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Exploration of Innovative Education Reform for Graduate Students in Electrical Engineering

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Abstract: For all the remarkable gains higher education has scored, many challenges still lie ahead of the postgraduate construction in the context of the expanding scale of postgraduate enrollment, the construction of "double first-class" as well as the laws of the new engineering discipline, all of which affect the innovation in academic research. Due to this significance, the main objective of this paper was to insist on and fully implement the student-centered premise, and innovate the talent cultivation mode and mechanism system by adjusting the ways and methods of education and teaching. For validation, this paper endeavors to stimulate the vitality of postgraduate learning, promote the reform and development of electrical education, and is well in progress in improving the quality of talent cultivation amid the new engineering education. Herein, we used a questionnaire, and surveyed a sample of 300 postgraduate students to explore current bedrocks in academic research innovativeness and propose the appropriate solutions, amid the aspects of the training program, research team, teaching program, assessment system and make requirements for the teaching of professional postgraduate students in all aspects, as a work to form a good cultivation mode in the process of “double first-class” construction, and deliver high-quality inter-disciplinary talents to the society and the country.

1. Introduction

For all the drawbacks like the changing international situation and the COVID-19 epidemic around the world, China pursues a road of reforming postgraduate students together with other countries[1]. The United States makes full use of the model of market principles, characterized by adaptability, high flexibility, openness, and combines basic research with research based on diversity, forming a new model of combining and emphasizing research-based master's and specialist master's training[2]. Postgraduate training in the UK has formed a prominent feature of professional academic institutions and disciplinary teams as the main, which is more conducive to showing the characteristics of schooling[3]. At this point, the strengths of the discipline are promoted through research collaboration within institutions and teams[4].

On this very note, the trend of diversification and flexibility in postgraduate training in foreign countries has provided useful reference for the development of standardized, autonomous, dynamic and distinctive for both academic and professional degree postgraduate education in China[5].

Postgraduate education, as an essential part of the national innovation system, has caused the introduction of several new policies and corresponding adjustments in the educational structure. In this connection, the demand for talent for innovative, technology in key areas and at the forefront of scientific research is booming rapidly in China. The cultivation of professional master's students has become an inevitable requirement for China's economic development and the training of high-level technical talents[6]. That means the work of postgraduate education reform still has a long, hard journey to go before it can achieve the corresponding increase in the requirements for innovation and quality in postgraduate academic research along with the expanding of the scale of postgraduate students for all[7].

2. Background

2.1. Expanded postgraduate enrolment

Science and technology are closely linked with education, so the phenomenon of graduate enrollment expansion may continue to exist. This is undoubtedly a greater challenge for colleges and universities, which means that teaching resources should be more suitable for the current graduate education, and the faculty of colleges and universities will increase accordingly[8]. A host of graduate students and doctoral students will enter colleges and universities to study, thus producing a large number of high-quality scientific research achievements. As for society, the expansion of postgraduate students has suspended the employment pressure, and when the major enterprises resume their production work, the shortage of talent will be replenished and the relevant system construction will be improved, which will help to enhance the scientific and technological strength of China[9].

2.2. New energy development reform

As the national goal of "carbon neutrality" and "carbon peaking", it has become a trend to encourage the development of new energy sources. In the daily education of postgraduates and the study of the curriculum, we should pay more attention to the infiltration of the new energy transition. Herein, we take the discipline of electrical engineering as an example. Based on the characteristics of electrical engineering, colleges and universities need to make corresponding guiding reforms in the postgraduate courses[10]. In addition to the in-depth study of the energy Internet, more penetration of cross-disciplines is described as a clean, low-carbon, safe, and efficient energy system and promotes the development of new energy storage and high-quality rules[11].

3. Research Question

In a bid to improve the academic creativity of electrical engineering postgraduates, this study explored the following research question by investigating the views of postgraduate students at different levels on academic innovation: *how to foster creativity in academic research?*

4. Methods

4.1. Study Context

This study is open to all electrical engineering postgraduate students, and aims to get to the heart of the many issues that affect the innovativeness of academic research by analyzing the many problems that they all face in reality.

