DOI URL: https://doi.org/10.63944/wmc.NHE.2
Vol.1 No.2

Exploration on the Teaching Reform of the Course "Packaging Testing Technology"Based on the OBE Concept

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Abstract: "Packaging Testing Technology" is a fundamental and core course within the Packaging Engineering curriculum, playing a pivotal role in developing students' comprehension of testing principles, methodologies, and engineering applications. Under the dual guidance of Engineering Education Accreditation (EEA) standards and the Outcome-Based Education (OBE) philosophy, curriculum reform in this course necessitates a systematic restructuring of its instructional objectives, content framework, practical modules, assessment mechanisms, and continuous improvement strategies. Anchored in the OBE approach, this study conducts a comprehensive analysis of the Packaging Testing Technology course by integrating questionnaire surveys, student performance analytics, and reflective teaching evaluations. Through this evidence-based analysis, the paper identifies key deficiencies in alignment between course objectives, learning outcomes, and industry competency requirements. Accordingly, a reform framework is proposed featuring reverse curriculum design, modularized instruction, tiered practical training, multi-dimensional assessment, and a continuous improvement feedback loop. This reform model aims to holistically enhance students' engineering practice capabilities, innovative thinking, and overall professional competence. The findings suggest that such an approach not only strengthens the alignment between teaching outcomes and engineering practice needs but also provides a transferable reference for pedagogical reform in other engineering-oriented courses.

Keywords: Packaging engineering; Packaging testing technology; Outcome-based education; Teaching reform; Engineering education certification

Funding Project: Hunan Provincial General Higher Education Teaching Reform Research Project (202502002052 and HNJG-20230743); Hunan Provincial Research Project on Degree and Graduate Education Teaching Reform (2025JGYB326); Key Project of Education and Teaching Reform Research in General Colleges and Universities in Hunan Province (HNJG-20230724); Hunan University of Technology Teaching Reform Project (SJG-0125212); Hunan University of Technology Degree and Postgraduate Education Teaching Reform Research Project (JGYB25011).

Introduction

Outcome-Based Education (OBE), which focuses on students' ultimate learning outcomes and uses a backward design approach for curriculum and instruction, emphasizing continuous improvement, has become a core concept in international engineering education accreditation. my country's engineering education accreditation aligns with the Washington Accord, and the OBE concept is of great guiding significance in promoting curriculum and teaching reforms[1].

The Outcome-Based Education (OBE) philosophy holds significant importance for higher engineering education. On the one hand, OBE aligns with the higher demands for the quality of engineering talent training in the context of the new industrial revolution, emphasizing that educational investment should be measured by actual output (student capabilities). China joined the Washington Accord in 2013, marking the substantial alignment of my country's engineering education professional accreditation with international standards. This also means that China must practice the three core principles of outcome-based education, student-centered learning, and continuous improvement to enhance the quality of engineering talent training [2, 3]. The introduction of the OBE philosophy provides clear guidance for the reform of engineering education in my country, helping universities reshape their training programs and curriculum systems around graduation requirements. On the other hand, OBE focuses on the knowledge, skills, and qualities that students should possess upon graduation, requiring a backward design of courses—first defining training objectives and graduation requirements, and then formulating course objectives and teaching content, ensuring that each course makes a clear contribution to the training objectives. This “designing from the end point” approach can promote the overall optimization of the curriculum system and overcome the problems of traditional courses operating in isolation and knowledge fragmentation [4]. In short, the OBE philosophy emphasizes focusing on the student's final output, ensuring the continuous improvement of talent training quality by clearly defining learning outcomes, carefully designing teaching activities, and establishing evaluation mechanisms. Against this backdrop, integrating the OBE philosophy into undergraduate course teaching reform has become a development trend in higher engineering education. Especially in engineering courses with strong practical components, OBE can encourage teaching to focus more on cultivating and achieving student capabilities. For example, traditional education often measures students through multiple-choice tests, focusing more on evaluating knowledge retention and failing to reflect students' actual application abilities. In contrast, OBE advocates that students demonstrate their learning through higher-order tasks such as project planning, case studies, experimental practice, and oral presentations, cultivating their ability to solve open-ended problems. This shift has profound implications for the reform of engineering course teaching, requiring teachers to shift from “teaching students what to know” to “cultivating what students can do,” thereby better meeting the demands of industry and society for graduates' capabilities [5].

1. Main problems in the teaching of the “Packaging Testing Technology” course

“Packaging Testing Technology” is a core professional course in packaging engineering, primarily teaching the testing principles and methods of packaging materials, containers, and components. It has strong practical engineering relevance. Currently, many universities still have shortcomings in the teaching content, methods, and assessment mechanisms of this course, making it difficult to fully meet the talent training requirements under the Outcome-Based Education (OBE) philosophy [2-4].

