Research and Practice of "Four-in-one" Practice Teaching Guarantee System for Postgraduates of Local Engineering Colleges in the New Era

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Abstract: This paper discusses the current situation, problems, and corresponding solutions of postgraduate practice teaching in local colleges and universities by combing and comparing relevant literature at home and abroad. It finds that postgraduate placements in local higher education institutions, which lack a clear and transparent industrial background, face numerous obstacles. These challenges include seamlessly integrating student internships with their specific academic research fields, reconciling conflicting interests in mentor research activities with the practical aspects of student internships, carefully managing the complex allocation of intellectual property generated by research results during internships, balancing the ratio of available capacity between students and internship facilities, and cultivating deeper levels of participation and cooperation in the internship ecosystem. To address these challenges head-on, this paper proposes the implementation of a comprehensive 'four-in-one' placement assurance system, tailored specifically for postgraduate students. This innovative system involves the establishment of a robust practice teaching evaluation framework that incorporates input from campus mentors, company mentors, base mentors, and experimental teachers. It also emphasizes the refinement of the placement evaluation process to ensure its efficiency and effectiveness. Finally, it calls for the enhancement of the quality assessment of placements, to provide postgraduate students with an unparalleled learning experience that enhances their professional growth and development. This study aims to provide a reference for similar institutions cultivating applied talents in the same environment.

1. Introduction

After hosting three pivotal conferences in July 2013, November 2014, and July 2020, the realm of postgraduate education has steadfastly shifted its focus towards nurturing individuals of impeccable moral character, deepening institutional reforms, and refining the quality framework to align with national imperatives and societal advancements. Presently, domestic postgraduate education is undergoing a gradual transition, evolving from primarily fostering academic excellence to a balanced emphasis on both academic and practical proficiency [1]. As the number of postgraduate students holding professional degrees continues to grow, it has become imperative for educational institutions to prioritize ensuring the quality of their education and enhancing their practical innovation capabilities.

The Ministry of Education, along with the pertinent professional degree education guidance committee, mandates that professional degree postgraduate students must engage in teaching practice for a minimum duration of six months. This requirement can be fulfilled in a phased manner. Hence, numerous postgraduate training institutions have mandated the inclusion of professional practice as an integral part of their training curricula. This necessitates postgraduate students to engage in practical work within collaborating organizations for a duration ranging from six months to a full year, upon the completion of their theoretical courses.

Additionally, they are required to undergo a dual evaluation process and submit comprehensive practice reports, ensuring a thorough learning experience. Domestic scholars such as Xiao Yang pointed out that there are problems such as low motivation to participate in off-campus practice bases and unclear responsibilities of on-campus and off-campus mentors. However, they still need to be studied and solved in depth to better cultivate postgraduates with professional degrees [2].

For local colleges and universities that do not have distinctive industry characteristics, their practice sessions to cultivate postgraduates face multiple challenges. The postgraduate practice process is intricately shaped by a diverse array of factors, including the school's reputation, students' aptitudes, alumni resources, local educational policies, and the prowess of teachers. This multifaceted landscape often poses challenges in ensuring the alignment of practice content with the student's area of study. Additionally, there may arise conflicts of interest between tutors' scientific research projects and the practical assignments assigned to students. The distribution of intellectual property rights associated with scientific research outcomes generated through the nurturing process at the base also presents a complex issue. Furthermore, the balance between the number of students and the available enrollment capacity can be a delicate matter. Lastly, the depth and sustainability of enterprises' participation and cooperation in this process are crucial factors that significantly impact the overall effectiveness of the postgraduate practice experience. The actual training effect of the practice of postgraduate students is not optimistic, and there is no formalization of practice evaluation. Given the above problems, local engineering colleges and universities should aim to improve the ability of talent cultivation, enhance the matching degree of social demand, and further improve the postgraduate practice cultivation system to meet the development needs of the new era. From the perspective of talent cultivation, pay attention to the quality management of the postgraduate practice process, optimize the practice teaching guarantee system, and promote postgraduate education in the direction of connotative development.

