

Exploration on the Cultivation Path of Graduate Students of Interdisciplinary Talents

Xiaoqing Yu¹, Jing Huang²

¹*School of Health Science and Engineering, University of Shanghai for Science and Technology, Shanghai, 200093, China*

²*Business School, University of Shanghai for Science and Technology, Shanghai, 200093, China*

Keywords: Interdisciplinary, Graduate Cultivation, the Cultivation Path of Interdisciplinary Talents

Abstract: Education is the great plan of the country and the Communist Party of China. Driven by various factors such as strategy, social development, and market demand, graduate education at the highest level in China's education system has received increasing attention, especially in the field of interdisciplinary graduate training. As a result, universities have entered an era of interdisciplinary research. Based on an analysis of the challenges faced in the development of interdisciplinary studies, a general path is presented for graduate education in interdisciplinary studies, taking into account the constructive case of the Academy for Advanced Interdisciplinary Studies at Peking University and the distinctive practices of other top universities in China. The general path starts from three aspects: the management system of interdisciplinary research platforms, the cultivation mode of interdisciplinary graduate students, and the resource allocation of interdisciplinary research, in order to strengthen the all-round, multi angle, and deep level development and integration of interdisciplinary fields, and cultivate advanced and innovative high-level talents.

1. Introduction

Multidisciplinary interdisciplinary training for graduate students refers to a training model that integrates knowledge from two or more disciplines as the main learning and research content, with the aim of forming composite knowledge, abilities, and qualities, and aiming to cultivate high-level talents who can solve complex interdisciplinary problems [1]. The development of modern science and technology indicates that interdisciplinary fields are most likely to cultivate advanced and innovative high-level talents who can solve major scientific and technological problems and social problems, and achieve significant scientific research results [2]. In order to promote universities to quickly respond to the country's demand for high-level talents and strengthen the development of emerging interdisciplinary fields, in 2009, the Ministry of Education issued the "Measures for the Setting and Management of Disciplinary Catalogues for Degree Awarding and Talent Training", which stipulated that degree awarding units can independently set and adjust second level disciplines and interdisciplinary fields managed according to second level disciplines under authorized first level disciplines. In January 2021, the Academic Degrees Committee of the State

Council and the Ministry of Education issued a notice stating that "interdisciplinary" has become the 14th discipline category in China. With the high attention and active promotion of the Ministry of Education, there are numerous "interdisciplinary" fields in China. As of June 30, 2022, the latest "List of Degree Awarding Units (excluding Military Units) Independently Setting Second level Disciplines and Interdisciplinary Fields" released by the Ministry of Education has included 5185 self-setting second level disciplines and 729 interdisciplinary fields, indicating that universities have entered an era of interdisciplinary fields. However, most universities in China are still in the initial exploration stage of interdisciplinary construction, and there are still many problems and challenges in the cultivation of interdisciplinary graduate students, and a universal paradigm has not yet been formed. How to establish a multi-dimensional, full process, and deep level interdisciplinary graduate education model is an urgent issue for many universities to conduct in-depth research, which has become a key focus of graduate education development and training model reform in various universities [3].

This article takes the Frontier Interdisciplinary Research Institute of Peking University as the main thread, supplemented by other key domestic universities, attempting to analyze the solutions in the successful cases of interdisciplinary graduate training in these universities, in order to extract a general path centered on interdisciplinary graduate training.

2. Difficulties in Interdisciplinary Graduate Education

2.1 The Inherent Management System of Universities Hinders the Development of Interdisciplinary Fields

Traditional disciplines have developed over a long period of time and, based on their own maturity, have formed unique research methods and scope. The long-term differentiation of disciplines has led to strict barriers between traditional discipline organizations, exacerbating knowledge gaps, personnel differentiation, cultural barriers, and hindering mutual infiltration and integration between disciplines [4]. On this basis, various higher education institutions in China have formed a traditional "school department" and "hierarchical" management model. This fixed management model objectively blocks the exchange and sharing of personnel and resources between different disciplines, thereby increasing the difficulty of interdisciplinary research and teaching. To achieve interdisciplinary integration, it means breaking the boundaries of existing disciplines, increasing scientific research exchanges, information interaction, and resource sharing among personnel from various disciplines.

