

# Analysis of the Guidance and Promotion of NSFC on the Cultivation Mode for Professional Degree Postgraduate Education

Lu Xia<sup>1</sup>, Yu Feng<sup>2,\*</sup>, Hao Yin<sup>3</sup>

<sup>1</sup>School of Water Resources and Environment, China University of Geosciences (Beijing), Beijing, China

<sup>2</sup>Graduate School, China University of Geosciences (Beijing), Beijing, China

<sup>3</sup>Department of Science and Technology, China University of Geosciences (Beijing), Beijing, China

\*Corresponding Author.

## **Abstract:**

At present, many key technologies in some fields are insoluble that restricts the development of human science and technology. And a large number of innovative, compound, and application-oriented talents are needed in the world. National Natural Science Foundation of China (NSFC) plays a promoting role in the development of professional degree postgraduate education. In this paper, there is a quantitative analysis of professional degree postgraduates of China University of Geosciences (Beijing) from different aspects, including dissertation, the number of SCI papers published by postgraduates and journal impact factors. The results indicate that, more than 80% of professional degree postgraduates were involved in projects funded by NSFC during their degree education; the total number of SCI papers published by professional degree postgraduates and the annual number of publications per capita have grown most rapidly in the past 10 years; the NSFC is more favourable and helpful than other forms of foundation funding for professional degree postgraduates engaging in scientific innovation. Therefore, the NSFC promotes the reform of cultivation mode for professional degree postgraduate education and forms the development pattern of high-level innovative talents.

**Keywords:** *National Natural Science Foundation of China, Professional degree postgraduates, postgraduates training, Professional degree postgraduate education.*

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## I. INTRODUCTION

With the flourishing new wave of technological revolution and industrial transformation, international technological competition has become increasingly fierce, and the competition amongst major countries is increasingly exemplified by the competition among technology and

human talents. At present, there are yet some bottlenecks urgently need to break through key technologies in many fields. Therefore, it restricts the development of human science and technology [1-3], requiring a large number of innovative, compound, and application-oriented talents. The focus of postgraduate education has changed from developing academic postgraduate to vigorously expanding professional degree postgraduate in many countries such as the United States, Britain, France, Germany, Japan and South Korea [4,5]. In china, the National Conference on Postgraduate Education was held in July 2020, wherein General Secretary pointed out the directives for the development of postgraduate education in the new era [6]. Thus, China's professional degree postgraduate education has entered a new stage of development. Professional degree postgraduate education is the main channel for cultivating high-level applied professionals with innovative and practical abilities in China [7]. The National Natural Science Foundation of China (NSFC) is charged with the important task of promoting basic and innovative research, and it has played a facilitating role in cultivating innovative talents in basic and applied research [8]. The role of NSFC in postgraduate training and scientific research is also gaining attention. This study researches the status and role of NSFC in cultivating professional degree postgraduates by (1) analysing the cultivation status of such students in the China University of Geosciences (Beijing), (2) combining the characteristics of the cultivation mode of professional degree postgraduates, and (3) considering these students' dissertation, scientific research practice, and quality of results.

## **II. CURRENT STATE OF PROFESSIONAL OF PROFESSIONAL DEGREE POSTGRADUATE EDUCATION**

### **2.1 The Professional Degree Postgraduate Education**

The professional degree graduate education is to develop application-oriented and compound high-level engineering technology and engineering management talents who have mastered solid basic theories and broad professional knowledge in a professional field, have a strong ability to solve practical problems, and have certain innovation capabilities [9]. This is not equivalent to past Master of Engineering training and is even more different from higher vocational and technical training. With over 30 years of training practice exploration, people have a clearer understanding of full-time master's professional degree postgraduate students. Moreover, the training mode of professional degree postgraduate has been gradually improved, and the demand for professional degree talents has become increasingly larger in many countries. Facing the demands of social development and technological competition in the new era, the training of professional degree postgraduates will focus more on the training of innovative and practical abilities in basic engineering technology.

Britain and the United States have developed the professional degree postgraduate education for a long time. According to the UK Education Statistics Agency, the number of professional degrees awarded annually in the UK already accounts for 80% of the total [10]. Universities in the UK develop the practical ability of these postgraduate students through the cooperation with enterprises, and emphasizing the influence of enterprises and employers in professional degree postgraduate education. Therefore they make students, colleges and enterprises a good exchange relationship [11]. In the United States, the social recognition of the professional degree is very high, and it is connected with the industry qualification examination, taking it as a necessary condition to register for the practice examination. Hence, the number of professional master's degrees awarded has already accounted for 83.5% of the total master's degrees in 2012. And, the enrollment scale of professional degree postgraduate is still showing a growing trend.

