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Research on the Implementation Strategy of Competence-Oriented Postgraduate Cultivation Programme for Local Applied Universities with Big Data Technology



Abstract: - Prioritising the innovation capacity of postgraduates is paramount, with an effective training model serving as the linchpin. As information technology rapidly evolves and the era of big data looms, postgraduate education faces unprecedented challenges and opportunities. It is imperative for institutions to harness the potential of big data development, leveraging new technologies to enhance the talent development process. The postgraduate programme is the baton for talent development, and incorporating new information technology requirements and multidisciplinary synergies into the programme environment can reinforce the enhancement of innovative practical skills and data literacy, among others. In this way, the institutions provide society with a supply of high quality talent and help to promote the development of new quality productivity. Due to factors such as the regional economy, teaching staff, student quality and academic reputation, some local applied universities find it difficult to fully implement various good ideas for the postgraduate development programme, which to some extent affects the synergy between talent cultivation and local economic development needs. Taking North China University of Technology as an example, this paper adopts the deep learning model in big data technology and integrates capacity training into the daily teaching and practice process of postgraduate students according to the principle of “classified training, optimized links and improved capacity”. The group explored the theme of harnessing the potential of digital technology to support the growth of postgraduate education. Through interviews with students, on-campus and off-campus tutors, alumni and other stakeholders in talent development, they re-imagined the framework for postgraduate education, embodying the principles of strengthening the theoretical base, enhancing the integration of industry and education, and prioritising capacity building, and taking advantage of the digitalisation and networking of education. The research results show that the digital transformation of the education process with the help of big data technology has a driving effect on improving the innovative practical ability and overall quality of graduate students. This measure provides a reference for similar universities to revise their talent training programmes, and enriches the solutions to the problem of “good programmes are difficult to implement” in graduate student training.

Keywords: Big Data Technology, Postgraduate Cultivation Programme, Competence Orientation, New Era, Data Mining.

I. INTRODUCTION

With the rapid development of the digital economy, driven by big data, the internet and artificial intelligence, new ideas, perspectives and methodologies are emerging. The widespread adoption of digital technology and the emergence of the big data era have profoundly changed all aspects of politics, economics, science and technology, and daily life. The integration of next-generation information technology with emerging industries such as high-end devices, renewable energy, advanced materials and smart oceans is key to boosting the economy and securing competitive advantage in the future [1-3]. In the era of big data, postgraduate education administrators must embrace innovation in teaching concepts to remain relevant. Emphasising the cultivation of innovative thinking, practical skills, as well as technological skills in information technology and digital media is critical to preparing graduates to thrive in today’s digital world [4]. In the 2020 National Conference on Graduate Education, it suggested that future postgraduate education should focus on cutting-edge science and technology and key areas, deepen the reform of the graduate training model, and enhance the innovation and practical abilities of graduate students [5]. The training institutions should make talent layout in advance and cultivate “new engineering” talents with innovation and entrepreneurship awareness, digital thinking, and cross-disciplinary integration ability [6,7]. At the same time, Chinese scholar Zheng Bao put forward the explicit requirements for the competence model of outstanding engineers, which should include “patriotic dedication and professional ethics”, “organizational

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leadership and collaborative communication skills”, and “engineering technology and professional knowledge” as three major categories of competence indicators[8].

Local universities play an indispensable role in the national higher education system, serving as a cradle for cultivating high-level applied talents and shouldering the important task of providing talent support for local economic development. According to the 2022 National List of Higher Education Institutions published on the website of the Ministry of Education, the number of local government-affiliated universities is 2702, accounting for 95.82% of the total number of general higher education institutions in the country. The document “Opinions of the Ministry of Education on the Setting of Higher Education Institutions during the 13th Five-Year Plan Period” points out the domestic universities divided into three types based on the positioning of talent cultivation: research-oriented universities, applied universities, and vocational skill-oriented universities. Among them, applied universities are mainly engaged in cultivating applied talents at the undergraduate and graduate levels to serve the development of the economy and society, and conduct research in areas such as social development and technological applications [9]. Applied education is an inevitable result of the popularization and universalization of higher education in China, and applied colleges have become the main part of China’s higher education system [10]. If we divide them according to the level of talent cultivation, there are 594 general colleges with the qualification to cultivate postgraduate students, accounting for only 19.71% of the total number of colleges in the country [11]. Among them, the number of local universities with the qualification to cultivate postgraduate students accounts for about 80.47% of the total number of universities with the same qualification in the country. By analyzing the statistics on postgraduate students published by the Ministry of Education, it shows that nearly 82% of graduates with master degree from local universities choose to enter the labor market directly and contribute to national economic and social development [12-14]. This datum vividly reflects the close integration of the talent training goals of local universities with the development of the national economy, the direct promotion of technological innovation and the service to society.