2. Research Status

In assessing postgraduate practice sessions, it is paramount to concentrate on the fundamental aspects that serve as indicators of the sessions' quality. Essentially, this involves pinpointing the key components of evaluation, posing the question, "What precisely are we evaluating?" The Guiding Opinions on Formulating the Cultivation Programme for Engineering Master's Degree Graduate Students (Document No. 2018[14] of the Degree Office) emphasizes that professional practice is an essential link for engineering master's degree graduate students to gain practical experience and improve their practical ability. Firstly, domestic scholars have thoroughly studied the quality evaluation of the practice link of graduate students. For instance, Jinliu Zhang developed a teaching quality evaluation system centered around the complete process of student nurturing. Employing the hierarchical analysis technique, he effectively assigned weights to various layers of indices, linking them seamlessly to their corresponding superior tiers. Furthermore, leveraging the grey clustering approach, he conducted a thorough cluster analysis of practical teaching quality evaluation indices, drawing insights from the whitening weight clustering coefficient [3]. On the flip side, Xutao Zhang and his colleagues crafted a hierarchical, multi-modular, and mutually complementary practical teaching curriculum, underpinned by a robust practical teaching support system bolstered by dedicated faculty and practice bases. This culminated in the creation of a four-in-one practical teaching evaluation framework, designed to encourage the seamless integration of learning and reflection, as well as the harmonious union of knowledge and action within engineering master's programs [4]. Additionally, Fanwen Kong and his team delved into the intricacies of the practice evaluation and assessment system for full-time professional degree postgraduates. Their exploration encompassed a comprehensive analysis of

practice ability requirements, the meticulous design of practice evaluation and assessment modules, the development of innovative practice link evaluation and assessment methodologies, the refinement of comprehensive and integrated practice evaluation techniques, and the rigorous validation of the entire practice evaluation and assessment system [5].

Secondly, scholars have conducted in-depth research on the quality assurance system of postgraduate practice links. Fuquan Wang and other scholars put forward measures to improve the management mechanism of practice bases, establish practice base groups, strengthen the construction of "dual tutors inside and outside the university" team, and enhance the weight of professional practice, to improve the construction of practice bases for professional degree postgraduates [6]. Yan Liu et al. elaborated on the operation problems of the dual tutor system, the imperfect base construction, the formalization of practice links, and the convergence of evaluation systems [7]. Jingbo Li et al. found that some courses in the curriculum system disconnected from the cultivation of practical ability, the on-campus teachers had inadequate guidance for the off-campus practice of graduate students, and the off-campus teachers had insufficient understanding of the connotation of the cultivation of graduate students of professional degrees in our university [8]. Taking professional master's degree students in the field of architecture and civil engineering as the research object, Wang Yong et al. put forward the idea of implementing practice in a classified way. They established a system to strengthen the quality assurance of practice links [9].

The above scholars have evaluated the explicit quality of postgraduate practice sessions from several subjective elements and included the implicit elements such as professional knowledge, ability, and attitude demonstrated by postgraduate practitioners in the scope of the evaluation, thus objectively reflecting the quality level of practice sessions. To improve the quality of postgraduate practice sessions, all parties need to make concerted efforts and promote together. The previous research of domestic scholars has a reference value, but whether it fully applies to local institutions without a distinctive industry background still needs further study. To solve the dilemma of practice education and break the phenomenon of "name but no reality" of postgraduate practice, this group is committed to answering the above questions to provide practical and effective solutions for postgraduate practice education.

3. Implementation Programme

Adhering to the core concept of "cultivating moral character, serving needs, improving quality and pursuing excellence," the group has established a "four-in-one" practice teaching guarantee system by optimizing practice teaching management, improving practice teaching resources and promoting practice teaching reform, with the dual teaching team and off-campus practice bases as the vital support. Built upon the solid foundation of practice teaching, this comprehensive system encompasses diverse aspects including practice recognition, dual-teaching teams, off-campus practical experiences, and on-campus experimentation. This integrated approach fosters a mutually beneficial and collaborative teaching pattern that encourages joint growth and development. In this comprehensive process, four different parties, namely campus mentors, company mentors, base mentors, and experimental teachers, work together seamlessly in the overall management of postgraduate placements. Their main is to carefully evaluate the active participation of postgraduate students in various practical settings, including hands-on experience in practice bases, case application exercises, and other operational practices. In addition, they scrutinize the tangible impact of these practical experiences on the nurturing and development of professional graduate talent, ensuring that the program meets its intended objectives.