In China, the Ministry of Education established a full-time professional degree postgraduate education system in 2009. And the professional degree postgraduate education has developed rapidly for decades, with the enrolment scale exceeding 50% of the total scale of full-time master's degree enrolment [12]. Moreover, the Programme for the Development of Professional Degree Postgraduate Education (2020–2025) was promulgated in 2020. According to the programme, professional degree postgraduate education should focus on major national strategies, key fields, and major needs of the society, and the enrolment scale should continue to expand, reaching about two-thirds of the total postgraduate enrolment scale by 2025. In the near future, the development of professional degree postgraduate education will be an inevitable choice for the economy and society to enter the stage of high-quality development. The enrolment scale of professional degree postgraduate students in China will continue to expand. At the beginning of the establishment of full-time professional degree courses, most universities still refer to the training mode of academic master's degree students in the training of professional degree students. A small number of these master's students engage in academic research by pursuing doctoral studies, but a majority of them engage in application-oriented work after graduation. This kind of talent development is very different from the developmental needs of the social industry. After nearly 10 years of exploration, the training model of professional degree postgraduate students has been gradually improved and the quality of training has also attracted great attention. Postgraduate students are truly integrated into all aspects of scientific research by participating in the research projects of their supervisors. Through the formulation of scientific problems; setting of research contents; proposal of research methods; design of research programmes; and even the collection, testing, and analysis of samples, etc., we inspire scientific innovation by improving the practical hands-on ability of postgraduates to achieve basic scientific innovation of high-level engineering technology.

## 2.2 Current Cultivation State of Professional Degree Postgraduates at the China University of Geosciences (Beijing)

The China University of Geosciences (Beijing) is one of the first 33 universities in China to establish a graduate school. It is a comprehensive research university mainly specialising in geology, resources, and the environment, and it encompasses professional degree postgraduate education in multiple engineering fields. Two disciplines—(1) geology and (2) geological resources and geological engineering—have been selected as the national ‘double first-class’ construction disciplines. Since 2009, the China University of Geosciences (Beijing) has been enrolling professional degree postgraduates, and Fig 1 shows the enrolment scale from 2009 to 2019. As the figure shows, the number and scale of enrolment of professional degree postgraduates have significantly increased year-on-year, while those of academic degree and doctoral degree have basically remained stable, and the scale of enrolment of academic degree postgraduates has even decreased slightly. It is gradually becoming a trend for the enrolment scale to shrink for academic degree postgraduates and expand for professional degree postgraduates, precisely in response to the current rapid economic and social development in China.

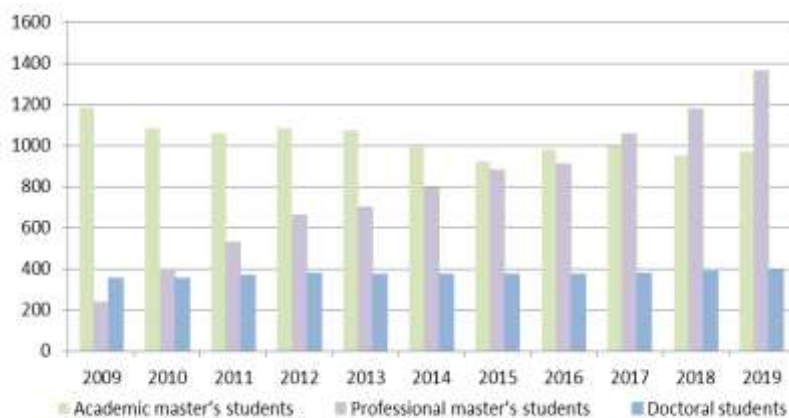


Fig 1: Enrolment scale of postgraduate students in the China University of Geosciences (Beijing) for the past 10 years

Based on the distinguishing and outstanding features of its geology disciplines, the China University of Geosciences (Beijing) has set up training objectives and development programmes for professional degree postgraduate students in various engineering fields, optimised the teaching curriculum system, strengthened the practical teaching components, and considered the industrial needs. The enrolment and training scales have exceeded 50% of the

total of full-time master's degree in the past 10 years. This study further analyses the training quality of professional degree postgraduates in the past 10 years in terms of the training system, dissertation, and scientific research achievements, and researches on the guidance and promotion of NSFC in the professional degree education.

