging student participation in research activities, institutions can effectively nurture the holistic development of graduate students in energy-related fields.

5. Summary

Energy colleges and universities should enhance the cultivation of graduate students by advancing high-quality graduate education. Graduate students represent valuable assets for society and the nation, and their potential should be maximized through advanced innovation education.

Through innovative education mechanism and research environment, perfecting research and practice platforms, and improving discipline curriculum system, etc, colleges and universities can effectively manage both individual and exogenous factors that influence the quality of graduate students' innovation abilities, thereby fostering the development of their practical innovation capabilities. This paper outlines the challenges faced by energy colleges and universities in enhancing the innovation abilities of graduate students and proposes several ideas and suggestions to serve as a research foundation for exploring innovative models for graduate student innovation ability cultivation in the future. Additionally, it aims to provide insights for the cultivation of innovation abilities among graduate students in colleges and universities.

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