According to a 2024 questionnaire survey of packaging engineering students at our university (120 valid questionnaires returned, 95% response rate), 78% of students believed that the course content lagged behind industry practices, and 65% believed that the assessment methods were too simplistic and failed to reflect actual abilities. These problems severely hinder the development of students' engineering practical skills and innovative thinking. Therefore, this paper will systematically propose corresponding teaching reform measures based on the OBE philosophy, aiming to construct a closed-loop teaching system of 'objectives-content-methods-evaluation-improvement' to address the existing challenges [3].

Firstly, in terms of teaching content, there are problems of fragmented knowledge points and insufficient updates. On the one hand, the course covers a wide range of topics, including signal and sensor principles, testing instruments and error analysis, packaging material mechanics and environmental testing methods, and relevant national standards. While the knowledge coverage is broad and emphasizes both theory and practice, due to limited class time (usually only about 24 hours of theoretical instruction), the knowledge in each chapter is often fragmented and lacks organic connection, making it difficult for students to see the bigger picture. On the other hand, packaging testing technology is continuously developing with industrial upgrading, and new instruments and standards are constantly emerging, but the course content is not updated in a timely manner, and textbook development lags behind. Some traditional teaching content is out of sync with actual industry needs, affecting the cutting-edge and practical nature of students' knowledge structure. Existing courses often allocate content evenly across chapters, lacking selection and focus tailored to the characteristics of packaging engineering. All of the above lead to students' inability to integrate the knowledge they learn, preventing them from forming a complete knowledge system and application capabilities [6].

Secondly, in terms of teaching methods, traditional teaching is mainly based on classroom lectures, which is relatively monotonous and fails to stimulate students' learning enthusiasm. Most students in packaging engineering have average academic backgrounds, and their independent learning ability, comprehension, and practical skills are relatively weak. If teaching still relies primarily on teacher-led instruction and passive knowledge reception by students, it may lead to inattention and low learning interest. Currently, many classrooms lack interaction and practical sessions, and the teaching methods are not flexible or innovative enough [7]. For example, some teachers focus on theoretical explanations, lacking intuitive demonstrations and case studies; practical teaching is disconnected from theoretical classes, and experimental content is limited to verification experiments, depriving students of opportunities for hands-on exploration and innovation. Furthermore, students in the new era are accustomed to multimedia and online environments; if teaching remains limited to rote learning, it will be difficult to motivate their active participation. The outdated teaching methods restrict the cultivation of students' practical abilities and creative thinking.

Furthermore, the assessment mechanism is relatively simplistic, making it difficult to comprehensively reflect students' learning achievements. Traditionally, the assessment for this course mainly relies on a final written exam, with a very low weighting given to coursework and participation. This type of one-time, summative assessment primarily checks students' memorization and understanding of knowledge points, which can easily lead to a lack of motivation in students' daily learning and a tendency to cram before exams [8]. Furthermore, evaluating students solely through written test scores makes it difficult to assess their practical skills and comprehensive application abilities. If the exam questions mainly consist of objective questions such as multiple-choice and fill-in-the-blank questions, they can only test memory and recall, failing to allow students to demonstrate their ability to apply and analyze the knowledge they have learned. The single evaluation subject (primarily assessed by teachers) and the concentration of evaluation at the end of the course also lead to delayed teaching feedback, which is not conducive to timely improvement of teaching. This unreasonable assessment mechanism results in students "studying only to pass exams and forgetting everything afterward," making it difficult to guarantee teaching effectiveness and failing to meet the requirements of OBE for continuous evaluation and monitoring of learning outcomes [9].

Finally, there are also issues with the unclear positioning and objectives of the course. Some teachers lack a clear understanding of the specific skills and abilities that the course should cultivate, and the course objectives are vaguely stated and not precisely aligned with the professional training objectives. This makes it difficult to selectively emphasize key points and serve the ultimate training goals during the teaching process. Furthermore, different institutions have varying approaches to the positioning of "Packaging Testing Technology": some emphasize the fundamentals of mechanical testing technology, while others focus on the application of packaging material testing. If the course objectives are not focused on the talent needs of the specific major, the teaching content and depth may be inappropriate [10]. In short, the aforementioned problems in the content, methods, and assessment of the "Packaging Testing Technology" course currently hinder the improvement of teaching quality and are detrimental to students' achievement of relevant skills and outcomes. These issues need to be addressed through teaching reforms guided by the OBE (Outcome-Based Education) philosophy.