### **III. POSTGRADUATE STUDENT PARTICIPATION IN RESEARCH FUNDED BY NFSC**

The postgraduates exercise and develop their innovative abilities by participating in their supervisors' research projects. The foundation of NFSC enforces important conditions that effectively ensure the quality of postgraduate training in China [13]. These projects are beneficial to the cultivation of postgraduates' innovative abilities. Projects funded by NFSC are closely related to the frontier of science and technology development and the urgent problems in social development from the topic to the content [14]. Therefore, the projects funded by NSFC emphasise innovation and provide opportunities for the innovative practice of postgraduates, which is beneficial to the cultivation of innovative thinking and innovative practice of postgraduates.

#### **3.1 Postgraduate Dissertation**

Postgraduates in China have been one of the main forces engaged in the research funded by NFSC, and the average workload of postgraduate students completing foundation projects accounts for 54.7% of the total project workload. The postgraduates basically carry out scientific research with the completion of their dissertations as the main mission, and the cultivation of scientific research ability is conducted throughout. By participating in projects funded by NFSC, postgraduates can understand the latest domestic and international research status and industry development needs, and their scientific research ability is cultivated and exercised through reviewing large volumes of Chinese and English literature, undertaking part of the research independently, participating in scientific experiments, and writing dissertations. Therefore, the postgraduate dissertation is a concentrated manifestation of the business quality and academic level of postgraduate education, as well as an important symbol of the level of postgraduate cultivation. The authors statistically analysed the degree dissertations of professional degree postgraduates at the China University of Geosciences (Beijing) during 2012–2019, and more than 80% of the postgraduates were involved in projects funded by NSFC during their degree education.

The China University of Geosciences (Beijing) graduated its first professional degree postgraduates in 2012, and the degree information statistics of excellent university-level

dissertations during 2012–2019 show that the share of dissertations with Scientific Foundation projects as the source of selected topics is higher. Scientific Foundation projects are the background of 80.22% excellent doctoral dissertations and 60.43% of excellent master's dissertations. The total number of postgraduate students participating in research work on projects funded by NSFC has continued to increase by 6.12 times from 2012 to 2019, with an average annual increase of 14.37%.

### 3.2 The Publication of Research Results of Professional Degree Postgraduates

The output of scientific research results is an important indicator of a country's scientific and technological prowess [15-18], and the publication of academic papers is an important part of scientific research activities conducted by postgraduate students. The authors counted the SCI papers published by postgraduate students at the China University of Geosciences (Beijing) from 2012 to 2019. Fig 2 shows that the overall number of SCI papers published by postgraduate students during their school years is growing rapidly. The proportion of papers published by postgraduate students to the total number of papers published in the university grew from 42.38% to 59.62%; thus, postgraduate students are a driving force of research innovation in the university. Further, the enrolment scale of doctoral candidate is basically flat, and the number of SCI papers published by the students as first authors shows high growth, with the total number increasing 4.5 times with the average annual growth of 27.68%, and the number of SCI papers published per capita per year has increased from 0.29 to 1.59. The total number of SCI papers published by academic master's students as first authors increased six times, with an average annual growth of 33.02%; the number of SCI papers published per capita per year increased from 0.02 to 0.14, a six-time increase. The total number of SCI papers published by professional master's students as first authors increased 16 times, with an average annual growth of 49.53%; the number of SCI papers published per capita per year increased from 0.01 to 0.11, a 10-times increase. It is thus concluded from Fig 2 that the total number of SCI papers published by professional degree postgraduates and the annual number of publications per capita have grown most rapidly in the past 10 years, and the overall training quality and innovation ability of students have improved significantly.

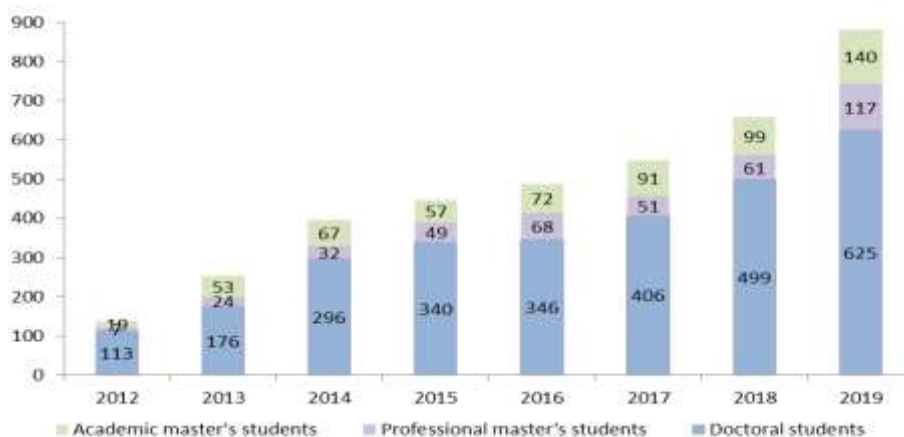


Fig 2: Publication of SCI papers by graduate students at the China University of Geosciences (Beijing) during 2012–2019