Based on the above, research on how to design postgraduate cultivation programme that meets the needs of regional economic development, how to cultivate outstanding applied graduate talents, and exploring typical cases of cultivating the abilities of outstanding graduate talents can all contribute to improving the quality of graduate talent training in local applied universities.

II. RESEARCH STATUS

In February 2022, China’s Ministry of Education proposed the implementation of a strategic action on the digitisation of education, which aims to take advantage of networking, digitisation and artificial intelligence to enrich the supply of digital education resources and services, promote educational innovation and changes in learning styles, and accelerate the realisation of balanced, personalised and lifelong education [15]. The development of graduate students’ skills is one of the most important tasks in graduate education. The training programme serves as a guiding framework for the development of graduate students’ skills, including the design of the graduate curriculum system and training components. The graduate curriculum system plays a fundamental role in professional training [16]. The thesis component focuses on cultivating graduate students’ innovative ability and academic literacy, while the practical component emphasizes the development of their practical skills and professional qualities [17].

At present, domestic scholars have made significant progress in formulating and optimizing graduate training programmes. Some universities have introduced a three-tier platform curriculum system into their curriculum framework, which consists of basic theoretical courses at the university level, basic courses in primary disciplines, and specialized courses in secondary disciplines [18]. To address the complexity of high-end engineering problems in the digital domain, universities are collaborating to create an innovative and comprehensive graduate computing programme system. The system will make extensive use of big data across diverse domains, including smart mining, intelligent buildings, connected cities and advanced healthcare, to meet the evolving demands of digital talent development. Postgraduate programmes should integrate institutional expertise with data-driven interdisciplinary approaches, and include specialised computing courses that span basic, professional, cross-cutting and extended knowledge domains [19]. They have also developed high-quality courses for graduate students and strengthened the cultivation of engineering practice and innovative ability [20]. In addition, some universities have established interdisciplinary curriculum systems that break down the barriers between departments. They emphasize the inclusion of flexible courses, implicit courses, practical courses and interdisciplinary courses to create a favourable academic and innovative atmosphere [21-23]. In terms of training components, some universities have proposed macro-level discussions on “what kind of graduate students to cultivate” and “how to cultivate graduate students”,

focusing on personalized training, updating training mechanisms, and transforming teaching philosophies [24-26]. Others stress that the design of training components should aim to enhance graduate students' ability to adapt to social demands [27], with strengthening process management and supervision [28,29]. The practical research conducted by these universities has yielded significant results, providing a solid basis for innovation in postgraduate training models.

As a local applied university, we are susceptible to various factors such as faculty strength, academic reputation, alumni resources, practical resources and student level. There are practical difficulties in applying the above research findings to the management of postgraduate education. For example, there is a tendency towards homogeneity in the education of academic and professional graduate students. There is also a lack of differentiation between undergraduate and postgraduate courses, with a limited number of actual courses offered despite the large number of postgraduate courses on offer. In addition, there are barriers to the implementation of practical components in graduate education, with a gap between theory and practice. With limited resources, it is essential to design a comprehensive training programme that meets the needs of regional economic development, enhances the core competitiveness of graduate students, and implements effectively. This programme will help local universities to address the above challenges in graduate education. It is a subject worthy of reflection and research.