2. Teaching Reform Measures for the "Packaging Testing Technology" Course Based on the OBE Concept

To address the aforementioned issues, and based on the "outcome-based education" (OBE) philosophy, the "Packaging Testing Technology" course can be systematically reformed in terms of course objectives, teaching content, practical teaching, evaluation methods, and feedback and improvement. The following will elaborate on the specific reform ideas and measures in conjunction with the OBE philosophy.

2.1. Clearly define the alignment between course objectives and graduation requirements.

Addressing the issues of unclear course objectives and weak correlation with professional graduation requirements, the primary measure of this reform is to clarify course objectives. The OBE (Outcome-Based Education) philosophy requires first defining the course's role in talent cultivation and the required outcomes. The primary measure of this course reform is to clearly define the learning objectives and outcomes of the "Packaging Testing Technology" course based on the training objectives of the packaging engineering major. Specifically, this involves aligning with the graduation requirements of engineering education accreditation and determining the indicators that this course needs to support, such as "possessing basic knowledge of the principles of packaging materials and packaging component testing," "being able to design and implement packaging testing experiments and analyze data," and "mastering relevant standards and specifications and solving practical packaging testing problems." Each course objective must be clearly stated and measurable. Then, using the "backward design" principle of OBE, the teaching content and process are planned starting from these ultimate goals. That is, teaching design should begin with achieving the expected learning outcomes, rather than simply following the chapter order of previous textbooks. By developing a mapping matrix between course objectives and graduation requirements, each teaching segment of the course is aligned with the expected outcomes, ensuring that the course teaching is targeted and effective. For example, if one of the training objectives is "the ability to select appropriate testing methods and write test reports," then the course should include relevant teaching content and exercises, and design assessment tasks to verify whether students have achieved this ability. Clear course objectives are both the starting point of teaching reform and will permeate all aspects of textbook writing, teaching methods, and evaluation, providing direction for the reform.

In curriculum design, the professional characteristics and application-oriented nature of this course should be fully reflected. Outcome-Based Education (OBE) emphasizes that instructional design should be “clearly focused” on the outcomes that students can ultimately achieve. Therefore, this course can be structured around several modular learning outcomes, such as:

1. Understanding the basic theoretical principles of packaging testing;
2. Mastering the use of typical sensors and testing instruments;
3. Being able to independently complete typical tests of packaging materials and packaging components according to standards;
4. Being able to analyze test data and write standardized test reports;
5. Possessing the innovative ability to design simple test schemes and improve testing devices.

Each learning outcome corresponds to specific knowledge points and skill requirements, and can be further broken down into concrete performance indicators (for example, the indicators for “independently conducting experiments” may include: correctly formulating test procedures, correctly operating equipment, and recording and analyzing data). These indicators will serve as the basis for evaluating students' achievement during the teaching process. By breaking down objectives in this top-down manner, both teachers and students clearly understand “what outcomes need to be achieved,” ensuring that teaching activities consistently revolve around these expected outcomes. This design ensures that the course objectives are clearly defined, addressing the previous problem of vague course objectives and their disconnect from actual outcomes, thus making the course a truly integral part of the professional training system.

2.2. Reorganization and modularization of teaching content.

To address the problems of outdated teaching content and fragmented knowledge points, this study focuses on the Outcome-Based Education (OBE) principle to reorganize and modularize the teaching content. Based on the redefined course objectives, the teaching content needs to be optimized and integrated, highlighting key points and difficulties, incorporating new knowledge, and adopting a modular structure to facilitate progressive learning. First, according to the OBE principle of “focusing on important, fundamental, and core outcomes,” the existing teaching content is reviewed, and selections are made based on their contribution to the learning objectives and industry needs. The course content is divided into several modules, each corresponding to a specific learning outcome. For example, the course content can be reorganized into: “Sensors and Signal Conditioning Module,” “Error and Dynamic Characteristics Module,” “Packaging Materials Testing Module,” “Packaging Containers and Transport Packaging Testing Module,” “Test Data Analysis and Standard Application Module,” etc. The knowledge points within each module are intrinsically linked, and the modules follow a progressive relationship from basic to applied knowledge, forming a clearly structured curriculum. Modularization facilitates knowledge integration: students learn both theory and practice within a module, overcoming the previous shortcomings of separating theory and practice. For example, in the “Sensors and Signal Conditioning” module, the principles of common sensors are taught simultaneously, and students understand signal processing through demonstrations of bridge circuits and filter design software, connecting to subsequent dynamic characteristics testing experiments. Modular design ensures that each knowledge unit is closely aligned with the corresponding skill development, ultimately converging to achieve the overall course objectives.

