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Exploration of Engineering Education Accreditation Implementation and Professional Connotation Development in Local Universities

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Abstract: In order to address the challenges faced by local universities in implementing Outcome-Based Education (OBE) concepts in engineering accreditation and the insufficient development of professional connotation, this paper uses the example of the School of Electronics, Electrical Engineering and Control at Qilu University of Technology. It discusses how the school leverages the advantages of integrating education and research by streamlining evaluation data, reducing evaluation steps, optimizing evaluation methods, and reconstructing a quality logic system centered on training objectives for continuous improvement. This results in a triple-loop evaluation and continuous improvement mechanism. The school also conducts regular evaluations of the curriculum system, implementing "burden reduction and efficiency enhancement" to guide the program back to the original intention of accreditation, truly reflecting the effectiveness of accreditation and promoting the development of professional connotation.

1. Introduction

In June 2016, China officially joined the Washington Accord, establishing an engineering education accreditation system that is both characteristic of China and internationally equivalent. On January 21, 2021, the Ministry of Education formally issued the "Implementation Plan for the Audit and Assessment of Undergraduate Education in Regular Higher Education Institutions (2021-2025)," which outlines the overall deployment of audit and assessment work. The plan clearly states that "student development is the core, emphasizing a student-centered approach, output orientation, and continuous improvement, driving the paradigm shift from 'teacher-centered' to 'student-centered' education." Accreditation and assessment are designed to resonate with each other[1], requiring engineering programs to firmly grasp the "main line" and maintain the "bottom line" in implementing these principles[2-3]. This includes clearly defining a quality logic system for

continuous improvement based on training objectives, establishing an output-oriented evaluation mechanism centered on curriculum quality, and gradually building a culture of continuous improvement to advance the high-quality development of higher education[4-5].

Local universities play a crucial role in cultivating talent for their regions. However, compared to many Double First-Class universities, they face a series of challenges, including weak faculty strength, insufficient research and educational output, inadequate inter-institutional collaboration, and inadequate execution of accreditation concepts among faculty and students. As a result, the implementation of Outcome-Based Education (OBE) in these institutions is not smooth, often leading to engineering education being "superficially similar" rather than genuinely aligned with the OBE principles.[6] Taking the engineering accreditation work for electronics and electrical engineering programs at universities in Shandong Province as an example, only six universities, including Qingdao University, have had 14 programs accredited, which is significantly lower than the number of first-class undergraduate programs approved in this field. This indicates a substantial gap in the promotion of OBE principles and the development of professional connotation in these programs within Shandong Province.

Qilu University of Technology is a key application-oriented research university in Shandong Province. The institution has adopted a "departmental system" reform as a breakthrough to promote the deep integration of education and research across its schools and departments. Therefore, this paper takes the School of Electronics, Electrical Engineering and Control at Qilu University of Technology as a case study to explore how, leveraging opportunities for integration between education and research, the school can address industry demands and talent shortages. By using engineering education accreditation as a lever, the goal is to guide programs back to the original intent of accreditation, truly reflecting its effectiveness and solidifying the development of professional connotation.

This paper proposes several initiatives for professional development within the school. First, it emphasizes strengthening the faculty team by leveraging resources from research platforms. A quality improvement logic system is reconstructed, starting from educational objectives, to establish a cyclical evaluation and continuous improvement mechanism that aligns with the current faculty shortages, reflects the integration of education and research, and meets accreditation standards. This mechanism simplifies evaluation data, reduces evaluation steps, and optimizes methods, promoting a shift from "quality monitoring" to "continuous improvement," and from a "teacher-centered" to a "student-centered" approach. Ultimately, this aims to foster a culture of ongoing improvement, enhance professional development, clarify teaching quality responsibilities for faculty, boost student engagement, and ensure mutual benefits for both teachers and students.

2. Current Status and Challenges of Major Development in the School of Electronics, Electrical Engineering, and Control

Qilu University of Technology is a key application-oriented research university in Shandong Province. The university is leveraging the “departmental system” reform to promote the deep integration of education and research within its institutes. Against this backdrop, the School of Electronics, Electrical Engineering, and Control comprises two secondary institutions: the School of Information and Automation and the Automation Research Institute of the Shandong Academy of Sciences. It offers four engineering majors, including Electronics Information and Automation, among others. The Electronics Information Engineering program has received certification, while Automation and Communication Engineering are in the process of certification, both of which have been approved as first-class undergraduate programs at the national and provincial levels.