III. OVERVIEW OF THE POSTGRADUATE CULTIVATION PROGRAMME

A. Theoretical Basis for Competence Planning in Training Programmes

The core task of talent cultivation is to develop talents. In designing the program, the joint research of Sino-European optimization takes as the theoretical basis [30], and the list of skills and knowledge that graduates shall possess clarified. The research focuses on the needs of teachers, current students, graduates and employers who relate closely to talent cultivation, in order to formulate an implementation plan based on these needs. Among them, the needs of teachers represent the needs of disciplinary development; current students, as the main learners, effectively provide feedback on the rationality of teaching content; graduates indirectly reflect the effectiveness of teaching; and employers represent social needs and the direction of talent cultivation. In order to implement talent development, this paper proposes a talent cultivation system based on professional skills, with general skills as expansion, skills sorting as guidance, and ensuring alignment with social needs. The diagram in Figure 1 illustrates the relationships among the four participants.

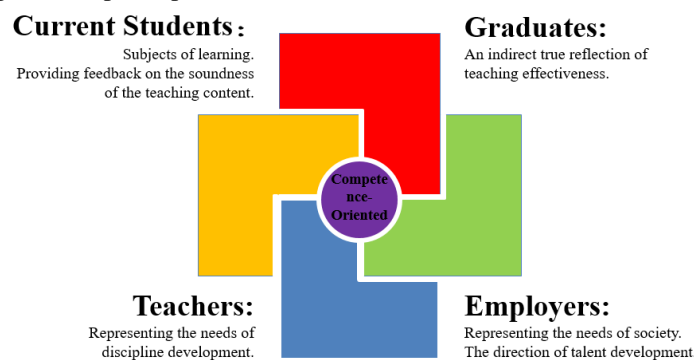


Figure 1: Schematic Diagram of the Relationship Between the Four Participants

Research has shown that participants in the study highly recognize the importance of ‘analytical and synthesis skills’, ‘ability to propose new knowledge’ and ‘application of professional knowledge in practice’, although the ranking of these skills may vary slightly [31], as shown in Table 1. Therefore, it is crucial to further strengthen and improve the development of these competencies in future talent development.

Table 1: Ranking of the Five Generic Competencies Considered the Most Important by Quadrilateral Participants

Competencies List	Respondent group	Current Students	Graduates	Teachers	Employers
Analytical and synthesis capacity		1	1	1	2
Ability to apply the fundamentals of the profession in practice		2	4	2	3
Compliance with social and professional ethics		3	5	-	4
Autonomous learning and self-management skills		4	3	4	-
Ability to generate new insights		5	2	3	5
Information management capacity		-	-	5	-
Ability to work in teams and collaborate across disciplines		-	-	-	1

The participation of Master’s students in the practice of topics and projects is not only the demand of the state and society for senior applied talents, but also the expectation of the training object itself to participate in the engineering practice during the training process [32]. The research team also conducted a follow-up survey on the impact of the practical component of graduate education on the development of graduate students’ skills, with the data presented in Figure 2. The data show that approximately 80% of the graduate students surveyed believe that the practical component of the training programme is helpful in improving their individual skills. Only 2-3% of the students surveyed indicated that it had little or no impact, while the remaining students considered its impact to be moderate. These research findings contribute to a clearer understanding of the correspondence between courses, training components and skills in the process of designing training programmes.

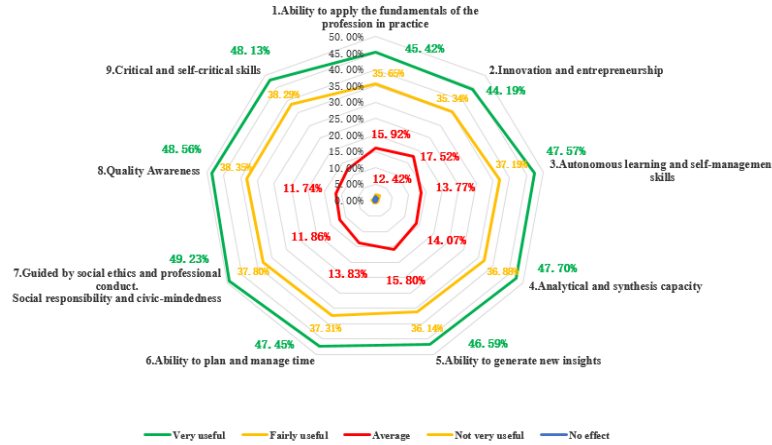


Figure 2: The Role of Practical Sessions in the Enhancement of Postgraduate Students' Competence