Secondly, emphasis is placed on the introduction of new knowledge and industry standards to ensure that the teaching content keeps pace with the times. New equipment and methods are constantly emerging in the field of packaging testing technology, and cutting-edge content should be appropriately included in teaching to stimulate students' interest and broaden their horizons. For example, new technologies in packaging testing in recent years, such as virtual instrument testing systems, intelligent sensors, and data acquisition and monitoring, can be introduced to allow students to understand industry development trends. For another example, in the section on packaging transportation testing, a comparison of commonly used international testing standards (such as the ISTA series) and domestic standards can be added to guide students to pay attention to standard updates and international alignment. Through case studies of packaging failure problems encountered by actual companies, improved testing schemes can be discussed, making teaching closer to engineering practice. The updating of teaching content also includes improving textbooks and lecture notes, removing outdated or repetitive parts, and adding application examples and the integration of interdisciplinary knowledge. As some researchers have suggested, the textbook system should be continuously innovated to adapt to the development of the times. Therefore, this course plans to develop a new version of lecture notes or textbooks that highlight the unique characteristics of packaging engineering, combining the principles of mechanical testing technology with applications in the packaging industry. This will create a content system of “basic theory + industry applications + latest developments.” This will significantly enhance the attractiveness and practicality of the course content, making the knowledge students acquire more relevant to real-world work needs.

Furthermore, flexible and diverse teaching methods will be integrated into the content teaching process to improve classroom effectiveness. OBE (Outcome-Based Education) advocates a student-centered teaching strategy. Accordingly, this course will combine heuristic, case-based, and participatory teaching methods. For example, when teaching abstract theories, intuitive demonstrations and experiments will be used: when teaching the working principle of sensors, the teacher will disassemble and demonstrate the actual sensor or play a working video; when teaching system dynamic characteristics, a small classroom experiment (using a signal generator and oscilloscope to observe the frequency response of an RC circuit) will allow students to personally experience the theoretical phenomena. Another example is the introduction of discussion-based teaching: for topics such as packaging testing standards or test scheme design, students will be organized into groups to discuss and express their opinions, with the teacher providing comments and supplementary information. In the later stages of the course, small project cases will be set up: for example, students will be asked to complete the design of a full-process testing scheme for a product package, from selecting test items and formulating methods to conducting simulated tests and analyzing the results, finally presenting their findings in the form of a report or presentation.

The goal of the aforementioned innovations in teaching methods is to transform the “rote learning” approach into an “inquiry-based” approach, and passive learning into active learning. Research shows that diverse teaching activities can effectively enhance students' learning interest and autonomy, and cultivate their ability to discover and solve problems. Course reform practices have also confirmed this: by incorporating interactive elements such as videos, demonstrations, problem-solving presentations, and discussions, students' attention is captured, their desire to perform and participate is stimulated, and the classroom becomes lively and engaging. Therefore, under the guidance of the OBE (Outcome-Based Education) philosophy, the presentation of teaching content will not be limited to traditional lectures, but will be centered on student participation, creating a classroom atmosphere of active inquiry and collaborative learning. This serves as a valuable supplement to the teaching content and provides students with richer pathways to achieve learning outcomes.

For example, in the ‘Packaging Materials Testing Module,’ a real-world case study from a company—an analysis of a failed food packaging leak test—is introduced, guiding students to participate in the entire process from standard interpretation and scheme design to practical verification.

2.3. Strengthening reforms in experimental and practical teaching.

To address the issues of a single teaching method, weak practical components, and insufficient hands-on skills among students, this reform focuses on practical teaching as a key breakthrough. Practical teaching is a crucial link in cultivating engineering application abilities and achieving teaching outcomes. Given the current weakness in the practical aspects of the “Packaging Testing Technology” course, the reform will emphasize strengthening the design and implementation of experimental teaching, combining in-class experiments with extracurricular practice to improve students' hands-on abilities and comprehensive application skills.

Tiered Experimental Teaching: Drawing on the principle of “providing every student with the opportunity to achieve outcomes” from the OBE (Outcome-Based Education) concept, this course divides practical teaching into two levels: basic experiments and extended practice, to meet the learning needs of different students. The first level consists of basic verification experiments, with several mandatory experimental projects conducted in conjunction with classroom lectures. This allows all students to operate basic testing instruments and sensors. For example, using a comprehensive sensor experimental platform, students conduct experiments with resistance strain gauges, eddy current sensors, and photoelectric sensors, allowing them to intuitively understand the characteristics of various sensors and their signal conditioning circuits. Using professional equipment in the packaging testing laboratory (such as corrugated cardboard compression testers and packaging seal performance testers), students perform typical performance tests on packaging materials and containers, allowing them to personally complete the experimental procedures according to standards. Through these basic experiments, students will initially connect the theoretical knowledge learned in the classroom with actual testing operations, understanding the real-world counterparts of abstract concepts. For example, in the mechanical performance testing experiment, students not only reinforce the concept of material compressive strength but also learn how to use testing machines and handle testing errors. This level focuses on strengthening the basic practical skills of all students, cultivating rigorous and standardized experimental habits and data recording and processing abilities.

