ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

A Study on the Evaluation System for Core-course "cluster-based" Practical Teaching Model Oriented Toward Physical Outputs

Haiting Di, Yaoxiang Li, Huadong Xu, Haibin Wang, Hongfei Wang

College of Mechanical and Electrical Engineering, Northeast Forestry University, Harbin 150040, China

Abstract

Targeting the "cluster-based" practical teaching model for core courses oriented toward tangible outputs, this study designs a comprehensive evaluation system that is diversified and quantitative. A long-term support system has also been established, comprising a project resource repository, a case library, intellectual property protection, and a continuous improvement mechanism. The proposed quantitative and diversified evaluation system overcomes the limitation of a single evaluation perspective, thereby making evaluation more comprehensive and objective and fostering students' capacity for self-reflection and self-assessment in learning. The long-term support mechanism provides a guarantee for the sustainable development of this teaching model.

Keywords

Physical output, clustered practical teaching, evaluation system, long-term guarantee mechanism.

1. Introduction

Practical teaching plays a vital role in talent cultivation and serves as a bridge connecting knowledge and application, university and society, and learning and creation [1]. Various programmatic documents have emphasized the importance of practical teaching in talent cultivation [2, 3]. For this reason, many universities have carried out extensive research and practice on practical teaching models [4, 5].

In the preliminary research, this project team proposed a core-course "cluster-based" practical teaching model oriented toward physical outputs, constructed a "project chain" spanning multiple core courses, and developed a physical-output-driven implementation plan for cluster-based practical teaching. In this study, we construct a standardized, diversified, and quantitative evaluation system and establish a support system and long-term safeguard mechanism for the cluster-based practical teaching model.

2. Problems Existing in the Practical Teaching Evaluation System

Research and practice on physical-output-oriented practical teaching have made considerable progress. Disciplinary competitions, as a practical approach involving physical outputs, have effectively stimulated students' enthusiasm for innovative practice and promoted physical outputs [6]. In addition, some domestic universities have attempted to integrate knowledge from multiple courses to carry out relatively large-scale design or fabrication, thereby improving the practical effects of physical outputs. Some studies have also conducted research on related evaluation systems and achieved certain results [7]. However, the practical teaching evaluation system oriented toward physical outputs still faces sme problems [8, 9].

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

2.1. Lack of corresponding standards and single evaluation method

At present, evaluation is usually completed solely by the instructor in terms of evaluation subjects [10], which is a typical "top-down" evaluation. Students, as the main subjects of learning, have no opportunity for self-evaluation or peer evaluation, nor is there third-party evaluation from industry and enterprise experts. This results in a single evaluation perspective that is insufficiently comprehensive and objective. It also fails to cultivate students' ability to reflect on and evaluate their own learning and cannot effectively stimulate students' initiative and enthusiasm.

2.2. The evaluation system lacks support and long-term safeguard mechanisms.

There is a lack of safeguard mechanisms for management systems, including resource and funding safeguard systems, outcome recognition and transformation systems, and archives and data management systems. Only by improving these relevant safeguard systems can the practical teaching model be continuously revised and improved, thereby achieving high-quality and sustainable long-term development.

3. Diversified and Quantitative Evaluation System

Teaching evaluation is an important part of the practical teaching process. A sound evaluation system helps focus students' learning objectives and, to some extent, plays the role of a baton [10]. In the construction and practice of the "clustered" practical teaching model, this study established a diversified and quantitative evaluation system.

3.1. Diversification of Evaluation Objective Dimensions

In terms of evaluation objective dimensions, the evaluation method based only on final results is broken, and evaluation standards covering multiple dimensions such as physical work quality, design document quality, process performance, and defense/presentation performance are established.

Physical work quality is the most direct and objective output of practical teaching. It is embodied in the functionality, innovation, and comprehensive knowledge application of the physical object, and is the material carrier reflecting students' comprehensive ability and innovative spirit. Design document quality includes requirement analysis, scheme demonstration, detailed design (mechanical drawings, circuit diagrams, code, etc.), calculation notes, experimental methods, technical parameter reports, etc. It is the textual embodiment of engineering thinking and academic standardization, and essentially evaluates students' logical thinking, standardized expression, and scientific research literacy and ability. Process performance evaluates students' degree of investment and active contribution throughout the whole project cycle. This dimension pays more attention to students' implicit abilities and non-technical literacy, mainly including task undertaking, willingness to learn and explore proactively, team communication and division of labor and cooperation ability, and the analytical ability. The evaluation of the defense/presentation performance serves as the final refinement and elevation of the project outcomes. It tests students' abilities in summarization, communication, and marketing. This evaluation covers summarization ability, language accuracy, deportment, PPT, demonstration video, and responsiveness to questions.

