Education Reform and Development, 2025, Volume 7, Issue 11
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Strategy Design for the Quality Monitoring System of Mechanical Majors Based on Engineering Education Professional Certification

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Abstract: In response to the talent demands of engineering education professional certification for mechanical majors, this paper aims to cultivate applied and innovative talents and designs strategies for a teaching quality monitoring system. The strategies include the improvement of undergraduate talent training programs, the enhancement of theoretical classroom teaching quality, the improvement of practical course teaching quality, the enhancement of teachers' professional and teaching abilities, and the design of a diversified assessment system for course teaching quality. These five monitoring subsystem strategies cover the main areas involved in teaching work, ensuring continuous improvement in talent training programs, course construction, practical links, teachers' lecturing abilities, and teaching quality assessment. This system aims to continuously improve teaching quality and lay a foundation for the efforts to cultivate applied talents with solid theoretical knowledge, strong innovation capabilities, and practical skills.

Keywords: Mechanical engineering; Teaching monitoring system; Engineering education program; Continuous improvement; Assessment

Online publication: December 12, 2025

1. Introduction

The Washington Accord is an agreement for the mutual recognition of undergraduate engineering degrees. It was initiated and signed in 1989 by private engineering professional organizations from six countries: the United States, the United Kingdom, Canada, Ireland, Australia, and New Zealand. The agreement primarily addresses the mutual recognition of qualifications for undergraduate engineering degrees, which typically have a duration of four years. On June 2, 2016, China's application for full membership was unanimously approved by the Washington Accord General Assembly, becoming the 18th full member of the Washington Accord, thereby achieving international recognition for engineering education and engineering qualifications [1–4].

Engineering education professional certification is a specialized accreditation implemented by professional accreditation bodies for engineering programs offered by universities. It is conducted by professional associations (federations), professional societies, along with educational experts and industry experts in the field, to provide a guarantee of quality for preparatory education for engineering and technical personnel entering the industrial sector. It is also an internationally recognized system for ensuring the quality of engineering education and serves as an important foundation for the international recognition of engineering education and engineering qualifications. The core of this certification is to confirm that engineering graduates meet the established quality standards recognized by the industry, and it is a qualification evaluation oriented towards educational goals and graduation requirements [5].

The implementation of engineering education professional certification in China is beneficial for constructing a quality monitoring system for engineering education, advancing engineering education reform, and further improving the quality of engineering education. It establishes a professional certification system for engineering education that is connected with the engineer system, promotes the connection between engineering education and the industry, enhances the adaptability of engineering education talent training to industrial development, and facilitates the international recognition of Chinese engineering education, thereby enhancing the international competitiveness of China's engineering and technical talents. Therefore, only schools (and majors) that have undergone engineering education professional certification can gain greater social recognition, and their graduates will be more readily accepted [6].

2. The current state of teaching for mechanical engineering majors under engineering education professional certification

Since the 1990s, research on ensuring the quality of higher education has emerged worldwide, with more than 100 countries establishing higher education quality assurance agencies. Currently, there are four main models for higher education quality assurance and evaluation internationally: the institutional audit model represented by the United Kingdom, the quality accreditation model represented by the United States, the self-assessment model represented by Japan, and the government assessment model represented by France [7].

China's general undergraduate teaching quality assurance system is in the stage of research and development. Ma [8] has constructed a quality monitoring and evaluation system for the practical teaching of mechatronics majors, but it is not closely integrated with engineering practice and lacks sufficient training in engineering thinking. Both Cao [9] and Pan [10] have proposed reform suggestions from the perspective of professional course teaching quality evaluation, but they have overlooked the process supervision of both theoretical and practical teaching. Huang [11] has provided methods for the continuous improvement of theoretical teaching quality from aspects such as training programs, curriculum systems, classroom teaching quality, and course design, but the teaching of practical courses has seen little effect. Mei Yi, based on the philosophy of engineering education professional certification, conducted a teaching quality analysis of manufacturing equipment courses. By integrating innovative awareness and engineering application capabilities, it has, to some extent, improved the ability to solve simple engineering problems, but there is a lack of teaching feedback information [12].

Analyzing the current state of research, the deficiencies in the teaching status of mechanical engineering majors are mainly manifested as: insufficient investment in practical teaching equipment, a lack of applied teaching staff, incomplete monitoring systems for theoretical and practical teaching processes, a lack of detailed teaching feedback loops, and an imperfect assessment mechanism.