3.1 Designing an Assessment Program for Postgraduate Practice Teaching

The development of professional doctoral students typically involves a comprehensive approach that combines coursework, practical work experience, and dissertation

writing. In particular, the practical component goes beyond traditional internship practices and instead spans the entire educational journey, beginning with teaching practice courses and culminating in dissertation research [10]. To this end, we introduce a comprehensive and tiered practice and innovation skills training framework, meticulously structured into different levels, modules, and stages. This assessment scheme aims to increase the proportion of professional practice within postgraduate education, thereby promoting a closer integration between practice courses and innovation skills training. The specific assessment content of postgraduate practice is shown in Table 1.

Table 1. Postgraduate Practical Sessions Assessment Content

Type of Practical Activity	Practical content				Criteria for obtaining credits
Professional practice (for postgraduate professional degree students)	1) Engaging in specialty-related practical activities at school practice bases and joint training bases 2) Industry practice, practical internships, etc., recommended by the supervisor (group) or the faculty 3) Participate in the supervisor's off-campus research project practice				0.3 credits per week
Professional capacity building category (for all postgraduate students)	Academic lectures or academic research	1) Listening to academic reports, lectures, etc., at the faculty level or above 2) Participation in academic research activities agreed to by the Head of Discipline and related to the subject matter			0.3 credits per session
	International exchange	Participation in international exchange training programs (e.g., student exchange, etc.)			2.0 credits per semester
	Academic paper	Level A (delineation consistent with the Institute of Science and Technology)			5.0 credits per article
		Level B (delineation consistent with the Institute of Science and Technology)			4.0 credits per article
		Level C (delineation consistent with the Institute of Science and Technology)			3.0 credits per article
		Level D (delineation consistent with the Institute of Science and Technology)			2.0 credits per article
	Academic competition	National level	Non-examination category	First prize and above	4.5 credits per item
				Second prize	3.5 credits per item
				Third prize	2.5 credits per item
			Examination category	Third prize and above	1.5 credits per item
			Award of excellence or participation		0.5 credits per item
		Provincial category A	Non-examination category	First prize and above	2.5 credits per item
				Second prize	2.0 credits per item
				Third prize	1.5 credits per item
			Examination category	Third prize and above	1.0 credits per item
			Award of excellence or participation		0.3 credits per item
		Provincial category B or school-level	Third prize and above		0.3 credits per item
			Award of excellence or participation		0.2 credits per item
		Knowledge expansion	Full participation and awards		0.1 credits per item
	Research and innovation practical activities	Hosting incubation investments in innovative entrepreneurial projects			3.0 credits per item
		Hosting research and innovation projects			1.0 credits per item
	Patent or soft copy application	International patents for inventions			4.0 credits per item
		China invention patent			4.0 credits per item
		Utility model patents			1.0 credits per item
		Design patents			1.0 credits per item
		Software copyright			1.0 credits per item
	Technology standard	International technical standards (participation)			4.0 credits per item
		National technical standards (participation)			4.0 credits per item
		Provincial and ministerial standards (participation)			2.0 credits per item
		Industry standards (participation)			2.0 credits per item
	Article	Academic monographs (edited and co-edited)			3.0 credits per item
		Academic translations (edited and co-edited)			2.0 credits per item
		Dictionaries, toolkits, point-of-view books, novels, plays (edited and co-edited)			1.0 credits per item
	Teaching practice	Teaching assistant positions to assist with undergraduate and graduate			0.5 credits per class

|		course teaching assistantships and other tasks		
	Certification examination	National professional and technical qualification examination	Advanced Certificate	3.0 credits per item
			Intermediate certificate	2.0 credits per item
			Junior certificate	1.0 credits per item
General competency development category (for all postgraduate students)	Voluntary activities for the public welfare	Participate in voluntary service activities organized by the university (college) and off-campus social welfare organizations, public welfare organizations, communities, and other social administrations		0.3 credits per session
	Social practice research activities	Participate in social practice research activities organized by higher education departments, industry associations, and schools (colleges)		0.3 credits per session
	Service management practices	1) Served as a key student leader at school, college, or class level 2) Serve as a liaison for graduate student teaching 3) Holding a school (college) bursar position		0.3 credits per semester
	Physical, Aesthetic, and Labor practical activities	Participation in sports, aesthetic, and practical labor education activities organized by higher education authorities, industry associations, and schools (colleges)		0.3 credits per session