### 3.3 Analysis of the Participation of Professional Degree Postgraduates in Research Projects

From 2012 to 2019, nearly 4,000 SCI papers were published by postgraduates as first authors at the China University of Geosciences (Beijing). It shows the funding received by these studies is analysed in the Fig 3. And red colour represents the funding of China Geological Survey (CGS); green colour represents the funding of National Science and Technology Major Project of China supported by Ministry of Science and Technology (MOST); and blue colour, with the highest proportion, represents funding by the NSFC. Among the SCI papers published by doctoral students as first authors, 63.69% researches were financially supported by NSFC, of which 45.50% were firstly funded by NSFC and 22% were supported by major national projects. Among the SCI papers published by c as first authors, 67.18% researches were financially supported by NSFC, of which 51.64% were firstly funded by NSFC and 16% were supported by major national projects. Among the SCI papers published by professional master’s students as first authors, 86.57% were financially supported by NSFC, of which 60.45% were firstly funded by NSFC and 11% were supported by major national projects. It can be concluded from the above that the proportion of SCI papers published by professional master’s students as first authors is higher than that of doctoral students and academic master’s students, and the projects funded by NFSC are of great assistance to the innovative research activities of professional master’s students.

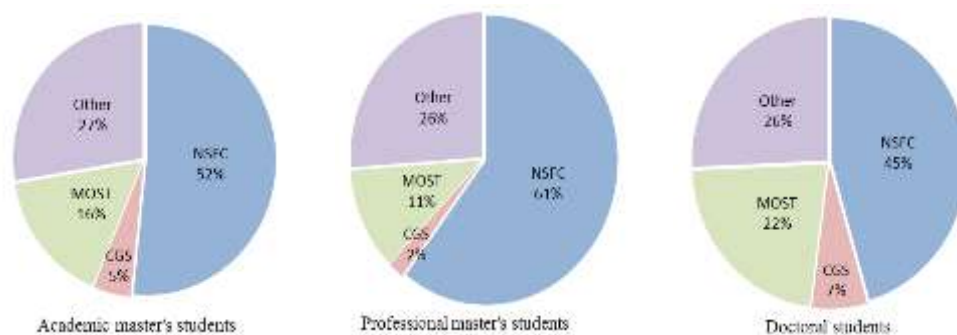


Fig 3: Situational analysis of funding for postgraduate students' publication of SCI papers in the China University of Geosciences (Beijing), 2012–2019 (NSFC: Fund of National Natural Science Foundation of China; MOST: Fund of National Science and Technology Major Project of China supported by Ministry of Science and Technology; CGS: Fund of China Geological Survey)

### 3.4 Qualitative Analysis of the Research Results

The impact factor (IF) is a statistical and evaluative parameter introduced by SCI for scientific journals [19-21], and it determines the ranking and level-grading of scientific journals in the Journal Citation Reports (JCR). The evaluation of papers has always been highly valued by scientific institutions, and the scientific and objective nature of using IF to evaluate the scientific level of some research institutions and predict their scientific development is recognised worldwide [22,23] (Sadegh and Massarrat, 2019; Frahm, 2014). Fig 4 shows the average IF of SCI-indexed papers published by professional master's students as first authors in the China University of Geosciences (Beijing) from 2012 to 2019. Figure 4 shows that the average IF of SCI-indexed papers published by professional master's students funded by NSFC increased gradually than the average IF between 2012 and 2009. Further, 2019 saw a record high IF of 3.21, indicating that the international recognition of academic papers funded by NSFC and the quality of these papers are steadily improving. In addition, according to Thomson Reuters, 34.60% of annual publications of journal papers have IFs in the top 25% in each disciplinary classification of JCR. The above conclusions indicate that most scientific research results published by professional master's students involved in scientific innovation are funded by NSFC, and compared with doctoral and academic master's students, the National Natural Science Foundation of China is more favourable than other forms of foundation funding for professional master's students engaging in scientific innovation.