3. Constructing a teaching quality monitoring system for mechanical engineering majors in the context of engineering education certification

Engineering education professional certification adheres to the principle of student-centeredness, with a focus on student learning outcomes (Outcome-based), and evaluates the achievement of course teaching objectives and the teaching process as two key points. It also features a continuous and effective quality improvement mechanism, which is an important criterion for assessing the quality of undergraduate teaching [13]. Jiangsu Ocean University's School of Mechanical Engineering offers majors in Mechatronics Engineering, Mechanical Design, Manufacturing and Automation, and Robotics Engineering, with both Mechatronics Engineering and Mechanical Design, Manufacturing and Automation having successfully passed the engineering education professional certification. The teaching quality monitoring system is an important measure to ensure the quality of undergraduate education; its scientific integrity directly affects the enhancement of teaching quality. An unscientific monitoring system not only fails to guarantee the quality of talent cultivation but may also have a negative impact on the normal development of students [14]. Therefore, it is necessary to design a teaching quality monitoring system strategy for mechanical majors based on engineering education professional certification. On one hand, by conducting an in-depth analysis of the current teaching quality monitoring, the system can be improved, facilitating the review of mechanical majors that have passed the engineering education professional certification. On the other hand, it is beneficial for the Robotics Engineering major to apply for and pass the engineering education professional certification. This teaching quality monitoring system includes the strategic design of the following five monitoring subsystems, as shown in **Figure 1**.

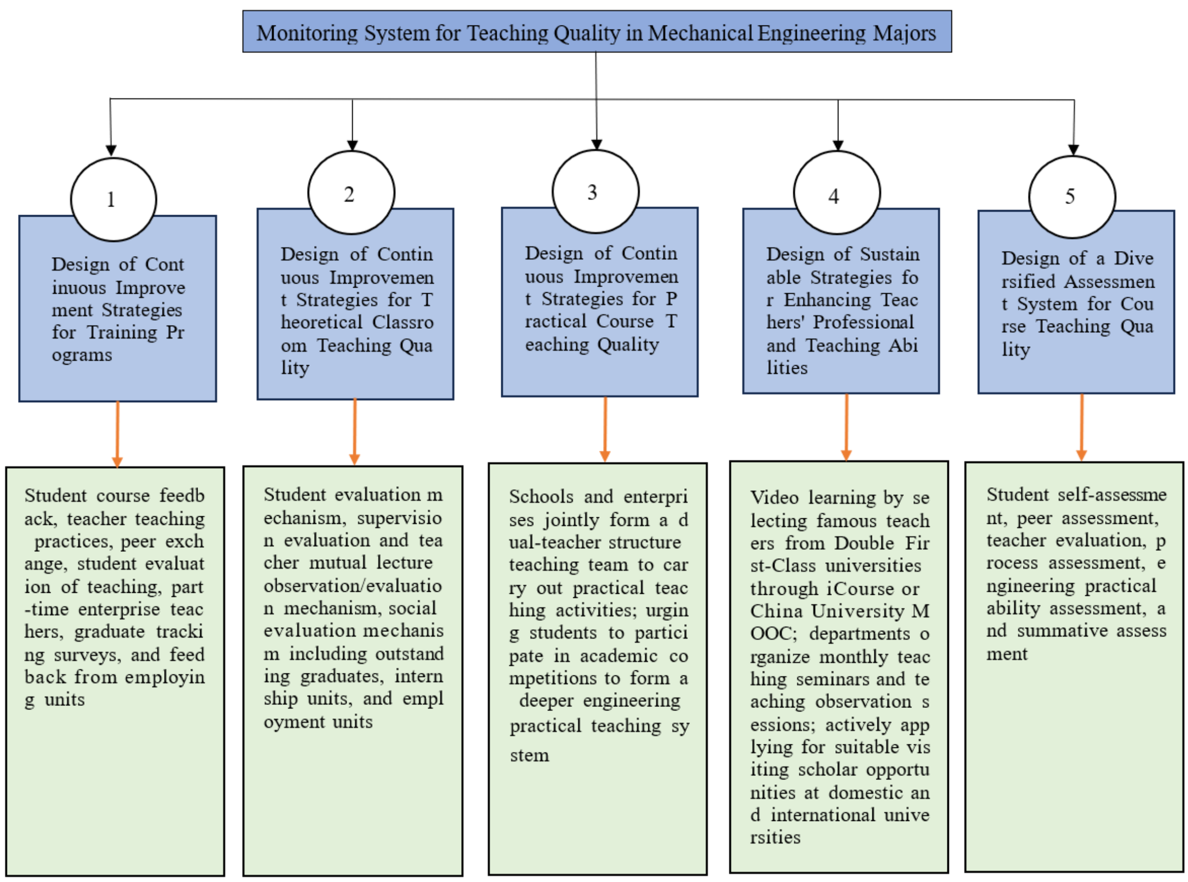

Figure 1. Teaching quality monitoring system for mechanical engineering programs.