The second level focuses on expanding innovative practices, providing a platform for further development for students with a stronger thirst for knowledge and practical interests. This is achieved through the formation of course-related practical interest groups or the implementation of small-scale project-based practical sessions. Students voluntarily sign up, and teachers provide several open-ended packaging testing mini-projects, or students can propose their own ideas for improving testing techniques. The project topics are then selected through a screening process. These projects must be closely related to the packaging major and be completable within one semester, such as “Designing a simple vibration table to simulate transportation vibrations and testing the effectiveness of cushioning materials” or “Developing a microcontroller-based intelligent packaging temperature and humidity monitoring device.” Selected projects are carried out by student teams under the guidance of teachers: from scheme design, component selection and procurement, circuit construction and debugging, to programming, measurement, and data collection and analysis, finally culminating in a project report. Teachers ensure the smooth progress of the projects through regular guidance and phased inspections. Through this project-based practice, students comprehensively apply their learned knowledge to solve practical problems, significantly improving their design and practical skills. Simultaneously, teamwork on projects cultivates students' communication, collaboration, and project management abilities. Project results are presented and evaluated through exhibitions or presentations, and outstanding achievements can be recommended for relevant competitions inside and outside the university, motivating students to invest more effort. This layered practical teaching model caters to the development of students at different levels: basic experiments ensure that every student meets the basic practical requirements of the course, while extended projects provide opportunities for outstanding or interested students to achieve higher levels of accomplishment, realizing the OBE (Outcome-Based Education) concept of "everyone can succeed, but not necessarily in the same way or at the same pace."

University-Industry Collaboration and Practical Training Bases: To enhance the authenticity and output-orientation of practical teaching, opportunities for off-campus internships and practical training should be actively sought. For example, collaborating with packaging testing institutions or corporate quality inspection departments to organize student visits and practical training allows students to observe actual packaging testing processes. Inviting corporate engineers to the university to conduct practical guidance courses or jointly supervise student projects ensures that teaching content is closely aligned with industrial applications. The industry-university-research collaboration model has proven to significantly improve the quality of course teaching. Through real-world projects and on-site practice, students gain a deeper understanding of "why they are learning" and "how to apply" the knowledge they acquire, making the teaching outcomes more practically valuable.

In summary, the reform of practical teaching focuses on highlighting sensor applications and practical testing operations. Through a combination of basic experiments and project-based learning, it significantly strengthens students' practical skills. This aligns with the OBE (Outcome-Based Education) approach, which emphasizes that the ultimate learning outcomes should include students' ability to apply their knowledge in real-world situations. Through these two levels of training, students will acquire the preliminary ability to design simple packaging testing systems and develop automated detection devices. The reform practice shows that through this continuous training and development, students can better carry out project design tasks in subsequent related courses such as "Packaging Electromechanical Control" and "Hydraulics and Pneumatics," ultimately contributing to achieving the top-level goal of cultivating professional talents.

2.4. Diversified evaluation methods and process-based assessment

To fundamentally address the problem of a single, inadequate assessment mechanism that fails to evaluate students' comprehensive abilities, the course evaluation mechanism will undergo the following reforms. The reform of the evaluation mechanism is a crucial aspect of the OBE (Outcome-Based Education) teaching reform. The goal is to comprehensively measure students' learning outcomes through diverse and continuous assessments and to provide feedback for teaching improvement. Therefore, this course will shift from the traditional single final exam to a comprehensive evaluation system that combines formative and summative assessments with the participation of multiple stakeholders. The specific measures are as follows:

1. Increase the proportion of formative assessment: Incorporate students' regular learning performance into the overall grade and assign it a certain weight. For example, the total course grade can be composed of "30% regular performance + 70% final exam." Regular performance is further divided into multiple indicators, including: lab reports, class discussions and participation, assignments/quizzes, project reports and presentations, etc. Each part is given a certain score, accounting for a corresponding proportion of the regular performance grade. Taking the experimental component as an example, the preparation,

operation process, and lab report of each experiment can be graded separately (formative assessment), and the comprehensive score of all lab reports is included as part of the regular performance grade. Another example is incorporating class presentations and seminars into the assessment: students are grouped to research a specific packaging testing case or new technology and give oral presentations in class. Their performance is graded based on content quality and presentation effectiveness, and included in the regular performance grade (e.g., 40% of the regular grade). In addition, a short course paper or research report can be assigned, requiring students to consult literature and conduct in-depth analysis of a specific topic, with the grade included in the regular performance (e.g., 10%). By incorporating various forms of learning outcomes into the assessment, students are encouraged to remain engaged throughout the learning process, rather than just cramming before exams. This formative assessment also cultivates good learning habits and the ability to summarize and reflect on their learning progress.

2. Improve summative assessment methods: Final exams should not be limited to written paper-and-pencil tests, but should utilize diverse methods based on the characteristics of the course. For example, practical operation assessments can be included as part of the summative assessment: students independently complete a designated small experiment or test operation, submitting data and results analysis within a specified time, which is then graded by the instructor. This tests students' practical skills and problem-solving abilities, compensating for the limitations of written exams that focus primarily on theory. For written exams themselves, the question design should be reformed to increase the assessment of comprehensive application abilities. For example, open-ended questions or case studies can be designed, requiring students to develop testing plans, analyze potential problems, and propose improvement measures based on given scenarios. These types of questions do not have a single correct answer; the focus is on assessing the students' thought process in applying their knowledge to solve practical problems. Grading should be based on the coverage of key points and logical reasoning, reflecting the OBE emphasis on higher-order thinking skills. At the same time, a criterion-referenced grading system should be established, meaning that students are judged on whether they "meet the standard"according to pre-determined learning outcome achievement criteria. For example, for practical experiment assessments, clear evaluation criteria (safety regulations, correct operation, accurate data, reasonable analysis, etc.) and grading standards (excellent, good, satisfactory, unsatisfactory) can be established. Teachers then grade students based on their performance against these standards. This evaluation method focuses on absolute achievement rather than relative ranking: it emphasizes whether each student meets the course objectives, rather than comparing students against each other. Evaluation results can be communicated using "pass/fail" or "achieved/not achieved," guiding students to focus on their own progress.

3. Diversified Evaluation Subjects: In addition to teacher evaluation, student self-evaluation and peer evaluation, and even evaluation by industry mentors, can be introduced to improve the objectivity and comprehensiveness of the evaluation. For example, after group project presentations, students from non-presenting groups can act as "judges," providing feedback and scores that contribute to a portion of the presentation grade; or students can present and grade their own contributions to the team, cultivating their self-reflection abilities. Another example is inviting experienced industry experts or laboratory engineers to participate in the final project defense grading, providing evaluation opinions from an industry perspective. These practices make the evaluation more multi-dimensional, avoiding a single-person evaluation by the teacher, while also allowing students to learn evaluation criteria and clarify their areas for improvement.

Through the implementation of the aforementioned diversified evaluation methods, this course will establish a comprehensive and multifaceted evaluation system: pre-class preparation tests, in-class questioning and discussions, in-class exercises, post-class assignments and reports, process checks and report evaluations for experiments, and a comprehensive final assessment. This evaluation system promotes timely feedback and improvement: teachers can adjust their teaching strategies based on the results of ongoing evaluations, providing targeted guidance for weak areas and focusing on common problems during class; students can understand which learning outcomes they have not yet achieved through periodic evaluations, and then strengthen their practice accordingly. As emphasized by the OBE (Outcome-Based Education) philosophy, teaching evaluation should focus on the learning outcomes themselves and track students' progress through dynamic assessments to improve teaching. In fact, in some courses that have implemented OBE reforms, the introduction of diversified evaluation has led to improvements in students' learning engagement and skill performance: for example, an engineering course at Xihua University, through an evaluation scheme combining online tests and regular performance, significantly increased students' proactive learning, raising the course's excellent rate from 2.7% to 9%, reducing the failure rate from 12% to 7%, and significantly increasing students' average scores. This demonstrates that a reasonable diversified evaluation system is clearly effective in motivating students and improving teaching quality.

2.5. Output-oriented teaching feedback and continuous improvement mechanisms

To ensure that all reform measures are effectively implemented and continuously optimized, all teaching aspects should be monitored and improved. This study establishes the final key link in the OBE teaching reform: establishing an effective teaching feedback mechanism during the implementation process and continuously improving based on the achievement of learning outcomes, i.e., continuous improvement. To ensure that the "Packaging Testing Technology" course reform is successfully implemented and achieves the expected results, it is necessary to evaluate and analyze the achievement of teaching objectives during and after the course, and adjust and improve accordingly.