Since the certification of Electronics Information Engineering began in 2019, the university and

the school have established a series of regulations aimed at ensuring that all educational processes effectively support the achievement of graduation requirements, with a Students-Centered approach and a focus on training objectives. By analyzing the talent development needs to meet graduation requirements, the quality standards for key educational processes have been clarified. A multi-tiered quality monitoring mechanism has been established, centering on the rational evaluation of the output-oriented curriculum system and course quality, which includes three levels: university, school, and program, as well as an evaluation mechanism for the achievement of graduation requirements.

Through years of implementing evaluation and continuous improvement mechanisms, the school has identified several challenges. Specifically, the transition from a “superficial” to a “substantial” certification process still encounters many issues. These include the overwhelming volume of evaluation data, the complexity of the evaluation process, and the intricacies of evaluation methods, which fail to genuinely reflect the effectiveness of certification. Additionally, there is a lack of understanding of the OBE (Outcome-Based Education) concept among some faculty, graduates, current students, and employers, as well as insufficient depth of understanding. Furthermore, challenges arise from inadequate faculty and resources, making it difficult to operate the evaluation and continuous improvement mechanisms. Lastly, there is insufficient participation from all faculty and students in the integrated educational reform, raising concerns about the validity and rationality of basic course evaluation data and whether faculty and students are truly implementing the OBE philosophy.

3. Design of Reform Plans and Solutions to Problems

3.1. Design of Reform Plans

To address the series of issues in the certification process transitioning from "superficial" to "substantial," the key challenge lies in how to deeply implement the OBE (Outcome-Based Education) concept among both faculty and students, ensuring it is genuinely understood and practiced in their work. The reform plan should follow a progressive approach, starting from simple to complex, and gradually advancing through different phases, as illustrated in Figure 1.

Since 2021, the School of Electronics, Electrical Engineering, and Control has been focused on the current situation of the department while deeply implementing the OBE philosophy. Each semester, through opportunities such as freshman orientation and enterprise visits, training and research are conducted to help faculty and students theoretically grasp the three core principles of certification: "Students-Centered, Outcome-Based Education, and Continuous-Quality Improvement." Subsequently, methods such as surveys and comparative analysis are employed, combining existing institutional documents with those from peer institutions for restructuring. This ultimately leads to the establishment of a three-tiered evaluation and improvement mechanism—encompassing external, internal, and in-class assessments—that aligns with the OBE concept. This mechanism is implemented throughout each evaluation cycle, with conclusions used for ongoing improvement.

Through this practical process, faculty and students further enhance their understanding of the OBE philosophy, strengthen teachers' sense of responsibility and desire for reform, and stimulate students' intrinsic motivation for independent learning. This allows both teachers and students to experience the changes brought about by OBE firsthand. Ultimately, engineering certification becomes a systematic tool for building the professional core, leading to improved programs, empowered faculty, and engaged students, achieving simultaneous optimization of the program, faculty, and students.