3.1. Continuous improvement strategy design for undergraduate talent training programs based on the strategic goal of 'Building a well-known, distinctive high-level applied research-oriented maritime university in China'

Based on the OBE (Outcomes-Based Education) teaching philosophy, the training objectives for mechanical engineering majors should be supported by appropriate teaching content, and the knowledge and ability requirements in the courses must fully cover the professional ability requirements in the course objectives. The formulation and revision of the talent training plan stem from student course feedback, teaching practices of faculty, peer exchanges, student evaluations of teaching, part-time teachers from enterprises, tracking surveys of graduates, and feedback from employers. The continuous improvement design of the talent training plan is a core element of engineering education. There should be a minor adjustment to the talent training plan every year and a fine-tuning every four years, guided specifically by the achievement of course objectives. Teaching content should also keep pace with societal and industry development needs. The selection of teaching methods should serve the realization of course objectives, and the course syllabus must have a clear correspondence with the graduation requirements indicators and support the requirements in the professional ability matrix. It should be explicit in the syllabus which abilities are being supported and cultivated. The course syllabus should act as a "guide" for the course teaching process. The development of the course syllabus is a key component of course evaluation, and course evaluation is the closed-loop feedback tracking mechanism of the teaching quality monitoring system.

The method of course evaluation is based on the course syllabus, employing the rationality evaluation and achievement evaluation of course objectives. The rationality evaluation of courses is conducted on an annual basis, throughout the entire semester in which the course is offered, ending at the end of the term. The evaluation sample consists of the current students. Based on the evaluation results, the relevant course team proposes continuous improvement measures. The course evaluation results are kept together with the exam papers in the exam paper box. Achievement evaluation includes assessments of the achievement of professional training objectives, graduation requirements, and course objectives. Professional training objectives are supported by the achievement of graduation requirements, which in turn are supported by the achievement of course objectives. Whether graduates can match the needs of society and industry development, align with the school's educational positioning, and correspond with the characteristics of the major largely depends on the formulation of professional training objectives. Graduation requirements are established based on the capability elements of the training objectives. The ability to formulate effective continuous improvement measures and enhance the quality of talent cultivation and the development of the entire major depends on the objectivity, scientific nature, and comprehensiveness of the evaluation system.

Jiangsu Ocean University's School of Mechanical Engineering, to ensure the stability and continuity of teaching, will keep the "2 stages + 4 platforms + 10 modules" curriculum system essentially unchanged in the 2024 revision of the training plan. At the same time, based on the continuous improvement strategy of the talent training plan and the university's own characteristics as well as the needs of the maritime field, a curriculum system that unifies normativity and autonomy in talent training is constructed. The setting of training objectives and graduation requirements follows the national standards for teaching quality. The adjustments to the 2024 training plan are as follows: To highlight the maritime characteristics of the curriculum system, at least 3 maritime characteristic professional courses are set (including 1 compulsory professional course), and the compilation of textbooks that meet the needs of the maritime field and the characteristics of the school is encouraged. Practice with maritime characteristics is carried out to cultivate students' awareness of knowing the sea, loving the sea, protecting the sea, and strengthening the sea. To strengthen the collaborative training of industry and education, the proportion of industry-education integrated courses has increased to more than 30%. To enhance the effectiveness of practical teaching, the proportion of practical credits is increased to more than 35%, and students are encouraged to concentrate on internships and training in enterprises in their fourth year. To promote the alignment of course design with international standards, at least 2 bilingual or fully English international courses are offered. Students are encouraged to use appropriate digital tools, platforms, and resources through digital platforms to enhance their digital learning capabilities, and to cultivate and stimulate students' digital learning power, adaptability, and creativity.