Organizations are the foundation of management. In terms of organizational system, universities often do not establish separate physical organizational structures and management systems for cultivating interdisciplinary graduate students. The established interdisciplinary research organizations are mostly virtual, affiliated with existing departments, and lack strong organizational support [5], resulting in interdisciplinary research only falling on the plan and independent research in practice. Although some schools have established interdisciplinary research centers and explored interdisciplinary construction, most of the teachers are part-time, including administrative managers and mentor teams, and their work is not sustainable, resulting in many problems in actual operation.

2.2 The Traditional Training Model for Graduate Students Restricts the Cultivation of Interdisciplinary Talents

The three fundamental questions that must be answered in the development of higher education in China are "what kind of people to cultivate", "how to cultivate people", and "for whom to cultivate people". High level universities have developed a first-class graduate training model

through long-term improvement, covering enrollment management, training objectives, curriculum system, training process, and thesis content. However, this traditional single discipline graduate training model cannot meet the requirements of interdisciplinary graduate training.

Specifically, in terms of enrollment, it is constrained by traditional enrollment models, which either restrict cross disciplinary postgraduate entrance exams or mainly focus on a single subject knowledge point as the assessment content. This survival of the fittest system restricts the interdisciplinary development. In terms of training, China's graduate students adopt a mentor responsibility system, where each graduate student is usually matched with a mentor. However, this single mentor system cannot meet the requirements of interdisciplinary graduate training. In addition, the number of master's students is still relatively scarce, and the number of doctoral students is even scarcer. It is difficult for mentors to recruit difficult graduate students to conduct interdisciplinary research. In terms of curriculum design, a single subject based curriculum system is still in a dominant position. Although some universities have made improvements to the interdisciplinary curriculum system, most teachers are limited to their own fields of research and have not actively explored and reflected on cutting-edge interdisciplinary fields [6]. Therefore, currently, most universities only increase the number of courses in a small part of other disciplines, which only achieves a simple sum of the number of interdisciplinary courses, rather than the construction and reform of interdisciplinary integration of course content. This is in line with the elective system established by universities, which allows students to take a few credits of courses offered by other colleges on campus. Under this curriculum system, although students can gain knowledge from multiple disciplines and fields, it is difficult to establish an interdisciplinary thinking system unconsciously during the course learning process. As far as the thesis is concerned, there is still a lack of separate and clear interdisciplinary graduate thesis evaluation standards. This leads to degree theses that go beyond the boundaries of the discipline being matched with experts who are only deeply involved in the field during blind review, resulting in being rated as unqualified. This makes supervisors and students very cautious in selecting topics and hesitant to conduct interdisciplinary research.

3. Exploring the Path of Interdisciplinary Graduate Education

3.1 Building a Platform to Overcome Management System Barriers and Focusing on Interdisciplinary Talents through Institutional Innovation

Breaking down disciplinary barriers, eliminating fragmentation, and promoting interdisciplinary integration are prerequisites for the emergence of interdisciplinary studies [7]. Independent interdisciplinary research institutions, as carriers of interdisciplinary and interdisciplinary research, not only break down disciplinary barriers and provide legal space for exploring interdisciplinary boundaries, but also effectively promote the development of interdisciplinary research, promote scientific and cultural transformation, and institutional innovation.