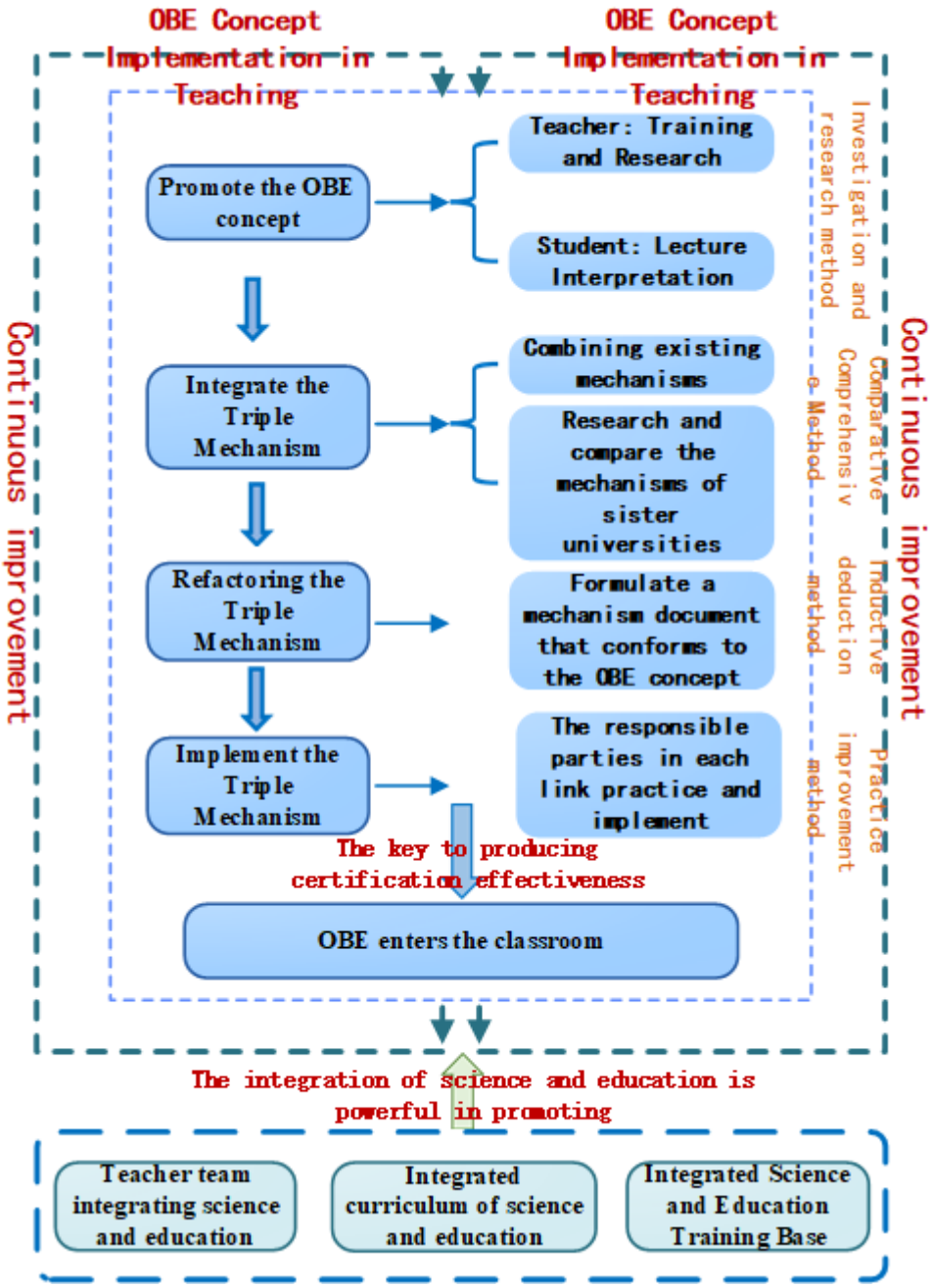

Figure 1: Reform Plan Design

3.2. Solutions to the Problems

3.2.1. Reconstructing the Three-Tier Evaluation and Improvement Mechanism to Implement "Reducing Burden, Increasing Efficiency"

The college's mechanism documents, such as the "Professional Continuous Improvement Implementation Plan" and the "Teaching Process Quality Monitoring Mechanism" (see Figure 2), have been revised to reconstruct a continuous improvement quality logic system that begins with training objectives. This forms a three-tier evaluation and improvement mechanism for training objectives, graduation requirements, and course objectives, with regular evaluations of the curriculum system. By adhering to the dual requirements of validity (matching evaluation methods

with objectives) and reliability (ensuring consistent conclusions across different evaluators), core courses are used to support the achievement of graduation requirements, and primary teaching activities are aligned with course objectives. Evaluation samples of statistical significance are selected, and evaluation data are streamlined. Teachers are encouraged to use modern information technologies, such as MOOCs and the internet, to deeply mine routine assessment data, reducing evaluation steps. A combination of direct and indirect, self-assessment and external evaluation, qualitative and quantitative evaluation methods are adopted to optimize the evaluation approach. This aims to implement "reducing burden, increasing efficiency" by guiding programs to focus on key tasks, returning to the original intention of certification, and achieving "improvement through evaluation."