3.2. The design of continuous improvement strategies for theoretical classroom teaching quality based on feedback information

The theoretical classroom teaching adheres to a student-centered approach, with a focus on student learning outcomes as the guiding principle. It encourages student participation in the teaching process by integrating engineering scenarios with theoretical classroom instruction, thereby stimulating the students' internal motivation to learn. Teachers shift from being the "leaders" of teaching to facilitators, ensuring that the teaching process is centered on student development. This approach enhances students' interest in their professional studies, which is conducive to creating a cognitive environment that allows students to more deeply understand engineering theories and principles. To improve the quality of theoretical classroom teaching, establishing a continuous improvement strategy for classroom teaching quality based on feedback information is essential.

Firstly, establishing a reasonable student teaching evaluation mechanism is essential. This mechanism includes mid-term and final-term teaching evaluations. As the primary evaluators, students assess the teaching quality of teachers through attending classes, questionnaires, and discussions, providing suggestions for improvement to enhance the teaching skills of the teachers. The mid-term teaching evaluation scores constitute 20% of the total student evaluation scores. As the primary evaluators once again, students assess the teaching quality of teachers through the same methods for the final-term teaching evaluation, which constitutes 80% of the total student evaluation scores. These student evaluation scores are then integrated into the teacher's title evaluation process.

Subsequently, establish a supervisory teaching evaluation and peer listening to lectures and evaluate the teaching mechanism. The school and college form a supervision team to systematically oversee teachers' lesson plans, preparation, teaching performance, classroom attendance, teaching logs, and schedule adjustments or cancellations through random checks, discussions, student interviews, and questionnaire surveys. The college mandates that each teacher attend one class of six different teachers per semester. Through peer listening to lectures and evaluating the teaching mechanism, mutual teaching and learning are facilitated.

Finally, establish a social evaluation mechanism that includes outstanding graduates, internship units, and employment units. Through mechanisms such as outstanding graduate discussions and visits to internship and employment units, provide external support for the continuous improvement of course teaching and talent training programs through external tracking and feedback.

Reflect the teaching and talent cultivation issues identified by the aforementioned evaluation mechanism in a timely manner to the relevant teaching responsibility units or directly responsible individuals. Verify, process, and respond to the feedback, and make improvements in subsequent classroom teaching. Additionally, the improvement process and its effects must be tracked and documented.

3.3. Design for the continuous improvement of teaching quality in practice-based courses focused on engineering practice and innovative capabilities

Building on the theoretical professional studies of the first two academic years, the third year begins with the engineering practice teaching segment, placing a strong emphasis on cultivating students' engineering concepts and the ability to solve complex engineering problems. By integrating classroom teaching with experimental practice and industrial site projects through the engineering practice segment, the focus is on developing students' practical engineering and engineering application skills.

Practical teaching also adheres to a 'student-centered' approach, and the engineering practice capabilities of teachers directly affect the quality of talent cultivation in this specialty. Therefore, it is particularly important to have a high-level, practical teaching team. Consequently, schools and enterprises jointly form a dual-teacher structured teaching team to carry out practical teaching activities, allowing team teachers to move freely between schools and enterprises. Among them, in-school instructors are required to regularly visit research institutes and enterprises for further study, conduct research topics, and participate in joint development projects (for no less than two months) each year to continuously improve their theoretical knowledge and practical skills. Enterprise instructors are mainly senior engineers with more than five years of work experience. Half of the class hours for each core practical course are taught personally by enterprise instructors, with content closely related to production practice, and in-school instructors follow up throughout. On one hand, students gain a deeper understanding of the theoretical part through the study of actual enterprise cases, effectively enhancing their engineering design capabilities, engineering innovation capabilities, and hands-on skills. On the other hand, in-school instructors can better connect theory with practice. Additionally, enterprise instructors assess students' engineering practice abilities and determine whether their practical skills meet the production requirements of enterprises. At the same time, enterprise monitoring and evaluation mechanisms are introduced to dynamically supervise and provide feedback on various teaching segments of engineering practice, and continuous improvements are made based on the feedback to enhance the teaching effectiveness of engineering practice courses and achieve the goal of cultivating high-level applied research talents.

Disciplinary competitions serve as a platform to demonstrate students' comprehensive qualities and their ability to solve practical problems. They are one of the ways to assess students' learning outcomes. By organizing mechanical discipline competitions and innovation contests, while also focusing on the integration of multidisciplinary knowledge and the cultivation of professional skills, a deeper engineering practice teaching system can be formed. This allows students to develop excellent professional engineering literacy and innovation capabilities during their time at school. Additionally, students should actively apply for national, provincial, and university-level college student innovation and entrepreneurship projects, widely participate in teacher-led research topics, and engage in innovation and entrepreneurship activities to further hone their learning skills, engineering practice skills, and innovative design capabilities.