Peking University (hereinafter referred to as "Peking University") established the Frontier Interdisciplinary Research Institute (hereinafter referred to as "Cha Yuan") in 2005, and matched a comprehensive and deep level comprehensive institutional system for the sustainable development of Cha Yuan: establishing six university departments to coordinate departmental resources; Taking solving key disciplinary problems as the original driving force, we introduce talents into three major categories: humanities and social sciences, science and engineering, and medical sciences, and build interdisciplinary research teams; Colleges and universities have not conducted performance evaluation according to the "signing articles" and "on-site projects" to solve the pain points of teacher title evaluation and employment. Colleges and universities implement the unified teaching workload system of the whole school, promote the participation of all teachers in interdisciplinary

research, increase the interaction and mutual assistance among teachers, and improve the quality and time investment of interdisciplinary curriculum design [8]. The Med-X Research Institute of Shanghai Jiao Tong University (hereinafter referred to as "Jiao Tong University") was established in 2007. Unlike the Peking University Branch School, the Med-X Research Institute of Jiaotong University focuses on the medical field and aims to solve clinical medical problems [9]. The research institute also adopts a combination of full-time and part-time employment to hire personnel from different professional backgrounds, aiming to establish an integrated innovation platform of "industry, academia, research, and medicine", fully reflecting the cross disciplinary characteristics of medicine and industry; The research institute is also matched with a specialized coordination agency, providing part-time professors with relatively independent policies: their department cannot arrange tasks arbitrarily, the research institute provides direct guidance, the project ends and exits the platform, and they return to their original department to work; In terms of evaluation, based on the characteristics of the team's research and development projects, evaluation indicators are classified and formulated to strengthen the evaluation of intellectual property technology and patents.

In addition to the two domestic "Double First Class" universities mentioned above, other universities are also paying increasing attention to the construction of interdisciplinary research institutions. Zhu Huawei et al. [10] conducted a survey of 46 domestic universities, and nearly 70% of them established corresponding interdisciplinary research organizations based on the development of their disciplines, such as the Cross Information Research Institute of Tsinghua University, the Qiushi Higher Research Institute of Zhejiang University, and the Industrial Science Research Institute of Wuhan University. It is an important trend for interdisciplinary development in various universities to use independent interdisciplinary research institutions as carriers and, based on their own characteristics, configure suitable and implementable institutional systems for sustainable development.

3.2 Relieve the Constraints on the Training Process through Model Reform

Cultivating innovative talents with composite knowledge, abilities, and qualities is an important mission of universities and an important goal of interdisciplinary construction. Actively adapting to the needs of social development and exploring interdisciplinary graduate training models are inevitable requirements for the development of interdisciplinary graduate education. According to the training process, the following four aspects can be explored:

3.2.1 Expand Enrollment Scope

Expanding the enrollment scope and achieving interdisciplinary excellent graduate enrollment is the first step in interdisciplinary graduate training, while ensuring the quality of teaching staff. To encourage interdisciplinary and integrated learning, some universities have adopted a single enrollment plan and encouraged students from different professional backgrounds to apply, in order to broaden their enrollment scope. For example, Peking University implements a separate enrollment plan for interdisciplinary subjects and establishes dedicated channel management [8] 115; at the same time, interdisciplinary applications are encouraged. In the field of life sciences, not limited to students majoring in biology and medicine, applicants from other science or engineering majors (such as mathematics, physics, chemistry, engineering, psychology, information, computer science, etc.) who have a strong interest and research creativity in life sciences are welcome to ensure the scale and quality of enrollment. Hohai University has also explored its enrollment model, similar to the Peking University campus, with a single enrollment plan for multiple interdisciplinary subjects; At the same time, attention should be paid to attracting students from different

professional backgrounds. For example, in the master's entrance examination for the interdisciplinary direction of smart water conservancy, it is explicitly required that excellent undergraduate students in computer science and technology, information and communication engineering, software engineering, mathematics, geographic information science, and other fields apply to ensure the necessary source of students for the development of interdisciplinary fields [11].

In order to promote the cultivation of versatile talents and help students with surplus resources gain better learning and growth experiences, some undergraduate institutions in China with a long history of education, strong faculty, and high teaching and research levels have implemented a full-time undergraduate minor major system, which allows full-time undergraduate students to study majors other than the undergraduate major category of their major on campus. Whether in undergraduate education or interdisciplinary enrollment, it is important to focus on these students and encourage and guide them to engage in interdisciplinary research.