4.2. Participants

Three hundred postgraduate students in electrical engineering took part in the study, as shown in Figure 1. The participants were representatives selected from different laboratories. Among others, 150 students left their contact details as a sample to express their willingness to follow up on the further progress of the study and to contribute to the follow-up survey. The participants, whose academic research requirements differed according to their year level, discussed their own and their cohort's research innovations in light of the real needs of academic research.

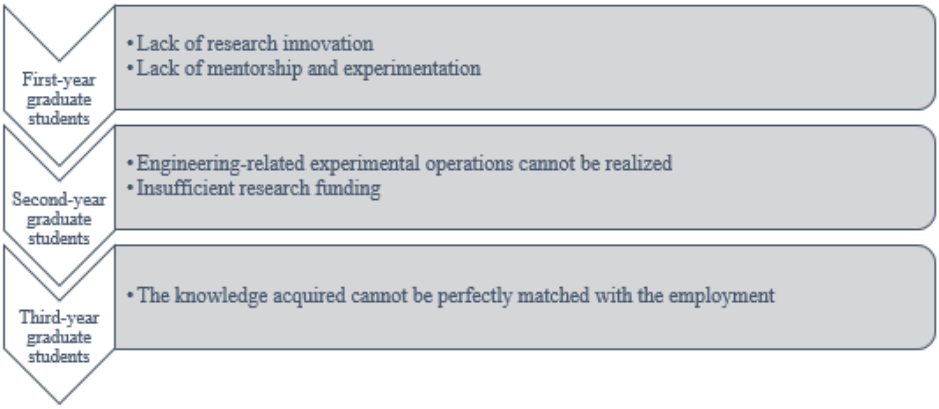

Figure 1: Reasons for constraints on academic creativity by grade levels

4.3. Data Collection

The aim of this interview, conducted in 2023, was to explore students' understanding of the creative power of academic research. Their views on innovativeness are discussed on the experiences both inside and outside of school learning and corporate partnerships, including questions such as:

- What are the current problems in postgraduate study?
- What are the gaps between yourself and your goals and what are the reasons for such gaps?
- What aspects of your creativity are currently constrained?
- What are some good suggestions and ideas for improvement?

4.4. Data Analysis

In recent years, with the expansion of postgraduate enrolment, more and more undergraduates have moved on to new levels of study. At the same time, this has brought many problems. Different students face different academic research problems[5], and different internal and external factors that limit their academic research innovation[12]. The question of how to ensure that students can improve their academic research innovation while acquiring learning outcomes has become an issue of concern[13]. In this regard, the following survey was conducted[14].

We used the internet questionnaire and the survey questions were transformed into QR codes or web links. Some students from major universities were allowed to answer the questionnaire online through social software such as WeChat. The questionnaire was open to all electrical engineering postgraduates, with a total of 300 participants, of whom 35.68% were first-year postgraduate students, 46.15% were second-year postgraduate students, and 18.46% were postgraduate students in their third year and above. The questionnaires were distributed randomly and with a certain degree of generalisability. The questionnaire data were analyzed using graphical analysis. And the corresponding data was shown in Figure 2.

As for the survey of the problems encountered in the current study and research. The results of the

survey show that 44.62% of the students have difficulties in reading and refining literature, and this problem is concentrated in the first year of study in the sample year. 63.08% said that the high pressure of research directly affects the ability to innovate in academic research. In addition, 64.62% of the students reported difficulties in programming, which limits further innovation in new optimization algorithms, scheduling, load forecasting and wind power forecasting.

This issue was further investigated and analyzed and the results obtained were as follows.