3.4. Designing sustainable strategies for the enhancement of teachers' professional and teaching abilities

The college encourages each teacher to select top-tier university teaching from the 'Love Courses' or 'China University MOOC' platforms that offer courses identical to their own, for video-based learning. The learning content includes teaching methods, course key points and difficulties, course schedule arrangements, interaction methods with students, homework assignments, assessment methods, etc. If there are any questions or ideas, teachers should actively engage in discussions with the instructors to continuously improve their professional capabilities.

The department organizes a monthly teaching seminar and teaching observation study, requiring young teachers to actively participate, thereby better facilitating resource sharing, learning from others' strengths, and continuously improving their own teaching levels. At the same time, young teachers are organized to participate in basic teaching skills competitions, innovative teaching contests, national and provincial teaching competitions, and young doctoral teachers are sent to enterprises for temporary positions to enhance their teaching abilities.

The school has a quota for visiting scholars each year. Teachers who teach courses and conduct research should actively reach out to well-known universities at home and abroad, and select the most suitable institutions to apply for visiting study. During their visit, they should actively engage in teaching exchanges with the host department, participate frequently in lesson observation and evaluation activities, and attend academic events to broaden their research fields, thereby improving their teaching and research capabilities as much as possible.

3.5. Design of a diversified assessment system for course teaching quality

In traditional teaching models, teachers are the main body in assessing students' academic performance, and students can only passively accept the teacher's evaluation, which does not fully reflect the students' achievements. American psychologist Bandura's triadic reciprocality theory suggests that cognition of external objects should combine three elements: environment, behavior, and person. This theory provides a basis for reforming assessment methods. Guided by the philosophy of engineering education professional accreditation, the evaluation has expanded from traditional teacher assessment of students to include self-assessment by students, peer assessment, teacher evaluation, process-based assessment, engineering practice ability assessment, and summative assessment. The evaluation subjects have shifted from a monolithic to a diversified approach.

The design of a diversified assessment system for course-teaching quality includes: self-directed learning (5%), independent homework completion by students (5%), classroom discussions (10%), transitional assessment (20%), engineering practice capability assessment (30%), and final-exam score (30%). The specific distribution is shown in Figure 2. Specifically, reviewing the main content of the previous class through questions at the beginning of the class to understand students' independent study is part of the self-assessment by students. To ensure students better grasp key and difficult knowledge, teachers need to assign targeted homework, and the students' timely and independent completion of this homework falls under the peer-assessment category. In the teaching process, classroom discussions and questions are used to gauge students' enthusiasm for the course and their learning status, which is part of the teacher's evaluation. Attendance and mid-term assessments are used to understand the teaching situation and students' mastery of knowledge, to identify issues in a timely manner and make corrections, which is part of the process assessment. Engineering practice ability is assessed by enterprise instructors who set project topics based on enterprise production needs, to evaluate students' practical skills and determine whether their operational skills meet the production requirements of enterprises. The final exam scores represent the culmination of the assessment process.

