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Development and Practice of a Quality Evaluation System for Professional Graduate Education in Engineering

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Abstract: There are many limitations in the current quality evaluation of engineering professional graduate education, such as a lack of alignment between evaluation criteria and educational goals, neglect of the educational process, absence of assessment for industry-university cooperation, and limited application of evaluation results in quality improvement. Due to the above limitations, a quality assurance system for engineering practice, technological innovation, and professional ability has been established. The framework has set different evaluation criteria, multiple indicators, multi-party participation, and systematically used the evaluation results. The framework has been used for the professional graduate programs at the School of Mechanical Engineering. After implementation, the indices of engineering-oriented training, management of the educational process, participation in industry, and application of evaluation results for quality improvement have been observed.

Keywords: Professional graduate education; Quality evaluation; Engineering education; Industry-education integration; Continuous improvement

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1. Introduction

Graduate education is an important part of the national education system and plays a key role in training high-quality professionals and promoting scientific and technological innovation. With the continuous development of the socio-economic situation and the transformation of the industrial structure in China, the demand for high-level, application-oriented professionals has increased significantly. Professional graduate education has thus expanded, placing more emphasis on professional competence, practical skills, and the application of disciplinary knowledge. The rapid development of advanced manufacturing, new materials, artificial intelligence, new energy, and related fields has raised the level of expectations for the knowledge, practical ability, and innovation ability of engineering professionals.

Engineering professional graduate students are supposed to not only obtain advanced disciplinary knowledge but also apply it to real engineering situations and contribute to technological innovation and industrial development. Therefore, the quality of professional graduate education has direct implications for the preparation of high-level engineering professionals and the translation of scientific and technological advances into practical applications. An evaluation system that reflects the objectives of professional graduate education and the distinctive characteristics of engineering training is therefore important for guiding educational practice and supporting quality improvement.

Graduate education quality has been examined from multiple perspectives, with increasing attention to educational inputs, processes, outcomes, and student development [1]. Existing evaluation frameworks have incorporated dimensions such as program objectives, faculty and supervision, curricula, research and practical training, educational outcomes, and career development [2–5]. Methodologically, approaches such as expert assessment, the analytic hierarchy process, fuzzy comprehensive evaluation, and combinations of qualitative and quantitative methods have been used to construct and assess educational quality frameworks [6–7]. In engineering education, increasing attention has also been given to professional competence, authentic engineering practice, employability, and collaboration between universities and industry. Systematic reviews have shown that engineering competence involves the integration of disciplinary knowledge with professional skills and engagement with real-world engineering problems, while university–industry collaboration can provide important opportunities for problem-solving, product development, workplace learning, and transition to professional practice [8–11].

Although previous studies have established a useful theoretical and methodological foundation for evaluating professional graduate education, further research is needed to address the specific characteristics and quality formation mechanisms of professional graduate education in engineering. Correspondingly, this study develops a quality evaluation system for professional graduate education in engineering that emphasizes engineering practice and industry-education integration and extends evaluation across the educational process. The proposed system is subsequently implemented in mechanical engineering programs to examine its practical applicability and its potential to support quality diagnosis and continuous improvement.

2. Major limitations of current quality evaluation

2.1. Misalignment between evaluation orientation and educational objectives

Professional graduate education in engineering aims to develop high-level, application-oriented professionals with strong competencies in engineering practice, technological innovation, and professional practice. Quality evaluation should therefore reflect these educational objectives. However, some evaluation practices remain strongly focused on conventional academic indicators, such as journal publications, research projects, and academic awards. Less attention is given to engineering design, technology development, process improvement, technology transfer, and the ability to solve complex engineering problems. Therefore, the evaluation criteria may not fully reflect the differences between professional and academic graduate education. This misalignment may weaken the distinctive focus of professional programs and limit the role of evaluation in promoting engineering practice and application-oriented innovation.

2.2. Insufficient evaluation of the educational process

The quality of graduate education is determined by several factors, namely coursework, supervision, research training, engineering practice, and thesis writing. Existing evaluation practices tend to focus on educational resources and conditions, such as faculty and training platforms, as well as outcomes such as degree theses, research achievements, and employment. Less attention is paid to the quality of the educational process itself. The number and composition of supervisors reflect the availability of faculty resources, but give little information about the actual quality of supervision. The number of practice bases indicates the availability of practical training opportunities but does not show how extensively students engage in engineering projects or develop their competencies through such experiences. As a result, evaluation may focus primarily on whether adequate conditions are provided and expected outcomes are achieved. It is difficult to identify problems that appear during the educational process.