B. Key Aspects of Competence Implementation in Training Programmes

Education in the age of big data can harness the power of big data analysis to provide a tailored training ground to foster students’ innovative capabilities and collaborative spirit. Through comprehensive intelligent guidance and accurate process evaluation, students of all abilities can touch the cutting edge of modernity and achieve success quickly [33]. The graduate education programme integrates the requirements for skills development by incorporating elements such as core graduate courses, practical placements and training at research bases, research on scientific projects, high-quality academic papers and high-level disciplinary competitions. It incorporates these skills elements into the daily training process of graduate students, forming an interactive relationship between “graduate courses, training components and skills development”, as shown in Figure 3. In addition, training institutions are strengthening the link between skills development and the curriculum system, practical components and research work through thematic discussions, project-based approaches and case-based teaching. In addition to these efforts, it is also important to consider the integration of practical engineering applications with the development of independent thinking and innovation skills to enhance the competitiveness of graduates in the labor market.

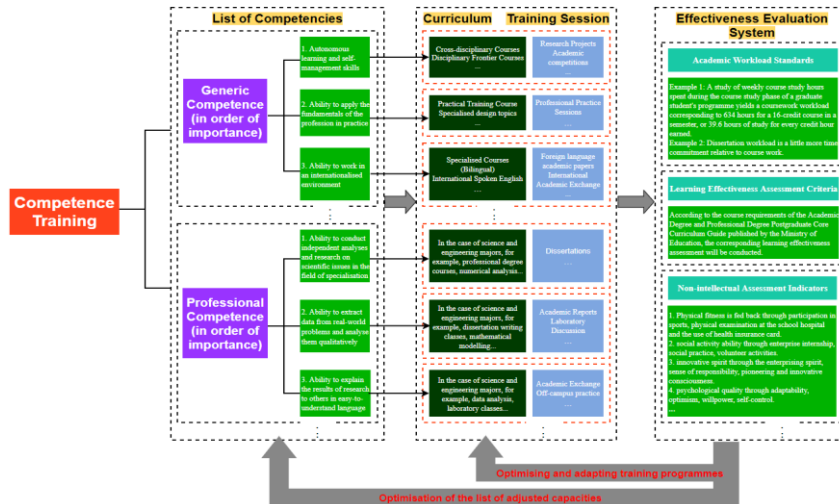


Figure 3: Schematic Diagram of the Correspondence Between Programmes (Training Sessions) and Competencies

IV. EVALUATION OF THE EFFECTIVENESS OF THE IMPLEMENTATION STRATEGY OF THE POSTGRADUATE CULTIVATION PROGRAMME

A. Case Study on Assessing the Effectiveness of Competency in Training Programmes

The establishment of an effective evaluation system and information feedback platform is crucial in supporting the development of graduate skills within educational institutions. By establishing a multi-level supervision system and conducting surveys on both graduates and employers to obtain timely feedback on the effectiveness of the educational process, it is possible to identify and address any shortcomings in the training and teaching process. Given the large amount of data collected, deep learning methods are used to learn how to use the data to accurately reflect the quality of postgraduate teaching [34]. This creates a virtuous cycle of “skills development-feedback-optimization” that ensures the continuous integration of skills development throughout the educational process, ultimately achieving optimal training outcomes under given conditions. In this paper, the discipline of mathematics is used as an example to present the assessment and evaluation indicators for graduate student skills within the framework of curriculum, training components and skills development. These indicators illustrates in Figures 4 and 5. The appraisal indicator codes used in Figure 5 are consistent with those in Figure 4.