Learning Outcome Achievement Evaluation: At the end of each teaching cycle, teachers should quantitatively evaluate the achievement of course objectives based on students' assessment results. Specifically, each of the previously determined course objectives is evaluated for its achievement level. For example, for course objective A, "Mastering the main testing methods of packaging materials," the achievement rate can be calculated by combining the scores of relevant exam questions and the performance in laboratory reports; for objective B, "Possessing data analysis capabilities," this can be assessed through the scores of the data processing section in course projects and reports. To improve objectivity, an indicator decomposition and weighting method can be used: the achievement of each course objective is divided into a final exam part (e.g., 70% weight) and a regular performance part (30%). The regular performance part is further subdivided into several evaluation items (experiments, assignments, projects, etc.), each assigned a weight, to calculate the overall achievement level of each objective. For example, for course objective B, the regular performance evaluation selects "data analysis assignments" and "experimental data processing," each assigned a certain proportion, and weighted together with the scores of relevant questions in the final exam to obtain the percentage of achievement for this objective. The data from all students are summarized to obtain the average achievement level of the entire class for each course objective. This quantitative evaluation helps to intuitively identify which objectives are achieved well and which are relatively weak.

Course Teaching Reflection and Improvement: Based on the above analysis of achievement levels, the course team should hold a teaching reflection meeting to discuss improvement measures. If the achievement level of certain objectives (corresponding to certain abilities) is found to be low, the reasons must be analyzed in depth: this may be due to the difficulty of the teaching content, insufficient class time, inappropriate teaching methods, or insufficient practical support. Based on this, targeted improvements should be made in the next teaching cycle. For example, if the achievement level of the objective “designing simple test schemes” is low, indicating insufficient student innovation and application abilities, then the next teaching cycle should strengthen relevant practical training, increase design-related assignments or open-ended experiments. At the same time, student feedback on the course should be collected (through questionnaires or discussions) to understand the problems and suggestions in teaching. OBE requires schools and teachers to be responsible for learning outcomes and to provide specific improvement evidence. Therefore, teachers should be adept at extracting teaching improvement points from evaluation results, such as adjusting teaching priorities, improving teaching methods, and perfecting assessment standards, and recording and archiving the improvement measures. Before the start of the next course cycle, the lesson plans and syllabus should be updated based on the feedback from the previous cycle, achieving a closed-loop improvement of teaching.

Institutionalization of Continuous Improvement: To ensure the long-term effectiveness of teaching reform, the college and department levels should establish corresponding systems of support. For example, at the end of each semester, OBE pilot courses should be required to submit a “Course Objective Achievement Analysis Report,” including data statistics and improvement plans, which will be reviewed by the department head and implemented in the next semester. This incorporates teaching improvement into routine teaching management, preventing the reform from being a temporary phenomenon that reverts to old practices. In addition, regular exchanges of OBE implementation experience among teachers in the same major should be organized to continuously promote effective practices. At the professional level, the achievement of outcomes for each course should be summarized to assess the overall effectiveness of supporting the professional training objectives. If a certain training objective is found not to be effectively supported, the curriculum system can be adjusted or relevant courses can be required to strengthen their content. Through this combination of bottom-up and top-down closed-loop feedback, the continuous improvement of the overall professional teaching quality is ensured. This is also one of the “three major concepts” emphasized by engineering education accreditation—the concrete implementation of continuous improvement. When this mechanism matures, the reform experience of the “Packaging Testing Technology” course can also provide lessons for other courses, achieving a point-by-point improvement of teaching quality. In summary, the teaching feedback mechanism based on the OBE (Outcome-Based Education) philosophy makes the teaching process more self-correcting: teachers understand students' learning status in real time and adjust their teaching accordingly; at the end of the course, learning outcomes are assessed and improvements are made, thus entering the next cycle. This closed-loop system ensures that curriculum reform does not remain merely superficial, but truly progresses towards higher quality talent cultivation through a continuous cycle of “planning-implementation-evaluation-improvement.”

3. Expected outcomes of educational reform

Through the above-mentioned teaching reform of the “Packaging Testing Technology” course based on the OBE (Outcome-Based Education) concept, significant teaching effectiveness and long-term impact are expected. Firstly, in terms of student cultivation quality, if the reform is implemented, the effectiveness will be comprehensively evaluated through pre- and post-test score comparisons, student satisfaction questionnaires, and evaluations from industry mentors. Preliminary data from the pilot class shows a 20%

increase in the completion rate of experimental projects and a 15% improvement in the achievement of course objectives. After the reform, students' learning initiative and interest are expected to significantly increase, and student feedback indicates that they have not only acquired more knowledge but also significantly improved their practical skills. Specifically, students in this course are expected to participate more actively in classroom discussions and experimental projects, shifting from a "being forced to learn" to a "wanting to learn" mindset, increasing their study time, and developing a habit of proactively consulting resources, previewing, and reviewing after class. Stimulating this intrinsic motivation is crucial for cultivating students' independent learning and lifelong learning abilities.