2.3. Insufficient evaluation of the effectiveness of industry-education cooperation

Industry-education integration is a typical feature of professional graduate education in engineering. However, the current evaluation methods are often quantitative in nature, such as the number of industry supervisors, joint training bases, and university-industry projects. The above indices do not provide concrete data on the extent of industrial participation or its effect on students. Strengthen cooperation with the industry to promote joint construction and implementation of the curriculum, select relevant research topics, and organize engineering practice and thesis defense sessions. It is also important to assess whether students work on real engineering problems through industry-based projects and whether such experiences contribute to their engineering and innovation competencies. Current evaluation practices do not adequately capture these aspects. Consequently, they may reflect the presence of university–industry collaboration rather than its actual educational value.

2.4. Limited use of evaluation results for feedback and continuous improvement

Educational quality evaluation should not only assess educational outcomes but also identify weaknesses and support continuous improvement. However, evaluation results are often presented as overall scores, ratings, or rankings. Such results provide limited information about differences across evaluation dimensions or specific areas requiring improvement. In addition, evaluation findings are not always effectively translated into actions such as program revision, curriculum improvement, supervisor development, practice-based enhancement, and resource allocation. Follow-up mechanisms for monitoring corrective actions and assessing their effectiveness also remain limited. As a result, evaluation may serve primarily to judge educational outcomes rather than to diagnose problems and guide continuous improvement.

3. Development of a quality evaluation system for professional graduate education

3.1. Focusing on engineering competencies and differentiated evaluation

The educational objectives of professional graduate programs in engineering provide the basis for quality evaluation. Accordingly, engineering practice, technological innovation, the ability to solve complex engineering problems, and professional competence are treated as key evaluation components. This shifts the focus from conventional academic achievements toward engineering competencies and practical value.

Academic achievements remain part of the evaluation, but a broader range of representative outputs is considered. These include engineering designs, technological developments, process improvements, product development, software systems, technical standards, and technology transfer. Evaluation considers both the results and whether they can solve actual engineering problems and what practical value they have.

The system will also consider the various types of engineering in different ways. In general, the basic quality level should be relatively high; otherwise, the other parts will have different requirements according to their own disciplines and engineering applications. Therefore, the evaluation criteria will be more closely in line with the educational objectives of all the professional engineering courses.

3.2. A five-dimensional framework for process-based evaluation

The evaluation framework extends beyond educational outcomes to cover the entire educational process. It follows the sequence of foundational support, educational process, collaborative education, educational outcomes, and developmental gains. Accordingly, five dimensions are included: educational foundations, educational process, industry-education integration, educational outcomes, and developmental gains.

Educational foundations cover program design, supervisors, curriculum resources, training platforms, and quality assurance mechanisms, which provide the basic conditions for graduate education. The educational process focuses on course delivery, supervision, research training, engineering practice, and thesis work, with emphasis on the quality of implementation. Industry-education integration examines the substantive involvement of industry in program development, joint supervision, curriculum development, enterprise-based projects, and joint training bases. Educational outcomes include degree theses, engineering practice, innovation achievements, technology transfer, employment quality, and employer evaluations. Developmental gains focus on students' progress in professional knowledge, engineering practice, innovation, teamwork, and professional competence.

The above five dimensions connect educational conditions, processes, industry participation, outcomes, and student development. Together, they provide a multidimensional view of educational quality and extend evaluation from final outcomes to the entire educational process.

3.3. Strengthening industry-education collaboration through multi-stakeholder evaluation

Professional graduate education in engineering involves multiple stakeholders and takes place across both university and industry settings. The proposed system therefore adopts a multi-stakeholder approach involving universities, supervisors, graduate students, industry partners, and employers. Universities and academic units focus on educational conditions, institutional arrangements, and program implementation. University supervisors assess students' professional knowledge, research training, and innovation capabilities, while industry supervisors focus on engineering practice, project performance, and the ability to solve complex engineering problems. Graduate students provide feedback on course delivery, supervision, and their educational experience. Employers assess graduates' professional competence and adaptability to workplace requirements.

The system has objective data and people's views. Quantitative indicators are academic results, the length of engineering experience, participation in corporate projects, and representative works. The attributes that are not easily quantifiable, such as engineering innovation, practical performance, professional ability, and the quality of industry-education cooperation, will be judged by experts, industry assessments, and questionnaires. Collect data from multiple sources and use various methods to assess the level of education in different areas.

3.4. Using evaluation results to support continuous quality improvement

The proposed system emphasizes the diagnostic role of quality evaluation and its use for continuous improvement. Rather than relying solely on an overall score or rating, evaluation results are analyzed separately across the five dimensions: educational foundations, educational process, industry-education integration, educational outcomes, and developmental gains. This dimension-specific analysis provides a quality profile that helps identify the strengths and weaknesses of each program.