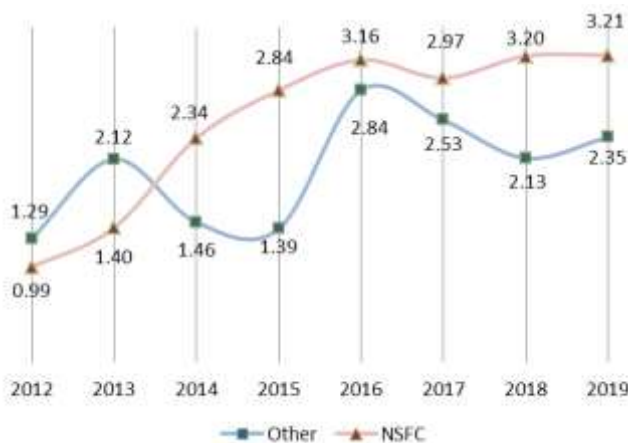


Fig 4: Average impact factor of SCI-indexed papers published by professional degree master's students in the China University of Geosciences (Beijing) from 2012 to 2019

#### IV. PROJECTS FUNDED BY NSFC LEAD THE PROFESSIONAL DEGREE POSTGRADUATE EDUCATION PARADIGM

The NSFC play an indirect role in the cultivation of professional degree postgraduate students, mainly by encouraging them to participate in the research of the foundation's projects, shifting the focus of its funding for young talents to the graduate stage, promoting the development of professional degree postgraduate education in China, meeting the urgent demand for high-level innovative talents in China, and providing strong talent support for the transformation and upgrading of the national industry and innovation development.

First, it promotes the improvement of SCI papers' quality for professional master's students. From the statistics of 2012 to 2019, the number of academic papers funded by NSFC has increased year-on-year, and the number of professional master's students participating in scientific research work of the projects funded by NSFC has continued to increase. The average impact factor of SCI-indexed papers marked with NSFC funding has increased gradually from 0.99 in 2012 to 3.21 in 2019, which is higher than the average IF. Professional master's students have gradually developed from pure 'mechanics' to high-level talents with both 'academic innovation' and 'application practice'.

Second, it has promoted the construction and development of professional master's disciplines and degree programmes. The National Natural Science Foundation of China is adapting to the phased development needs of basic research; coordinating the key elements of basic research; and gradually building a four-in-one funding pattern of exploration, talent, tools

and integration. Through the arrangement of various types of funding, it has promoted the optimisation and reorganisation of disciplines, enhanced core competitiveness, improved teaching and research conditions, and strengthened the development of the disciplines themselves. New professional master's degree programmes have gradually formed new disciplinary directives based on the research results of the funded projects. The several new disciplines have also gradually led to many new doctoral and master's degree programmes through the support and incubation provided by NFSC.

Third, the educational structure of professional degree doctoral training has been explored. In 2019, the state focused on major strategies, key fields, and significant social needs, and adjusted the master's degree in engineering (40 fields in total) into eight professional degree categories, including electronics and information, machinery, materials and chemicals, resources and environment, energy and power, civil engineering and water resources, biology and medicine, and transportation [24]. A further challenge for professional degree education will be the doctoral students and the establishment of knowledge systems for professional degrees in these large fields, all of which require a large number of scientists from interdisciplinary disciplines. The Department of Intersectional Sciences of the NSFC is oriented to major basic science problems and characterised by intersectional science research. Further, it coordinates and deploys research in intersectional fields oriented to major national strategic needs and emerging science frontiers, promotes multidisciplinary collaborative research on complex science and technology problems, promotes the construction of professional degree doctoral disciplines in forming large fields, explores the educational structure of professional degree doctoral training, and cultivates professional degree doctoral students with scientific talents of professional degree doctoral students with cross-scientific research paradigm.

## V. CONCLUSION

Given the new requirements of the new era, the demand for high-level innovative talents in various industries has become more urgent in the all world, and the status and role of professional degree postgraduate education has become more prominent. The NSFC plays a role by encouraging professional degree postgraduate students to participate in the research of its projects. This work explores the important position and positive role of the foundation in the training of students by statistically analysing the overall scientific research level of such students in the China University of Geosciences (Beijing) for 2012–2019. For this purpose, it used indicators such as the number of published papers, journal IF, and JCR partition from two perspectives: the dissertation and research practice of postgraduate students. Several high-level scientific research achievements have been produced through the funding of NSFC, which has favourably promoted the reform of professional degree postgraduate education in China and

formed the development structure of high-level innovative talents in China.

## ACKNOWLEDGEMENTS

This study was financially supported by Chinese Society of Academic Degrees and Graduate Education (Grant No. 2020MSA174) and Beijing Association of Higher Education (Grant No. YB202114).

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