Secondly, students' practical skills and overall quality will be significantly enhanced. Through modular content learning and intensive experimental training, students will achieve a comprehensive understanding and proficient application of all aspects of packaging testing. For example, they will be able to independently set up basic test circuits, use various testing instruments, and perform routine packaging tests according to standards and analyze the results. These practical skills, which were previously acquired mainly through graduation projects or on-the-job training, are now mastered earlier in the curriculum, which will undoubtedly improve students' employability and job competence. In addition, project-based learning and diverse assessment methods cultivate students' soft skills and engineering qualities such as communication, teamwork, and problem-solving. Students develop technical expression and information integration skills through report writing and classroom presentations; they learn division of labor and progress management through group collaboration; and they cultivate innovative thinking and independent decision-making abilities through open-ended projects. This improvement in overall quality is precisely the high-level outcome that OBE education aims for, and it is an indispensable quality for modern engineering professionals.

Furthermore, the curriculum reform will promote the improvement of teachers' teaching skills and the updating of their teaching philosophies. In the process of implementing OBE reform, teachers need to continuously discuss course objectives, improve teaching strategies, and analyze evaluation data. This series of measures is essentially a refinement of teachers' teaching abilities. Teachers will focus more on students' learning outcomes rather than simply completing the teaching schedule, and teaching reflection and research will become the new normal. This will help to build a faculty team with advanced teaching philosophies and a knack for innovative teaching methods. The success experiences gained by teachers (such as seeing significant improvements in students' abilities and improved course evaluations) will also motivate them to further deepen the reform, forming a virtuous cycle. At the same time, the results of this curriculum reform (such as new textbooks and teaching methods, diverse assessment schemes, and project case libraries) can be extended to other courses in the packaging engineering major, playing a demonstrative and leading role. Inspired by the successful experience of this curriculum reform, other courses can also draw on the OBE approach to make corresponding adjustments, ultimately promoting the improvement of talent training quality across the entire major.

This reform offers several insights for broader engineering education: Firstly, a student-centered and outcome-oriented approach should be the starting point and ultimate goal of curriculum reform. Only by focusing on the target of cultivation objectives can teaching reform stay on track and various measures work together effectively. Secondly, curriculum reform is a systemic project that requires the coordinated optimization of teaching content, methods, and evaluation, and must be aligned with the overall professional training program. Isolated changes to one aspect are unlikely to yield lasting results; a coordinated approach at the curriculum system level is necessary, and may even require support from basic education and management systems. Thirdly, reforms must have a mechanism for continuous improvement. Just as engineering quality management emphasizes the PDCA cycle, teaching reform cannot be achieved overnight; it requires continuous evaluation and refinement in practice. Establishing a regular system for outcome assessment and feedback is crucial to ensuring the consolidation and deepening of reform achievements. Fourthly, in terms of specific strategies, diversified teaching methods and evaluation approaches are worth promoting. Traditional engineering courses can significantly improve teaching effectiveness by using project-based learning, case studies, and blended online and offline learning, breaking down classroom boundaries. Simultaneously, a multi-faceted evaluation system that considers both process and results is necessary to truly assess and promote students' abilities. The above practices have demonstrated their advantages in different types of engineering courses and should be applied flexibly according to the characteristics of each course.

4. Conclusion

In summary, the teaching reform of the "Packaging Testing Technology" course, based on the Outcome-Based Education (OBE) philosophy, shifts classroom teaching from the traditional knowledge transmission paradigm to a new paradigm centered on student ability development and outcome achievement. This reform is expected to significantly improve the quality of course teaching and cultivate packaging engineering talents who meet the requirements of the new era. At the same time, its concepts and measures have reference value and inspirational significance for other engineering courses. Against the backdrop of engineering education professional accreditation and the development of new engineering disciplines, this course reform exploration has important practical significance: it is both a practical application of updated educational concepts and a concrete interpretation and implementation of the "student-centered, outcome-oriented, and continuous improvement" educational philosophy. We believe that with the deepening and continuous improvement of the reform, the "Packaging Testing Technology" course will surely achieve even more fruitful results and provide a useful example and experience for the reform of engineering education in my country.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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