Transactions on Comparative Education (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/trance.2024.060611
ISSN 2523-5818 Vol. 6 Num. 6

Construction of a Teaching Quality Monitoring and Evaluation System for Mechanical Engineering under the Background of Science-Education-Industry Integration

Juan Ge[1,2,a,*], Chonghai Xu[1,2,b], Jin Du[1,2,c], Yuexia Lv[1,2,d]

[1]*School of Mechanical Engineering, Qilu University of Technology (Shandong Academy of Sciences), Daxue Road, Jinan, China*
[2]*Shandong Institute of Mechanical Design and Research, Jinan, China*
[a]*joycle_ge@163.com*, [b]*xch@qlu.edu.cn*, [c]*dj84105@126.com*, [d]*yuexialv@foxmail.com*
[*]*Corresponding author*

Keywords: Mechanical engineering, teaching quality, monitoring and evaluation system, science-education-industry integration

Abstract: In the context of integration of science, education and industry, building a sound teaching quality monitoring and evaluation system is an important way to improve the quality of higher education and cultivate high-level talents in mechanical engineering. This study analyzes the problems existing in the current teaching quality monitoring and evaluation system for the discipline of mechanical engineering, including single evaluation indicators, over-reliance on student feedback, lack of peer and expert review, insufficient application of data and technology, and lack of support for teachers' professional development. To address these challenges, this study proposes five innovative strategies: establishing a multi-dimensional evaluation framework, incorporation of diverse stakeholders in the evaluation process, utilization of digital intelligent technologies, enhancement of professional development mechanisms, and aligning evaluation outcomes with incentive mechanisms. These strategies aim to create a comprehensive and dynamic system that bridges education, industry and science, thus achieving continuous improvement and deeper integration between academia and industry.

1. Introduction

The teaching quality monitoring and evaluation system is an important cornerstone to ensure the quality of higher education. It plays a critical role in achieving educational goals, improving teaching effectiveness and cultivating high-quality talents. This system is not only the core mechanism for continuous improvement in teaching quality, but also an important means to promote the professional development of teachers and enhance the learning outcomes of students. Under the background of science-education-industry integration, developing a scientific, dynamic and comprehensive teaching quality monitoring and evaluation system is of importance for cultivating high-level talents that meet the needs of the new era, as well as promoting the deep integration of higher education and social development.

In recent years, a variety of researchers have explored the principles for constructing teaching quality monitoring and evaluation systems from various perspectives, including practical teaching, engineering education accreditation, and the use of big data technologies. Duan et al. [1] designed a professional teaching quality monitoring system in accordance with outcome-based education for geology-related disciplines. Zhu et al. [2] examined monitoring systems for practice-based teaching in high-level professional clusters and analysed challenges. They further proposed a framework which includes a standards chain, objectives chain, support systems, and an intelligent monitoring cloud platform. Liang et al [3] adopted a modular approach for automation disciplines using nodes, modules and systems to design a monitoring framework that integrates digitalization, multi-stakeholder participation and feedback. Wang et al. [4] proposed a practical plan for building a “five-in-one” system to cover culture, standards, frameworks, mechanisms and information. Additionally, Liu et al. [5] introduced a "dual-supervision" monitoring system focusing on both teaching and learning supervision, in order to enhance both learning enthusiasm of students and instructional effectiveness of teachers.

With the rapid development of digital intelligence technologies, emerging technologies such as big data, artificial intelligence, and the Internet of Things are profoundly transforming operational modes across various fields. In higher education, there is a gradual shift from traditional teaching models towards informatization and intelligentization. As a crucial component of engineering education, the mechanical engineering discipline is critical for training talent in manufacturing and technological innovation. However, current teaching quality monitoring and evaluation systems for mechanical engineering predominantly rely on manual assessments, which lack real-time and systematic approaches. Therefore, it is corresponding the interest of the present study to explore and construct a teaching quality monitoring and evaluation system for mechanical engineering education under the background of science-education-industry integration.

2. Problems Existing in Current Monitoring and Evaluation System

2.1 Limited evaluation indicators for teaching effectiveness

The evaluation of teaching quality often relies on limited and simplistic indicators, such as student feedback, course pass rates, and administrative reviews. Even though these indicators offer some insights, they fail to comprehensively assess the multifaceted nature of teaching effectiveness. For mechanical engineering, where theoretical knowledge must integrate with practical application, it is crucial to evaluate aspects such as the teacher’s ability to link theory with practice, facilitate hands-on experiments, guide project-based learning, and mentor students in industrial settings. The current systems rarely include these indicators, which results in an incomplete picture of teaching quality. Moreover, qualitative factors such as classroom engagement, innovative teaching methods and the ability to inspire critical thinking are often overlooked, which further limit the scope of evaluation.