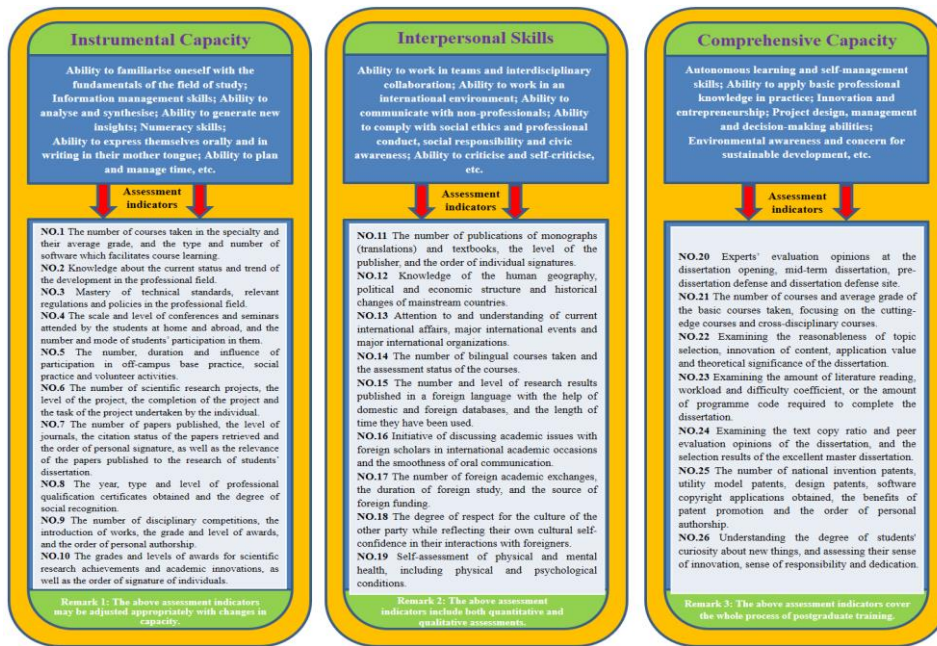


Figure 4: Parameter Map of Selected Generic Competency-Based Evaluation Assessment Indicators

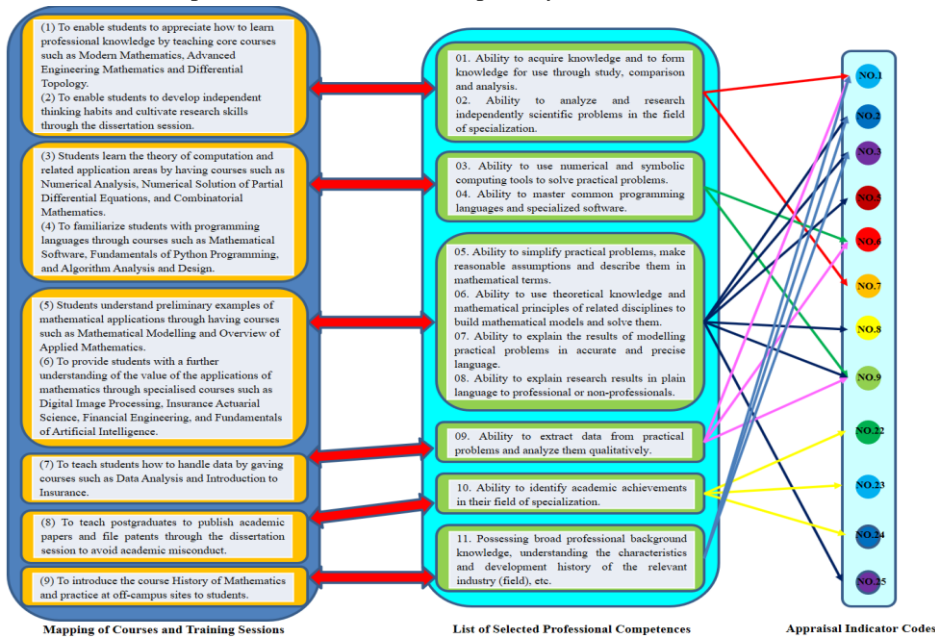


Figure 5: Assessment Indicators for Evaluation of Some Professional Competences and Chart of Training Pathway

B. Typical Evaluation Methods for Competence Development

The evaluation of courses (training components) serves as the primary means of assessing the development of competences. If evaluation methods are inappropriate or inadequate, this can undermine efforts to optimize course design, teaching processes and training components. Given the unique characteristics of different courses, this paper summarizes several typical evaluation methods, which presented in Table 2.