Expanding the enrollment scope can attract students from different professional backgrounds to engage in interdisciplinary research. Students can communicate with each other, learn from each other's strengths and weaknesses, which can not only stimulate the enthusiasm for interdisciplinary and integration, but also play a positive role in a virtuous cycle.

3.2.2 Build a Mentor Team

China's graduate education adopts a mentor responsibility system, which indicates that mentors bear the focus of graduate education. Mentors not only guide graduate course learning and scientific research development, but also focus on cultivating students' independent analysis and problem-solving abilities, as well as sound personality and moral character. It is necessary to strengthen the construction of interdisciplinary mentor teams, establish a multi-disciplinary and all-round interdisciplinary and closely collaborative mentor team, and provide sufficient teacher support for student cultivation.

Peking University Chayuan has established a "project mentor" management model in talent cultivation, driven by projects. Through laboratory rotation, mutual selection between teachers and students is achieved, solving the management problem of cross disciplinary guidance for graduate students by mentors during the incubation and early development stages of the teaching discipline [12]. In addition, a "dual mentor system" is implemented from different majors: one professional mentor and one thesis mentor, jointly cultivating graduate students. Among them, professional mentors are responsible for student professional courses and related field issues, recommending thesis mentors based on student interests and thesis topics, and thesis mentors provide guidance on student thesis quality. Xi'an Jiaotong University has equipped a strong faculty team for medical and engineering interdisciplinary graduate students. It adopts a "three mentor system" of medicine, engineering, and enterprise, forming a graduate student with one medical mentor, one engineering mentor, and one enterprise mentor [13]. The mentors jointly develop training plans and construct curriculum systems, running through the entire process of student training. Sun Yat sen University has also formed a three discipline mentorship team for interdisciplinary graduate students in biomedical engineering. The mentors are divided into three categories: "science, engineering, and medicine", focusing on basic research on new principles, methods, and structures of biomedical sensing, developing new technologies for preparing biosensors, exploring and cultivating the innovative ability of graduate students at the source, and building their ability to solve important interdisciplinary problems. The multidisciplinary mentorship team focuses on project research and aims to solve problems [14]. Through joint training, it continuously enhances the breadth of graduate students' basic knowledge, skills in different disciplines, comprehensive problem-solving abilities, and innovation and creativity.

3.2.3 Improve the Curriculum System

The first year of graduate school is mainly focused on course learning. It is necessary to improve the interdisciplinary graduate curriculum system, effectively cultivate graduate students' interdisciplinary thinking ability, master necessary interdisciplinary knowledge and basic skills.

Nanjing Agricultural University has established a good curriculum teaching system by offering more than 10 compulsory and elective courses on the integration of advanced agricultural information science, software development methodology, data warehouse and data mining, as well as the integration of agricultural science and information science and technology. Among them, the cross core courses are uniformly prepared by subject specific teachers, and the course content is collectively agreed upon [15]. The teaching outline is regularly revised to ensure the cross cutting, cutting-edge, and scientific nature of the course content. The joint hospital and enterprises of Jiaotong University offer theoretical and practical courses for the biomedical engineering major, with project-based teaching as the starting point, allowing students to experience the entire process of project promotion and promoting a deep understanding of enterprise research and development output. The relationship between scientific research and practical courses adopts a combination of theoretical lectures, clinical visits, and hands-on practice, aiming to deepen the understanding of medical devices in clinical use among master's students [16]. Fu Yu et al. from Renmin University of China [17] studied the construction mode of interdisciplinary curriculum system. They believe that traditional curriculum groups are often simplified and understood as "curriculum collections" Even if we start to pay attention to the connections between courses, it is difficult to achieve deep coupling and system collaboration of courses. The fundamental reason is that traditional course group construction thinking often takes a single course as the smallest basic teaching design unit. To this end, they proposed building a knowledge framework around important concepts, using knowledge modules as design reference points, and using the "course cube" formed by deep coupling of multiple courses as the new minimum component unit to construct a complete new type of course group. Based on this, they constructed a core curriculum cube model for the discipline of information resource management, and then verified the practical operability and implementation effect of this model through the "frontline, three layers, and four courses" practical example. In addition, many universities such as Peking University and Beijing University of Aeronautics and Astronautics are actively building interdisciplinary cutting-edge courses, exploring the construction of interdisciplinary curriculum systems, and through knowledge correlation and knowledge progression, to better play the role of course learning in the cultivation of interdisciplinary graduate students.