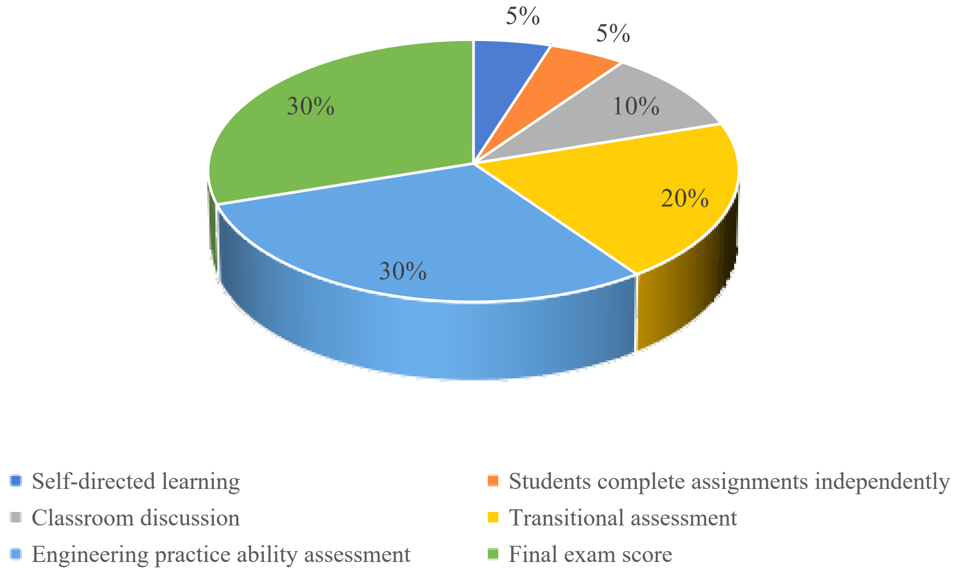

Figure 2. Distribution of the diversified assessment system for course teaching quality.

By employing this diversified assessment system, the primary responsibility for learning is emphasized among students, and their learning progress is monitored throughout the entire teaching process. This approach fosters students' interest in their academic field and enables the timely identification of issues within the teaching process, leading to continuous improvements and an enhancement in the quality of talent development.

4. Conclusion

The teaching quality monitoring system strategy proposed in this paper leverages the opportunity of engineering education professional accreditation to further refine the undergraduate talent training plan, enhance the quality of theoretical classroom teaching, improve the teaching quality of practical courses, elevate the professional and teaching capabilities of faculty, and design a diversified assessment system for course teaching quality. The strategic design of these five monitoring subsystems encompasses the main areas involved in teaching work, ensuring the continuous improvement of talent training plans, course development, practical components, faculty teaching abilities, and teaching quality assessments. This system is designed to continuously enhance teaching quality and achieve a progressive enhancement in the cultivation quality of high-level applied research talents.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zheng W, Hao C, Guo L, et al., 2017, Analysis on the Practice Teaching Reform of Mining Engineering Under the

Background of Engineering Education Accreditation. Education Teaching Forum, 2017(17): 158–159.

[2] Zhang H, Kong X, Chang X, et al., 2024, Discussion on the Training Mode of Applied Chemical Engineering Talents Under the Background of Engineering Education. Chemical Engineering Design Communications, 50(2): 79–81.

[3] Sun N, 2016, Current Situation and Prospect of Engineering Education Accreditation in China. Innovation and Entrepreneurship Education, 7(1): 29–34.

[4] Zhu Y, Ye Y, 2009, Research on ABET Engineering Accreditation Criteria. Modern University Education, 2009(3): 46–50.

[5] Luo Z, 2008, Engineering Education Accreditation and Its Impact on University Practice Teaching. Research and Exploration in Laboratory, 27(6): 1–3.

[6] Yao T, Wang H, She Y, 2014, Exploration of Engineering Education Accreditation in China: From the Perspective of the Washington Accord. University Education Science, 2014(6): 28–32.

[7] Xu J, 2020, Construction of Teaching Quality Monitoring System for Electrical Automation in Higher Vocational Colleges Based on Engineering Education Accreditation. Occupation, 2020(32): 77–78.

[8] Ma C, Chen H, Ri Z, et al., 2021, Construction of Monitoring and Evaluation System for Practical Teaching Quality of Mechatronics Under Emerging Engineering Education. Xinjiang Agricultural Mechanization, 2021(3): 45–46 + 48.

[9] Cao R, Wu Y, Fu X, et al., 2020, Evaluation of Core-Course Teaching Quality for Automation Specialty Based on Engineering Education Accreditation. Education Teaching Forum, 2020(13): 86–87.

[10] Pan C, Song X, Xiang J, 2022, Study on Teaching Quality Evaluation Criteria of "Mechanical Design" Course Based on Engineering Education Accreditation. Heilongjiang Education (Higher Education Research & Appraisal), 2022(5): 29–30.

[11] Huang Y, Lu H, 2022, Continuous Improvement of Undergraduate Teaching Quality Based on Accreditation: A Case Study of Automation Specialty in Anhui Polytechnic University. Science & Technology Vision, 2022(9): 108–110.

[12] Mei Y, 2022, Analysis of Teaching Quality Standards for Manufacturing Equipment Courses. Electronic Technology, 51(5): 97–99.

[13] Bansal S, Bansal A, Dalrymple O, 2015, Outcome-Based Education Model for Computer Science Education. Journal of Engineering Education Transformations, 28(2): 113–121.

[14] Gong J, Sun J, 2020, Construction of an Evaluative Teaching Quality Monitoring Mechanism. Research and Exploration in Laboratory, 39(12): 171–173.