2.2 Over-reliance on student feedback

Student feedback is a critical component of most evaluation systems, which offers valuable insights into the teaching and learning process. However, an over-reliance on student assessments can introduce biases and reduce the objectivity of evaluations. Student assessments are often influenced by factors such as grading leniency, personal preferences and course difficulty, but these criteria do not necessarily align with the actual quality of teaching. For mechanical engineering majors where mastering complicated concepts and rigorous training are essential, such biases can lead to the undervaluation of instructors who prioritize discipline and critical thinking over superficial satisfaction. Furthermore, student feedback mechanisms typically could not account for the long-term

impact of the teacher's contributions, such as the extent to which students are prepared for real-world engineering challenges. These limitations highlight the need for a more comprehensive and multidimensional approach to teacher evaluation, particularly in disciplines requiring high levels of analytical and practical proficiency.

2.3 Insufficient integration of peer and expert reviews

Peer reviews and external expert assessments have the potential to provide critical insights into various dimensions of teaching, including the effectiveness of content delivery, pedagogical strategies, and the alignment of curriculum with industry standards. In the field of mechanical engineering, peer reviews are particularly valuable for evaluating how effectively educators integrate emerging technologies, such as artificial intelligence and additive manufacturing, into their teaching practices. These reviews can ensure that curricula not only reflect technological advancements, but also enhance the practical application of these innovations in educational contexts. Additionally, external expert assessments, especially those conducted by industry professionals, offer a vital perspective on the relevance of course content in addressing current industry demands and anticipating future trends. Such evaluations serve as a bridge between academic instruction and industrial practices, fostering a curriculum that equips students with the skills necessary for professional success. The absence of these perspectives in existing evaluation frameworks limits opportunities for constructive feedback, which is crucial for supporting the professional development of teachers, refining teaching methodologies, and ensuring that academic programs remain aligned with the rapid pace of technological progress.

2.4 Inadequate use of data and technology for monitoring

Traditional methods, such as infrequent classroom observations and periodic surveys, offer limited and fragmented insights into teaching effectiveness. In contrast, learning analytics platforms present an opportunity to provide a more dynamic understanding of teaching performance. These platforms enable the analysis of real-time data on classroom interactions, assessment outcomes and student engagement, so they can offer actionable insights that go beyond surface-level evaluations. For example, data derived from virtual labs or simulations can serve as a robust indicator to assess how effectively teachers facilitate hands-on and practical learning experiences. However, most universities have yet not effectively incorporate digital tools and intelligent systems into teacher evaluation processes. The failure to adopt such advanced technologies not only limits the depth and relevance of evaluative data, but also undermines the ability to deliver timely and constructive feedback to educators.

2.5 Limited focus on professional development

Current monitoring and evaluation systems often emphasize identifying deficiencies in teaching practices, without adequately supporting professional development of teachers. Evaluations are frequently employed as an administrative tool to enforce compliance rather than as a developmental tool to help teachers enhance their skills. In the field of mechanical engineering where technological advancements occur at a rapid pace, teachers require continuous training in emerging tools, methodologies, and industry practices. However, current evaluation systems seldom incorporate mechanisms to identify areas for professional growth or offer targeted support, such as specialized training programs or collaborative opportunities with industry experts. This limited emphasis on fostering professional growth not only undermines motivation of teachers, but also restricts their ability to provide a state-of-the-art educational experience.

3. Establishment of Monitoring and Evaluation System under Digital Intelligence Era

3.1 Development of a multi-dimensional and multi-level evaluation framework

A robust evaluation system shall incorporate diverse and well-structured indicators to accurately assess teaching quality across different dimensions. For mechanical engineering majors, it is critical to evaluate how effectively a teacher bridges theoretical knowledge with practical skills. For example, the system evaluates a teacher's ability to guide laboratory experiments, facilitate project-based learning, and mentor students in industrial internship programs. In addition, quantitative indicators should be complemented with qualitative metrics, which may include a teacher's classroom engagement strategies, ability to inspire critical thinking and innovative teaching methodologies. Moreover, the evaluation framework shall account for industry relevance. This can be achieved by incorporating indicators that evaluate the integration of emerging technologies such as smart manufacturing, artificial intelligence, and additive manufacturing into the curriculum. By addressing both academic and professional dimensions, the evaluation framework will provide a comprehensive perspective on teaching quality.

3.2 Inclusion of diverse stakeholders in the evaluation process

To avoid the over-reliance on student feedback as the primary source of evaluation, the evaluation process should involve multiple stakeholders to enhance objectivity and depth. Peer evaluations from colleagues in similar disciplines can provide insights into teaching methodologies, content depth, and alignment with academic standards. Such evaluations can also highlight best practices and promote collaborative learning among faculty. Additionally, external experts from the industry should be included to evaluate the relevance of course content and teaching approaches to real-world engineering challenges. For example, industry representatives can assess how well courses align with the evolving demands of smart manufacturing and renewable energy systems. Finally, long-term feedback mechanisms, such as graduate surveys and employer input, can capture the sustained impact of teaching on professional success of students, which can offer a broader perspective on a teacher's teaching effectiveness.