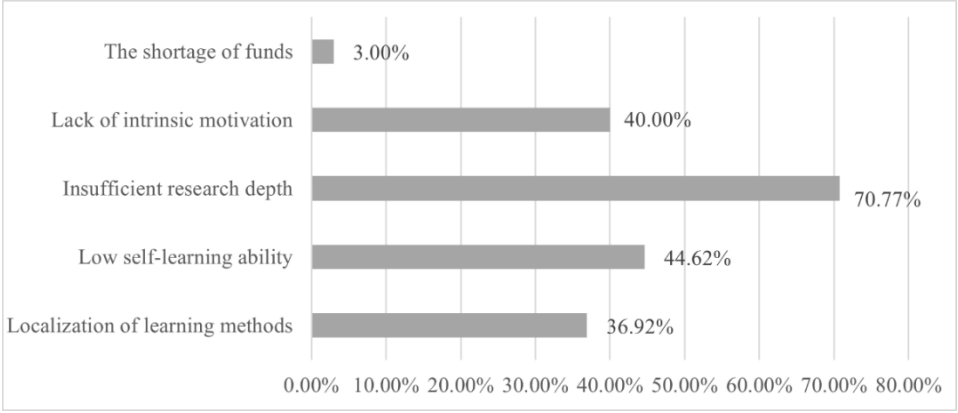

Figure 2: Reasons for the difficulties encountered by the Scientific Research Institute

As the graph shows, 70.77% of students believe that creativity is hampered by a tendency to 'intellectualize' learning and a lack of depth in research. In addition, some students said that the lack of funding for research hindered the process of research and thus prevented innovations from being realized.

For innovative topics we conducted a survey on the sources of innovative topics at the beginning of the study, based on the fact that practical activities and school-enterprise cooperation can, to a certain extent, improve students' practical and creative abilities, we also conducted some discussions as follows.

At the beginning of the research period, 70.77% of the students thought that the guidance of their supervisors had a great role to play; 84.62% of the students thought that literature reading could be ofgreat help and guidance in the initial search for innovative topics; in addition, 12.31% of the students relied on some hot and popular news to find innovative topics. And the corresponding data was shown in Figure 3.

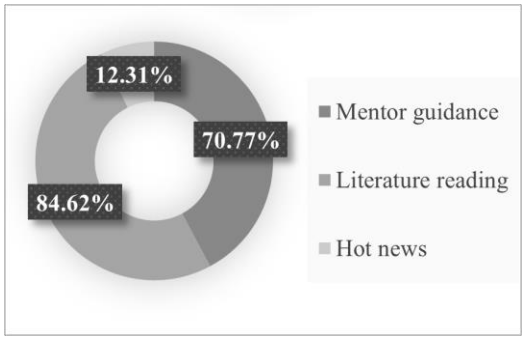

Figure 3: Source of initial innovative topics

The survey of practical activities and school-enterprise cooperation concluded that there is an urgent need for postgraduates to upgrade from both of them.

According to the sample, 86.15% of the students have never participated in a subject-related school-enterprise collaboration, while at the same time, only 21.54% of the total number of postgraduates have participated in practical activities. The current academic problems of the first-

year students are focused on reading and extracting theses. Some of the ideas are rather hollow when reading the thesis and cannot find innovative points that can be broken through[15]. For subjects that require experiments, there is a lack of appropriate guidance and it is difficult to find innovative points in the experimental process. The second-year students mainly focused on practical issues. There are fewer opportunities for practice and the available practice does not quite meet expectations. In addition to this, some data materials were outdated and old and not up to date due to the epidemic, and collaborative research on some activities was not effective. The third-year students should have laid the foundation for innovation in their first two years of study, but due to the combined pressures of employment and other aspects, they do not know how to apply what they have learned to their working lives, which to a certain extent limits the development of innovation[16].

5. Discussion

At the moment, most of the postgraduate courses in electrical engineering are following the traditional basic curriculum, without updating new theoretical content timely, students have a far cry from lacking practical hands-on training on the one hand, especially the experimental manipulation of new energy sources in electrical engineering[17]. In addition, students do not have a firm grasp of the professional fundamentals of electricity, electronics, and control on the other[18]. In so doing, there is a serious impediment to the development of innovation in academic research, and their ability to apply the knowledge needs to be further strengthened.