Table 2: Summary of Typical Evaluation Approaches

Serial Number	Typical evaluation approaches
[01]	Course Examinations
[02]	Dissertation
[03]	Evaluation of Group Work
[04]	Group Work Report (Oral)
[05]	Group Work Report (Written)
[06]	Literature Review
[07]	Behavioural Performance
[08]	Internship Practices
[09]	Research Paper
[10]	Primary Term Paper
[11]	Written Quiz
[12]	Hands-on Labs

Table 3 shows the different evaluation methods used in our daily teaching practice and their corresponding impact on skill development. The evaluation approach used in Table 3 derives from Table 2. From Table 3, it shows that each evaluation method to some extent enhances students' multiple skills. However, not all assessment methods have a direct correlation with specific skills. Different assessment methods play a complementary role in the development of multiple skills. In addition, these evaluation methods can further stimulate students' thinking and motivation to learn, thereby achieving the goal of skill development and training.

Table 3: Summary of Correspondence Between Evaluation Modalities and Selected Competency Points

Type of Competence	No. of Evaluation Modalities Used
Ability to analyze and synthesize	[02], [05], [10]
Ability to apply basic professional knowledge in practice	[05], [09], [10]
Ability to propose new insights	[06], [09], [10]
Autonomous learning and self-management ability	[02], [06], [11]
Innovation and entrepreneurship	[02], [06], [10]
Leadership	[04], [05], [11]
Ability to work in an international environment	[04], [05], [09]
Project design, management and decision-making skills	[02], [04], [05]
Ability to work in teams and collaborate across disciplines	[03], [05], [09]
Ability to express oneself orally and in writing in one's mother tongue	[02], [04], [07]
Ability to follow ethical and professional behavior	[05], [08], [09]
Information management skills	[01], [11], [12]

C. Effectiveness Analysis of Competence Development

When developing the skills of graduates, it is important to have a clear understanding of the effectiveness of such training. The effectiveness of training reflect in the knowledge, skills and overall qualities that talents possess [35]. Schools examine the match between graduate education and skills development by analyzing output data from research outcomes. Student outcomes include course grades, work experience, student volunteering, competition results, national and international academic exchanges, physical and mental health, awards and honors at all levels, quality of dissertation, research and academic output, quality of employment, social impact and benefits. Big data processing technology can not only analyse students' learning indicators, but also obtain data on students' life interests, practical activities, etc., to build a personal knowledge map for students [36].

At the same time, the research team conducted a survey of the four parties involved in the effectiveness of skills development and found that the rating of effectiveness was still significantly lower than its importance. Only the ability to ‘design, manage and make decisions’, which frequently used in work, had a small gap between effectiveness and importance. The gap for vocational skills was smaller than for general skills, which relates to our emphasis on vocational training in everyday life [31]. Of course, it is necessary to strengthen the practice of quality education. In the five most important skills, such as analysis, synthesis and the ability to propose new knowledge, the effectiveness of training is often unsatisfactory, and the area to which we should pay particular attention.

In particular, all four parties involved in the survey believe that the effectiveness of training in the ability to propose new insights, which should be highly valued by university educators, is insufficient. In other words, students lack independent thinking and critical thinking, and tend to accept things habitually in their work, which is not conducive to scientific and reasonable progress of work, and not conducive to the cultivation of innovative ability. We should pay attention to cultivating students’ independent thinking and critical thinking in everyday life, and guide students to think for themselves in teaching, while reducing the use of teaching methods that simply impart knowledge.

V. EFFECTIVENESS OF IMPLEMENTATION

A. Overall Impact of Programme Implementation

The school is constantly innovating its talent development system and mechanisms, adhering to the talent development concept of “consolidating theoretical foundation, deepening industry-education integration and emphasizing ability development”. In the whole process of postgraduate education, the demand for postgraduate ability improvement is integrated, and the curriculum and practical resources are optimized, build a high-level innovative and applied talent development discipline system, cultivating a large number of high-level technical talents for industry research and development.

During the implementation verification period, the quality control platform for postgraduate practice and education was established. The first-year postgraduates developed personal training plans based on the professional training programme in which they enrolled. At the end of each semester, the information platform evaluated the effectiveness of postgraduate ability development, and the evaluation results were an important reference for postgraduate classification training. Postgraduate students participated in practical activities such as innovation and entrepreneurship courses, academic competitions, professional qualification certificate examinations and certifications, practice at external postgraduate joint training bases, and domestic and international academic exchanges, according to the practical credit requirements specified in the training programme. They applied theoretical knowledge in practice, and improved their sense of social responsibility and social awareness.