3.2. Diversification of Evaluation Subject Dimensions

In terms of evaluation subjects, joint evaluation by course group mentors is adopted, and enterprise/industry experts are appropriately introduced for review. Combined with student self-evaluation and intra-group peer evaluation results, the overall score of the project team and the individual score of each student are obtained.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

Joint evaluation by course group mentors breaks the limitations of a single course and can evaluate students' comprehensive application ability and cross-course integration ability from a more macro and systematic "course group" perspective, ensuring the integrity of the knowledge system. The review mechanism of enterprise/industry experts introduces market standards and market value perspectives. They pay more attention to the innovation of the project, the rationality of the technical route, and the commercial or social value of the results, making the evaluation aligned with the forefront of industry development and actual needs. In the student self-evaluation process, students need to sort out their own contributions, gains, and shortcomings, which can realize self-motivation and self-management, and promote the development of students' cognitive ability. Intra-group peer evaluation reveals students' participation, collaboration, and actual contributions in teamwork. This can effectively avoid the "free-rider" phenomenon and make individual efforts in the team more fairly reflected. Finally, the four-party evaluation results are organically combined to achieve diversification in the evaluation subject dimension, balancing teamwork and individual contribution, encouraging collective wisdom while ensuring the visibility of individual efforts.

3.3. Quantification of the Evaluation System

A quantitative evaluation system helps improve the operability of the evaluation process. Its core lies in transforming abstract learning outcomes and complex behavioral performance into measurable and comparable objective data. Its beneficial effects are mainly reflected in the following aspects.

3.3.1. Improve the objectivity and fairness of evaluation

Traditional qualitative evaluation relies on the subjective feelings and impressions of evaluators, such as "good work" and "active performance", which is easily affected by subjective factors. The quantitative evaluation system sets specific and observable scoring points for each evaluation objective dimension. Its evaluation is based on specific data and facts rather than vague feelings, ensuring that the same "ruler" is used to measure all students and providing a fair competitive environment.

3.3.2. Strengthen the diagnostic and feedback guidance functions of evaluation

Traditional evaluation gives a single score or grade, such as "good" to a project or work, but this evaluation method cannot tell students exactly what is done well and what is insufficient. The quantitative evaluation system can provide subdivided scores for each dimension, and students can clearly see their strengths and weaknesses, which provides extremely clear directions for improvement. At the same time, teachers can analyze the quantitative data of the whole class to find common problems in teaching, making teaching improvement evidence-based.

3.3.3. Clarify objectives and provide students with a clear action guide

The quantitative evaluation system itself is a detailed checklist of learning objectives. At the beginning, students can see the evaluation standards and clearly know "what level of performance earns excellence" and "what level of performance is passing". Therefore, the quantitative evaluation system naturally guides students to strive toward these evaluation standards and becomes a silent "baton".

3.3.4. Make complex evaluation feasible and enhance the operability and efficiency of evaluation

Evaluating a practical project involving multiple dimensions and a long cycle is inherently complex. Without an operable evaluation system as support, the evaluation process and results will become unreliable and uncontrollable. A quantitative evaluation table can provide a scoring basis for evaluation subjects, with a clear process and convenient operation. At the same time, when introducing diversified evaluation subject dimensions, quantitative standards

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

are the only effective and feasible method to ensure consistency and comparability among different evaluation subjects.

4. Support System and Long-Term Guarantee Mechanism

By formulating specific implementation standards, establishing a project resource repository, a case library, and corresponding intellectual property protection mechanisms, and adopting continuous improvement methods, the normalized, high-quality, and sustainable development long-term mechanism of the "clustered" practical teaching model is promoted.

4.1. Institutional Management Guarantee Mechanism

A sound and efficient institutional management guarantee mechanism is the cornerstone for the smooth implementation of the practical teaching model and the achievement of expected results. To ensure the smooth implementation of the "clustered" practical teaching process, this major has constructed a systematic and standardized guarantee system from two dimensions: institutional construction and resource guarantee.

At the level of institutional construction, the Clustered Practical Teaching Management Regulations have been formulated, specifying and standardizing the project implementation process, implementation specifications, evaluation and assessment scheme, allocation of teaching hours for mentor guidance, and application and reimbursement procedures for consumables, providing a complete guiding scheme for the implementation of the practical teaching model.

At the level of resource guarantee, the college has established a "Special Fund for Practical Teaching" and incorporated it into the college's annual financial budget, forming a stable and continuous funding support channel. This special fund is mainly used for software and hardware construction, purchase of experimental materials, and construction of resource and case libraries.

4.2. Establishment of Project Resource Repository and Case Library

A dynamically updated project resource repository and case library have been established. The project resource repository focuses on "process" and "task". Its core is to introduce real product demands, technical problems, or R&D projects from cooperating enterprises. These projects usually have clear objectives, constraints, and industrial backgrounds, which help promote the integration of enterprise needs, technical standards, and real projects into the whole process of practical teaching, and enhance the industrial adaptability of talent cultivation. At present, the Agricultural and Forestry Intelligent Equipment Engineering major has established stable cooperative relations with relevant industry enterprises, clarifying the responsibilities and obligations of enterprises in project supply, technical guidance, achievement evaluation, and resource sharing, providing favorable conditions for industry-education integration in the practical teaching process.