3.2 Optimizing the Assessment Process for Postgraduate Practice Teaching

The research group has implemented a system of assessment of postgraduate student placements, and mentors are required to determine the placement by the research needs of the thesis. Postgraduate students and their mentors work together to develop a practical study plan, which is submitted to the faculty. The faculty is responsible for tracking and managing the placement and providing services to ensure that the placement process is carried out in an orderly manner. At the end of their placement, students are required to submit a comprehensive placement report, which is evaluated by the placement unit. Based on this evaluation, the College will award grades to ensure the high quality of the placement education, as illustrated in Figures 1-3. Students with excellent performance in practice will be given full consideration in evaluating prizes, merits, and recommendation work. In addition, the college also organizes and invites young postgraduate students to participate in practice summary exchange activities to help postgraduate students establish a correct concept of professional practice.

Figure 1. Screenshot of Postgraduate Practice Planner

Figure 2. Screenshot of Registration Form for Postgraduate Professional Practice
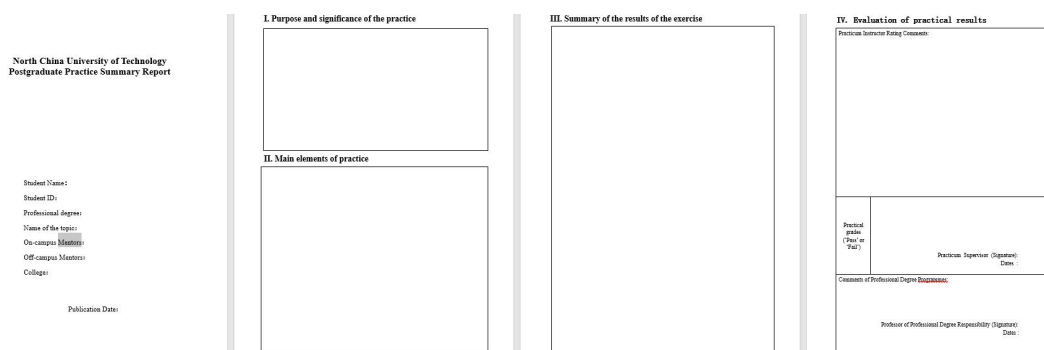
Figure 3. Screenshot of Postgraduate Practice Summary Report

3.3 Improving the Quality Assessment of Postgraduate Placements

The deep participation of postgraduate students is crucial to the practice link and is a core element in determining the quality of professional practice [11]. To improve the quality of professional postgraduate practice education and solve the problem of integrating practice and competence cultivation, the training units have constructed a comprehensive practice quality evaluation system by combining centralized and segmented practice. The system adopts "the implementation of postgraduate practice programs" and "the impact of postgraduate practice programs on talent cultivation" as its primary indicators. In addition, it is categorized into secondary evaluation indicators, as shown in Tables 2 and 3. Within the framework of the secondary indicators, the training units have formulated evaluation guidelines based on specific strategies to ensure the operability of the evaluation system. In addition, previous research results on postgraduate competence training are combined with evaluation indicators at all levels, so that the evaluation system plays a guiding role in postgraduate training and is easy to implement in practice. In the meantime, it is imperative that training units strictly adhere to the practice assessment procedures for professional degree postgraduates. For those postgraduates who do not meet the established standards or fail the assessment, remedial action must be taken, such as re-practice and deferral of graduation. This will ensure that professional practice is given its proper place in postgraduate education and that high standards and quality are maintained in the educational process.