B. Sub-impact of Programme Implementation

The University has continuously improved its comprehensive postgraduate education system, resulting in an increase of over 85% in postgraduate students’ innovative practical skills in project practice evaluations. The high level of achievement of postgraduate students is evident and the impact on their personal development is significant. Over the past five years, there has been a remarkable 148.6% increase in the number of high-level achievements by postgraduate students. There has also been a significant increase in the number of awards won in disciplinary competitions, with 1880 individuals receiving 881 awards at provincial and ministerial level or above, as shown in Figures 6 and 7.

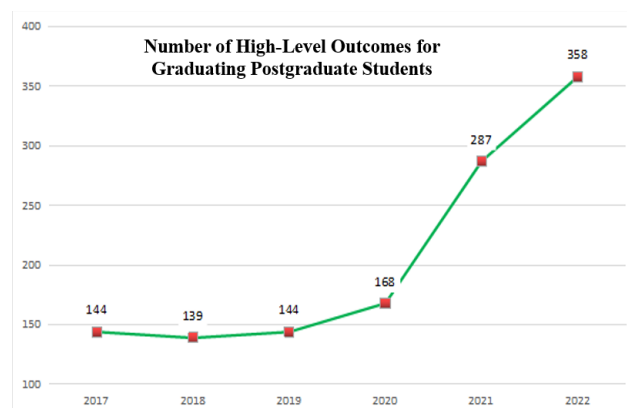


Figure 6: Number of High-level Outcomes for Graduating Postgraduate Students

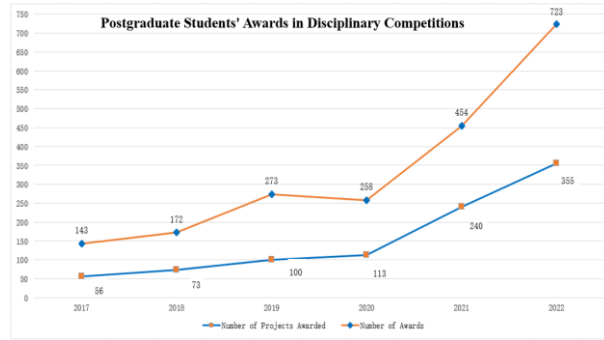


Figure 7: Postgraduate Students' Awards in Disciplinary Competitions

The quality of Master’s theses has improved continuously. According to the “Master’s Thesis Citation Report” published by CNKI, the average citation frequency of master’s theses from our university is higher than that of other high-level institutions, as shown in Figure 8 and Figure 9.

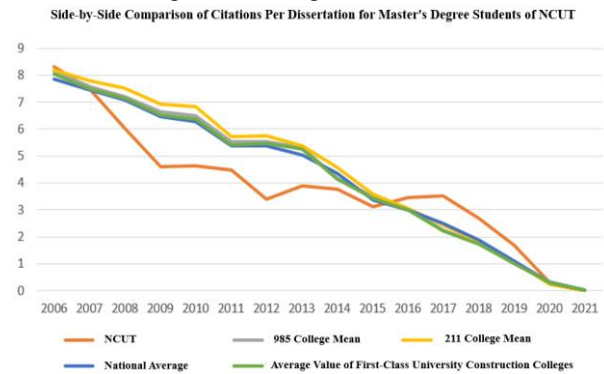


Figure 8: Side-by-side Comparison of Citations Per Dissertation for Master’s Degree Students of NCUT

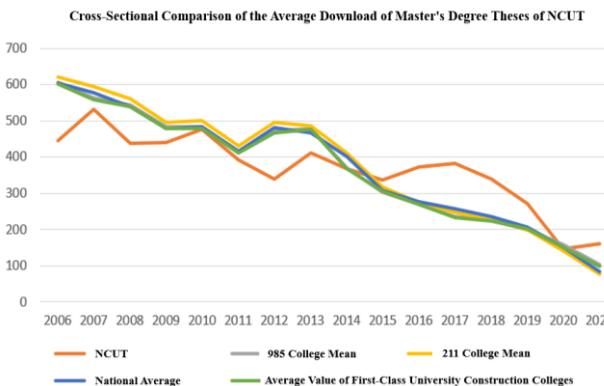


Figure 9: Cross-sectional Comparison of the Average Download of Master’s Degree Theses of NCUT

The employment rate of postgraduates has remained consistently high. Over the past five years, postgraduate employment has been stable and mainly concentrated in the Beijing-Tianjin-Hebei region. Graduates report high levels of job satisfaction, and the number of doctoral students and overseas students has increased steadily, averaging about 40 per year, as shown in Figure 10.