The case library focuses on "result" and "demonstration". Its contents include two types: classic successful/failed project cases from enterprises and outstanding works achievements completed by previous students. Incorporating students' outstanding works into the teaching case library not only enriches teaching resources but also greatly stimulates students' sense of achievement and intrinsic motivation, enhancing their enthusiasm.

4.3. Intellectual Property Protection Mechanism

Under the "clustered" practical teaching model, through intensive project practice, students will inevitably produce some design schemes, experimental schemes, physical works, and software codes with innovative value. Through joint application for patents, software copyrights, and publication of academic papers by students and teachers. These valuable knowledge

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

achievements are effectively protected and transformed into tangible carriers and continuous motivation for students' innovation ability. At the same time, these knowledge outputs are directly linked to awards and honors, credit recognition, and acquisition of innovation credits, motivating students to invest in the entire practical process.

4.4. Systematic Closed-Loop Quality Improvement Mechanism

To ensure that the physical output-oriented "clustered" practical teaching model can dynamically adapt to student needs and technological development and achieve a leap from short-term pilot to long-term development, this project adopts the method and concept of "continuous improvement".

After each practical teaching cycle, the teaching model is reviewed through questionnaire surveys, teacher-student seminars. The survey data are collated and analyzed to provide reference basis for continuous improvement in the teaching organization and implementation methods, optimization of evaluation standards, adjustment of physical output difficulty, and improvement of support and incentive systems under this teaching model, promoting continuous revision and improvement of the practical teaching model, thereby achieving high-quality and sustainable long-term development.

5. Conclusions

Under the background of emerging engineering education, aiming at core-course "cluster-based" practical teaching model oriented toward physical outputs, this study constructs a standardized, diversified, and quantitative evaluation system and obtained the following main conclusions:

(1) A standardized, diversified, and quantitative evaluation system was constructed, realizing an evaluation method with multi-subject and multi-objective collaboration, fully mobilizing students' interest in carrying out physical output practice, and solving the problems of single traditional evaluation methods and students' lack of initiative and enthusiasm.

(2) By establishing a dynamically updated project resource repository and case library, real enterprise project needs, technical standards, and industry experts were integrated into the whole process of course group practical teaching, ensuring that practical content resonates with industrial development, forming a new ecology of collaborative education, and solving the common problem of insufficient industry-education integration in practical teaching.

(3) Corresponding support systems and long-term guarantee mechanisms were established to promote the high-quality and sustainable development of the "clustered" practical teaching model.

Acknowledgments

This work was financially supported by Heilongjiang Provincial Higher Education Teaching Reform Research Project (SJGYB20260069).

References

[1] Di, H. T., Dong, X. B., Xiao, S. L., & et al. (2015). Simulation laboratory construction of stereoscopic telecontrol sand table for forest engineering science. Research and Exploration in Laboratory, 34(4), 246–248.

[2] Ma, P. J., Qiu, Y. T., Cui, J., & et al. (2020). Systematic reform of engineering training for "New engineering" and "Double first-class" construction. Experimental Technology and Management, 37(1), 220–224.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0021

[3] Di, H. T., Dong, X. B., Li, Y. X., & et al. (2018). Research on sustainable development mechanism for university virtual simulation experimental teaching resources. Experimental Technology and Management, 35(5), 236–242.

[4] Li, R. J. (2025). Research on the cultivation of exhibition professionals under the concept of industry-education integration community. Theory and Practice of Education, 45(30), 30–34.

[5] Di, H. T. (2015). Resource sharing mode of virtual simulation experiment teaching demonstration center. Research and Exploration in Laboratory, 34(12), 148–151.

[6] Bao, J. R., Qin, Y. P., Liu, C., & et al. (2024). Exploration of LSTM intelligence-oriented electronic information practice education reform. Experimental Technology and Management, 41(8), 222–229.

[7] Liu, J. X., Feng, L. Y., & Wang, Z. A. (2022). Assessment and implementation of college instruction based on OBE. Journal of North China University of Science and Technology (Social Science Edition), 22(6), 79–84.

[8] Ou, J., Wu, F. G., & Yang, W. B. (2021). An empirical study on experimental teaching quality evaluation based on student-centered concept. Research and Exploration in Laboratory, 40(7), 209–212, 224.

[9] Yu, Y., & Li, C. F. (2025). Construction and reform of the objective-content system for practical education in universities. Ability and Wisdom, (34), 93–96.

[10] Chen, Y. X., Lin, F., Du, X. D., & et al. (2025). Construction of an evaluation model for professional practice courses based on a formative assessment system. Journal of Higher Education, 11(15), 102–105.