The extensive expansion of graduate students has both advantages and disadvantages. The increase in the number of students in the group has greatly enhanced the academic atmosphere and the ability to collaborate within the group, but it has also led to a number of problems such as the shortage of laboratory equipment. In this regard, every effort should be made to arrange the rules and regulations for the use of experiments and to provide more experimental equipment to meet the normal research progress of graduate students.

What’s more, the curriculum system and cultivation mode of professional degree postgraduates need to be updated and optimized, and the classification and evaluation system is not yet perfect[19]. At this point, the proportion of practical courses, case courses, professionalism courses and other application courses focusing on practical engineering problems corresponding with the needs of the industry is still well on track. The teaching of practical courses is lagging far behind theoretical teaching, which endeavors to develop further enhance practical teaching and improve the ability of professional degree students to apply theoretical knowledge to solve practical engineering problems[20].

The cultivation of professional degrees for postgraduates should give priority to enterprises, as it works to form a joint mechanism of university-enterprise scientific research[21]. On this very note, the participation and completeness of the cooperation between the subject group and enterprises in the training process of postgraduates have yet to be strengthened[22], as a result, the university has to improve its support for the transformation of scientific and technological achievements of enterprises and has not strengthened the cultivation of practical ability elements for the characteristics of professional degree postgraduates. [23]

Although the process management and quantitative assessment mechanism of engineering practice have achieved some results, there is still a need for further efforts. The participation of professional degree students in engineering practice can better promote the integration of basic theory with engineering practice and enhance students' professional skills[24]. Due to the process management and supervision mechanism still needs to be improved, to a certain extent, it causes the lack of relevance of the engineering practice of professional masters and makes it difficult to effectively improve the practical working ability of professional masters. [25] Secondly, for the assessment and

evaluation of professional degree postgraduates, there is no refined assessment, lacking the examination of practical ability, innovation ability, and practical effectiveness of postgraduates[26]. In this context, the graduation requirements of professional postgraduates are too lenient and lack a sense of exploration[27].

6. Specific reform measures

6.1. Reform of training program

Alongside that, we are sober-minded that focusing on theoretical learning should also correspond with the strengthening of the practical operation. In this connection, the basic knowledge of professional courses should be combined with reality. We should keep abreast of the latest developments in the energy field, keep up with the times, respond to the latest needs of society, pay active attention to social development relating to the practical aspects of life, and truly put learning into practice. As the electrical program is a highly integrated subject, it is important to combine the teaching of strong and weak electrical knowledge with computer software and control circuit hardware. In this connection, as a way to the development of the academic ability of postgraduates, it should be combined with the teaching of professional basic experiments, linking theory with reality, and comprehensively cultivating the practical ability and scientific research academic ability of postgraduates[16].

6.2. Reform of research group

The same group should communicate more, discuss topics together, discuss emerging research directions in academia, pay more attention to new trends in the fields, and take the initiative to share them. At the same time. It is also important to establish a school-enterprise cooperation model, actively explore cooperation opportunities with relevant enterprises outside the university, and also actively employ enterprise experts to come to the university for practical guidance and other operations to establish a stable and united cooperation mechanism and make full use of enterprise resources[12]. Finally, universities should ensure that experimental resources are adequately equipped and create more opportunities for mutual learning, as shown in Figure 4.

Figure 4: Specific reform measures

7. Conclusions

Based on the changes in the post-epidemic era, postgraduate education is once again facing challenges. In this regard, this paper proposes some feasible solutions for the cultivation of postgraduate students in electrical engineering, to ensure the innovativeness and quality cultivation of postgraduate students in electrical engineering under the premise of expanding the scale of enrollment, new energy policy, and the background of "double first-class". At the same time, a questionnaire on the innovativeness of academic research is used as an example to propose specific measures and encourage the pursuit of humanistic literacy in the process of scientific research, to

cultivate young people of the new era who are ideal, competent, responsible, and moral.

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