3.2.4 Special Zone Management

The achievement of interdisciplinary graduate training goals cannot be achieved without the support and promotion of a corresponding and comprehensive interdisciplinary quality assurance system.

Peking University not only has a well-established system in mentor management, but also has established an interdisciplinary degree subcommittee responsible for discipline construction and talent cultivation quality. The school leaders serve as committee members and participate in actual work. Subsequently, the establishment of doctoral and master's programs in interdisciplinary disciplines has been successively completed, providing a pioneering institutional guarantee for the cultivation of interdisciplinary talents [8] 112. Similarly, Wuhan University has also established a degree evaluation committee composed of multidisciplinary experts, established quality evaluation standards for interdisciplinary graduate dissertations, and is responsible for the entire process of thesis proposal to defense [18]. This specialized management model ensures that the internal quality

assurance mechanism of graduate education is systematic and effectively implemented, and guarantees the sustainable development of interdisciplinary graduate education.

3.3 Accumulating Cross Research Kinetic Energy through Resource Increment Accumulation

At the beginning of its establishment, Peking University Chayuan was composed of four interdisciplinary research centers for virtual entities [8]110. With the significant increase in investment from developed country governments and various foundations, Peking University Branch actively builds a resource sharing platform to provide a foundation and guarantee for interdisciplinary talent cultivation. As of 2021, Peking University Branch has 2 physical centers, 9 virtual centers, 2 public technology platforms, and 2 joint training programs [8]111. Peking University Chayuan is also actively building communication platforms, specifically offering cross disciplinary salons to connect the scientific, industrial, and policy communities, promoting interdisciplinary integration, scientific and cultural transformation, and institutional innovation[8] 114. The Institute of Unmanned Systems at Northwestern Polytechnical University collaborates with enterprises through a council mechanism for resource sharing. The Council of the Research Institute is jointly established by more than 10 large domestic institutions and well-known enterprises, which provide funding sponsorship and targeted research projects to the research institute, as well as internship and training opportunities for students; the research institute has established part-time mentor positions for high-level experts in enterprises [19]. Shanghai University of Technology is also actively building a cross disciplinary medical and engineering education platform with multiple stakeholders involved. In recent years, the school has signed comprehensive cooperation agreements with more than 30 tertiary hospitals in Shanghai, including the First People's Hospital, Xinhua Hospital, Shanghai Chest Hospital, Naval Medical University and its affiliated Long March Hospital, and Changhai Hospital, to jointly carry out cross disciplinary talent cultivation in medical and engineering fields; In addition, the Institute of Excellence has expanded the resource sharing platform through the council mechanism: the first batch of 26 council units, including the Yangtze River Delta National Technology Innovation Center, the Chinese Academy of Sciences Shanghai Institute of Microsystems and Information Technology, etc. The extensive resource sharing platform provides a solid resource guarantee for interdisciplinary graduate training, promoting in-depth exchanges and cooperation among disciplines.

4. Conclusion

In the process of building world-class universities and disciplines, driven by national strategies, social development, and market demand, various universities are actively exploring paths for interdisciplinary construction and graduate training. However, the construction of interdisciplinary fields is not only constrained by inherent management systems and traditional graduate training models, but also faces problems such as being influenced by popular trends and blindly constructed, resulting in interdisciplinary discussions on paper. In this regard, it is recommended to design from the top level, focus on the characteristics of the school, and establish a separate interdisciplinary research institution with autonomy to overcome the obstacles of the inherent management system. A series of "lenient entry and strict exit" training policies should be formed by expanding the enrollment scope, multi-disciplinary entry into the training process, and specialized quality management throughout the process, forming a systematic training path.