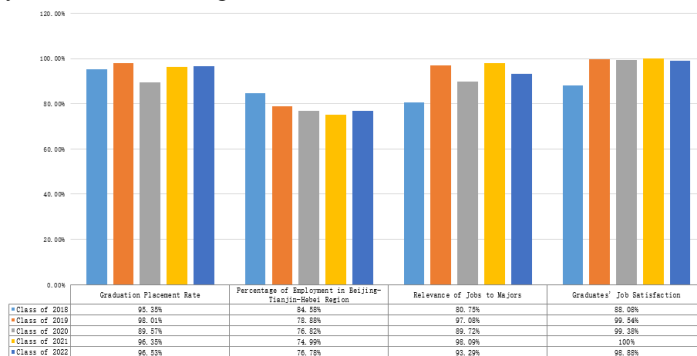


Figure 10: Employment of Graduating Postgraduate Students, Classes 2018-2022

Data source: Annual Report on Employment Quality of Graduates of NCUT from 2018 to 2022 years.

C. Impact Cases of Programme Implementation

The above data and graphs show a significant increase in the output of various postgraduate student achievements. These achievements attributed to the implementation of talent development programmes with a focus on skills, at the same time closely linked to the University's continuous investment in postgraduate education. In addition, the postgraduate education process has also witnessed the emergence of some exemplary cases. For example, postgraduates have presented papers at leading international conferences such as IFAC in the field of auditing, ICCV and CVPR in the field of computer vision, and the American Management Association, thus achieving breakthroughs in high-level academic exchange. The postgraduate team of the School of Electrical and Control Engineering had been elected as the outstanding entrepreneurial team among universities in Beijing, attracting widespread attention from society with three times. The quality of postgraduate education in the university's high-level and cutting-edge disciplines has improved significantly. In the field of control, postgraduate students have won seven provincial and ministerial awards for scientific and technological progress in the past three years, and 12 students have awarded the title of Outstanding Graduate Student in Beijing. They have also published 222 academic papers and won 49 national-level competition awards and 122 provincial and ministerial-level awards. The proportion of postgraduate students pursuing doctoral degrees has risen from 7.7% to 25%, and over 65% of graduates have employed in high-level and cutting-edge industrial units, receiving positive feedback from employers.

VI. CONCLUSION

Evolving societal demands for talent, coupled with the changing characteristics of graduate students, make the traditional teaching model obsolete for modern graduate education. By leveraging big data and artificial intelligence, teaching data can be easily collected and analysed, facilitating the modernisation of teaching methods. Therefore, the adoption of big data thinking is imperative for postgraduate teaching management in colleges and universities, providing accurate, scientific and efficient support for teaching management. Based on the Sino-European optimization theory, this paper highlights the importance of implementing a capability-based talent development programme for applied universities. It also proposes directions and suggestions for future research. Through research and analysis, a list of disciplinary professional skills and a ranking of their importance have been established, which effectively addresses the problem of what kind of skills should be cultivated in graduate students during the daily teaching process. This model breaks away from the traditional approach of focusing on curriculum and training processes, but instead takes a reverse approach to understanding what skills disciplinary professionals should have, and adapting training methods accordingly.

In the specific implementation process, the research team establishes the correspondence between capability objectives and courses and training processes, further clarifying the role of specific knowledge points in capability development. By teaching reform measures such as course layering, core curriculum group constructing, practical teaching platforms and information platform construction, they can provide a good hardware and software environment for the development of various capabilities in graduate students. This "reverse thinking, forward implementation" approach can effectively promote the role of daily teaching in capability training.

In conclusion, big data technology provides valuable opportunities for China's economic and scientific and technological revitalisation and development, vigorously develop higher education in the new era, explore a new way for the development of postgraduate education in the new era, and contribute wisdom and strength to the development of scientific and technological reform and innovation.

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