3.3 Integration of digital intelligence for smart monitoring and feedback

Digital intelligence technologies shall be adopted to revolutionize the efficiency and precision of teaching quality monitoring systems. Intelligent platforms can collect and analyse real-time data on various aspects of the teaching process, providing a dynamic and detailed picture of teaching performance. For instance, classroom analytics tools can monitor student engagement levels, interaction patterns, and participation in real-time. Similarly, data generated from virtual laboratories and simulation software can evaluate a teacher's effectiveness in facilitating hands-on learning and practical application of theoretical concepts. In addition, smart feedback systems can be designed to automatically generate comprehensive evaluation reports that include actionable recommendations. These systems can provide immediate insights into areas requiring improvement, and enable teachers to adjust their strategies promptly. Moreover, integrating data from diverse sources, such as student surveys, course assessments and resource utilization, can ensure a holistic understanding of teaching effectiveness. The seamless integration of above digital tools can ensure the accuracy of evaluations, and reduce the administrative burden on teachers and evaluators.

3.4 Strengthening professional development and support mechanisms

An effective evaluation system should consider the professional development of teachers as a key part of the evaluation framework, aiming to ensure teachers receive the guidance and resources they need to enhance their skills and adapt to changing educational demands. Based on the assessment results, a personalized development plan is developed. The plan focuses on specific areas such as experimental teaching methods, integration of emerging technologies or innovative teaching methods. Regular training programs, industry seminars and expert-led workshops can help teachers understand the latest advances in the field of mechanical engineering and incorporate the most cutting-edge practices into their teaching. In addition, educational universities should encourage innovative teaching methods, such as flipped classrooms, blended learning and project-based teaching, and promote these novel teaching practices by providing funding and support. Thus, the evaluation system can ensure that teachers continue to have the ability to provide high-quality and industry-relevant education.

3.5 Aligning evaluation outcomes with incentive mechanisms

The integration of evaluation outcomes with incentive mechanisms can serve as a powerful motivator for teachers to prioritize and improve teaching quality. By linking evaluation results to promotions, salary adjustments, and performance bonuses and other tangible rewards, universities can reinforce the importance of excellence in teaching. Recognition programs, such as "Outstanding Educator Awards" or "Innovative Teaching Grants," can highlight and reward exceptional teaching practices, inspiring others to strive for similar achievements. Additionally, providing teachers with constructive feedback and opportunities for self-reflection allows them to better understand their strengths and areas for growth. This can be facilitated through structured mechanisms, such as annual teaching improvement reports or collaborative discussions with peers and mentors. Thus, the teachers' motivation can be enhanced, and a culture of continuous improvement and excellence can be fostered within the universities.

4. Conclusions

Based on an in-depth study of the teaching quality monitoring and evaluation system in the field of mechanical engineering, this paper proposes a novel monitoring and evaluation system which includes multi-dimensional evaluation, stakeholder participation, digital intelligent technology integration, teacher professional development support and incentive mechanism. Through the improvement of the existing evaluation system, the system proposed in this paper can comprehensively reflect the teaching quality and enhance the fairness of teaching evaluation. At the same time, with the help of digital intelligent tools, real-time dynamic monitoring of the teaching process can be achieved, which improves the timeliness and pertinence of feedback, thereby promoting teachers to continuously improve their teaching methods and professional abilities. This study provides an effective way for mechanical engineering education in universities to meet the needs of engineering talent training in the new era.

Acknowledgements

This research was carried out with financial support of Shandong Province Undergraduate Teaching Reform Research Project (Z2021142, M2023246), Teaching Research Project from Qilu University of Technology (Shandong Academy of Sciences) (Research on the Construction of a "Student-Centered" Teaching Quality Monitoring and Evaluation System for Mechanical

Engineering, 2024yb10), for which due acknowledgement is given.

References

[1] Duan Y.M., Li H.Z., Song Z.F. Research on the teaching quality monitoring system of geological majors based on OBE. Journal of Hebei Open University. 2022, 27 (03): 74-76.
[2] Zhu Y.J., Cai B.B., Song C.P. Construction of a practical teaching quality monitoring system for high-level professional groups based on big data. Jiangsu Higher Vocational Education. 2022, 22 (02): 98-102.
[3] Liang H., Cong S., Ma J., Yao X.H., Cai C.T., Xiao M.X., Peng X.Y., Bao P.H. Design of teaching quality monitoring and assurance system in engineering colleges and universities: Taking automation major as an example. The Theory and Practice of Innovation and Entrepreneurship. 2024, 7(15): 1-4.
[4] Wang J.T. Construction of teaching quality monitoring system in applied undergraduate colleges under the background of transformation and development. Journal of Science and Education. 2024, (11): 1-3.
[5] Liu X.F., Zhu H.Y., Zhu B.Y. Research and practice of the "double supervision" teaching quality monitoring system in the application-oriented talent training model. The Theory and Practice of Innovation and Entrepreneurship. 2021, 4(10):178-180.