References

- [1] Wu Wei, He Xiu, Jiang Tianyue, etc. *The dilemma and way out of interdisciplinary training for graduate students. Research on Educational Development*, 2018,38 (21): 12-17
- [2] Liu Wusheng, Zhou Heping. *Exploration of the Training Model for Master's Degree Students in Interdisciplinary Majors under the Background of New Engineering and New Liberal Arts. Chinese market*, 2021, (22): 183-187
- [3] Shi Miao. *Research on the cultivation of interdisciplinary doctoral students in research-oriented universities. Shanghai Jiao Tong University*, 2011, 5-10
- [4] Wang Zhiteng, Shi Qiuhe. *The systematic structure of interdisciplinary organizational integration in universities. Research on Educational Development*, 2022, 42 (11): 13-16
- [5] Cui Yubao, Li Jinlong, Zhang Shulin. *Interdisciplinary construction: connotation analysis, implementation difficulties, and promotion strategies. Chinese Higher Education Research*, 2022, (4): 16-22
- [6] Li Zhanhua, Zhu Yan, Yao Xia, etc. *Exploration and inspiration for interdisciplinary graduate education under the background of "Double First Class" construction. Degree and Graduate Education*, 2020, (4): 17-23
- [7] Garry D Brewer. *The Challenge of Interdisciplinary. Policy Sciences*, 1999, 32 (4): 327-337
- [8] Li Ning, Huang Junping, Huang Haijun. *Cross fusion, mutual generation and win-win - Exploration of the Construction Model of the Frontier Interdisciplinary Research Institute of Peking University. Universities and Disciplines*, 2021, 2 (4): 108-120
- [9] Sun Lizhen, Wang Shuqin, Tan Hua, etc. *Organizational Model and Carrier Analysis of Interdisciplinary Research in Research Universities. Research and Development Management*, 2013,25 (2): 107-114
- [10] Zhu Huawei. *Research on the current situation of interdisciplinary construction and development in high-level universities in China - based on a survey and analysis of 46 graduate schools. Chinese Higher Education Research*, 2022, (3): 15-23
- [11] Li Ping, Gao Xin. *Enrollment Practice and Reflection from the Perspective of Interdisciplinary Graduate Education: A Case Study of Hohai University. Education and Teaching Forum*, 2022, (20): 15-18
- [12] Huang Junping, Chen Qiuyuan, Qu Yizhen. *Exploration and Practice of Interdisciplinary Talent Training Models: A Case Study of Peking University. Degree and Graduate Education*, 2017, (5): 39-42
- [13] Ma Feng, Li Yan, Wei Shasha, etc. *Exploration and practice of a cross disciplinary and composite medical graduate training system. China Medical Education Technology*, 2022, 36 (6): 717-722
- [14] Zhou Jianhua, Zhou Zhangkai, Li Xuemeng, etc. *Exploring the Practice of Cultivating Graduate Students in Biomedical Engineering by Integrating Science, Engineering, and Medicine to Achieve Source Innovation. Chemistry Education*, 2019,40 (16): 75-80
- [15] Yan Jianyong, Li Xiaofeng. *Establishing interdisciplinary degrees: an option for cultivating innovative talents in graduate studies. Higher Engineering Education Research*, 2017, (1): 179-184
- [16] Xie Mengmeng, Zhou Yue, Ye Jian. *Reflection and Exploration on the Reform of Graduate Education in Biomedical Engineering. Progress in Biomedical Engineering*, 2022, 43 (4): 246-250
- [17] Fu Yu, Lu Xiaobin, Niu Li, etc. *Research on the Design of Curriculum Cubes for Information Resource Management in the Context of New Liberal Arts: A Case Study of Renmin University of China. Library and Information Work*, 2022, 66 (11): 76-86
- [18] Gao Lei. *Research on interdisciplinary graduate training in research-oriented universities. Shanghai Jiao Tong University*, 2014
- [19] Wang Qian, Miao Ying. *Research on the Construction of Interdisciplinary and Interdisciplinary Research Institutions in Universities under the Background of "Double First Class" Construction. Economist*, 2021, (5): 199-200