Indicators associated with weaker areas are then examined to identify specific problems and determine appropriate improvement measures. The findings are communicated to academic units, degree programs, and supervisory teams. They are also used to inform program revision, curriculum improvement, supervisor development, engineering practice management, joint training base development, and resource allocation. Key indicators are reassessed in the next evaluation cycle to examine the implementation and effectiveness of these measures. This process establishes a continuous cycle of evaluation, diagnosis, feedback, improvement, and reevaluation, allowing evaluation to support both quality diagnosis and continuous improvement.

4. Practical outcomes

The proposed quality evaluation system was implemented in professional graduate programs within the School of Mechanical Engineering. Two training cycles, one before and one after implementation, were compared. The analysis focused on thesis topic selection, professional practice, industry supervisor participation, involvement in engineering projects, application-oriented outputs, and feedback on educational quality. Changes in these indicators were used to examine the practical application of the proposed system.

4.1. Stronger orientation toward engineering practice

Following implementation, changes were observed in thesis topic selection, participation in engineering projects, and application-oriented outputs. The proportion of theses derived from industry needs, engineering projects, or real production problems increased from 58.6% to 76.4%, an increase of 17.8%. The proportion of students participating in university–industry research or enterprise R&D projects increased from 65.2% to 82.7%, an increase of 17.5%. The proportion of students who have produced application-oriented results, such as patents, software copyrights, technical solutions, and process improvements, increased from 42.8% to 61.5%. The above changes show that the graduate training system is now closer to the actual work of engineers.

4.2. Improvement in the quality of the educational process

After implementation, some improvements have been made in the indicators of educational progress. The proportion of on-time completion for professional practice increased from 90.8% to 97.1%, and the proportion of students who received good or excellent ratings in the professional practice assessment rose from 76.5% to 88.9%. The proportion of students who wrote their graduation thesis proposals on time increased from 92.3% to 97.6%, and the first-attempt passing rate for the mid-term examination rose from 89.7% to 95.8%. Satisfaction among the students in the monitored department of the school has risen from 86.2% to 93.4%. In short, the above changes show that the new evaluation system has promoted professional practice, thesis progress, mid-term assessments, and supervision.

4.3 Greater depth of industry-education collaboration

Industry participation increased during the implementation of graduate education. The proportion of industry supervisors actively involved in joint supervision increased from 62.4% to 81.3%. Their participation in thesis topic selection or proposal guidance increased from 54.7% to 75.8%, while participation in professional practice assessment increased from 57.9% to 79.6%. The proportion of students completing professional practice within enterprises or through enterprise-based projects increased from 60.5% to 78.2%. In addition, the proportion of engineering practice projects jointly supervised by university and industry supervisors increased from 48.6% to 69.4%. This shows that industry involvement has been broadened in the development of theses, engineering practice, assessment, and joint supervision after the implementation of the evaluation system.

4.4. Greater use of evaluation results for quality improvement

The five indicators of the evaluation results were used, and only the overall score was not reported. The first round of assessment identified some deficiencies, such as low participation by industry supervisors and a lack of connection between professional practice and the thesis. Therefore, the following targeted optimization measures will be taken.

In the next evaluation period, the proportion of active participation by industry supervisors will be 18.9% higher, and their participation in thesis topic selection will increase by 21.1%. The proportion of thesis topics based on real engineering problems increased by 17.8%, and the proportion of good or excellent ratings in professional practice assessments rose by 12.4%. The proportion of happy students in the school has increased from 87.6% to 94.1%. The above changes indicate that the results of the evaluation were used to identify deficiencies and guide subsequent actions; thus, an initial cycle of evaluation, feedback, correction, and re-evaluation has begun.

5. Conclusions

Establish a quality assessment system that meets the goals of high-quality professional graduate education to enhance the overall level of the professional engineering program. To address the deficiencies in the current evaluation system, this paper has established a four-in-one quality evaluation system: setting up differentiated evaluation standards, developing multi-dimensional indicators, introducing multi-party evaluation, and enhancing the application of evaluation results. The five modules of the system are: educational foundations, educational process, industry-education integration, educational outcomes, and developmental gains.

Application of the system showed improvements in the indices for engineering practice, educational process management, and industry participation. Based on the evaluation results, some defects have been found, and corresponding countermeasures have been taken. These findings suggest that the proposed system better reflects the engineering, practice-oriented, and application-oriented characteristics of professional graduate education and provides a practical basis for quality diagnosis and continuous improvement. The study may therefore inform the development of differentiated quality evaluation approaches for professional graduate education in engineering and the preparation of high-level, application-oriented engineering professionals.

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Disclosure statement

The authors declare no conflict of interest.

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