Table 2. Indicators for Evaluating Postgraduate Practice (Students)

Level 1 indicators	Level 2 indicators	Specific evaluation elements
U1. Implementation of the Postgraduate Practice Programme	U11. Types and frequency of postgraduate placements participated in	U111. Research on scientific topics (number of projects)
		U112. Academic exchanges (listening to lectures and making academic presentations)
		U113. Academic practice (disciplinary competitions, patent applications, software copyrights, etc.)
		U114. Study in practice bases or other off-campus practice units
		U115. Vocational practice (innovation and entrepreneurship, vocational certification qualification exams)
		U116. Teaching practice (number of classrooms assisted)
		U117. Social practice (assistant manager, student work, public service activities, volunteering, holiday practice activities)
		U118. Physical, Aesthetic, and Labor practical activities
	U12. Content of subjects and frequency of participation in off-campus placements	U121. Quality development seminar
		U122. Situated cognitive learning
		U123. Professional and technical training
		U124. Enterprise operation simulation training
		U125. Research on enterprise innovation projects
U2. The impact of	U21. Relevance of the postgraduate	U211. The extent to which course knowledge is applied in practice
		U212. Promoting coherence between work-based learning and off-campus

postgraduate practice programs on talent development	curriculum to professional practice	placements
		U213. Whether professional practice is closely linked to program knowledge
		U214. Whether the curriculum system is currently adapted to the development of professional practice skills of professional master students
	U22. Relevance of research training to professional practice	U221. The fit between the research and the content of out-of-school practice
		U222. The dissertation topic is derived from engineering problems encountered during off-campus work placements
	U23. Relevance of mentoring to professional practice	U231. Support for postgraduate students to participate in off-campus placements
		U232. Degree of mentor guidance and interest in the off-campus placement process
	U24. Relevance of practical sessions to competence development	U241. Ability to apply the principles of the profession in practice
		U242. Ability to innovate and entrepreneurship
		U243. Ability to autonomous learning and self-management
		U244. Ability to analytical and synthesis
		U245. Ability to generate new insights
		U246. Ability to plan and manage time
		U247. Social ethics and professional conduct, social responsibility and citizenship
		U248. Ability to quality awareness
		U249. Ability to critical and self-critical

Table 3. Evaluation Indicators for the Management of Postgraduate Professional Practice (Faculty)

Level 1 indicators	Level 2 indicators	Specific evaluation elements
K1. Status of Postgraduate Professional Practice Sessions	K11. Professional Practice Feasibility Analysis	K111. Survey on the need for professional practice
		K112. Whether the setting of practice positions in the professional practice units is consistent with the educational objectives
		K113. Postgraduate professional practice management system through professional practice units
	K12. Status of professional practice management	K121. Records of postgraduate practice, practice plans, and practice hours
		K122. Degree of guidance and supervision provided to graduate students by on and off-campus instructors in professional practice.
		K123. Regular visits to practice bases in different areas
		K124. Postgraduate management randomizes practice site visits
		K125. Links between the award system and postgraduate professional practice
		K126. Number of postgraduate professional practice base construction
		K127. Postgraduate Professional Practice Base Carrying Status
	K13. Summary evaluation of professional practice	K131. Evaluation of both the outcomes of postgraduate professional practice and the whole process of practice by on-campus mentors
		K132. Evaluation of both the outcomes of postgraduate professional practice and the whole process of practice by off-campus mentors
		K133. Postgraduate students' satisfaction with professional practice units
		K134. Postgraduate students' satisfaction with on-campus mentors
		K135. Postgraduate students' satisfaction with off-campus mentors
		K136. Postgraduate students' satisfaction with graduate administration

4. Conclusions

The core of the "four-in-one" practice teaching guarantee system for postgraduates of local engineering colleges in the new era is cultivating high-level applied talents in line with the needs of the times. The research group has conducted effective research on the university's standard training bases, and the results show that

most of the base cooperation units are from national enterprises and institutions, scientific research institutes, which are highly compatible with the research direction of disciplines and specialties. Influenced by the external environment, only 64.5% of the bases played the role of practical training in the past three years. With the help of networked means, such as the platform for recognizing the achievements of postgraduate students, the management and guarantee capacity of practical teaching in the bases should be improved. The Recommendation emphasizes the importance of aligning training objectives with industry needs within training units. It emphasizes the need to capitalize on the expertise of the supervisory team and to make effective use of the potential of placement sites. It also underlines the importance of focusing on the practical achievements of postgraduates and their acquisition of professional qualifications. It also emphasizes the need to continuously refine and improve the key aspects of the placement guarantee system, including aspects such as placement management, resources, evaluation, and quality monitoring.

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