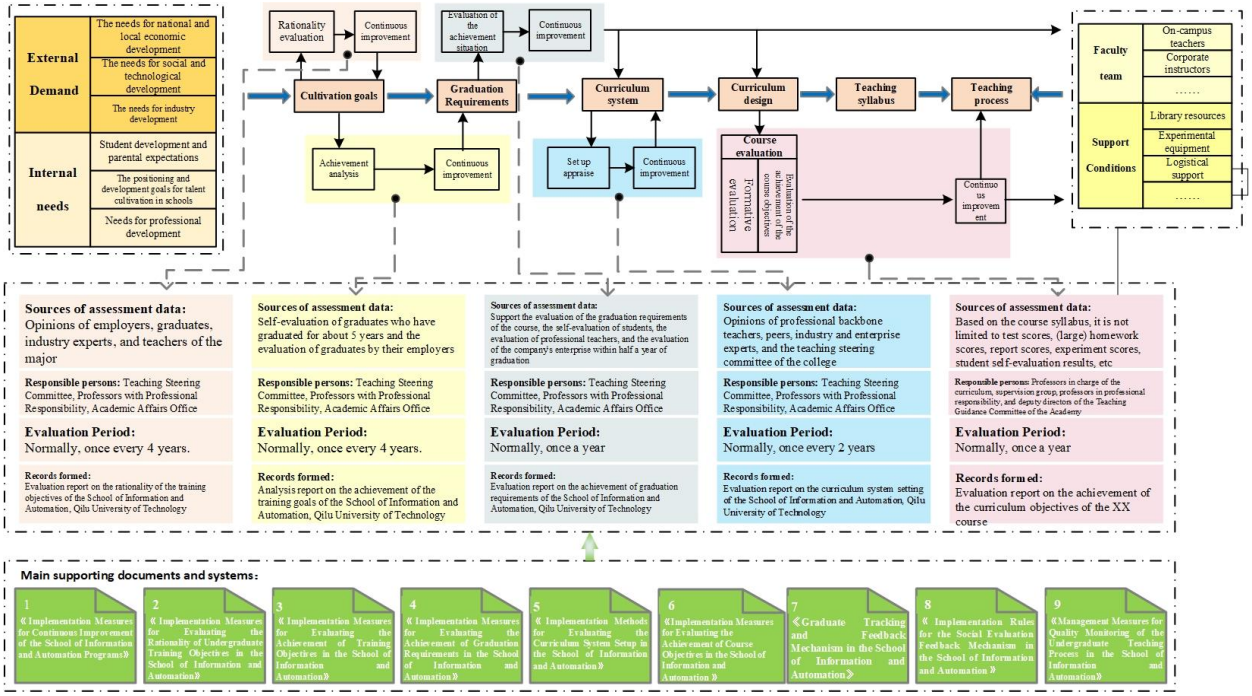

Figure 2: Continuous improvement quality logic system starting from cultivation objectives

3.2.2. Promoting the OBE Concept and Ensuring Deep Understanding

For faculty, internal training is strengthened while external collaboration is emphasized. At the beginning of the year, a training plan is developed, and certification experts are invited for lectures and discussions. Through the virtual teaching and research office policy, joint research and training sessions are held. For other stakeholders, a comprehensive promotion is conducted involving all participants and at all stages. Teachers deliver OBE concept presentations and discussions to all students, employers, and graduates during freshman orientation, classroom teaching, internships, recruitment, and academic advising sessions.

3.2.3. Relying on the science-education integration policy, promote the implementation of the triple-loop evaluation and improvement mechanism

Relying on the policy of integrated operation between institutes and universities, we endeavor to establish a teaching staff that integrates science and education. To ensure accountability and continuous improvement, we will refine the social evaluation feedback mechanism, with employers and engineers as its core participants, enabling regular circular evaluations among education, industry, and research sectors. Furthermore, research platforms are opened to undergraduates,

transforming research achievements into teaching content. This fosters a curriculum system that encompasses "specialized courses, science-education/industry-integration courses, and distinctive practical courses." By establishing a collaborative education mechanism that integrates science and education, mutually reinforcing each other, we aim to facilitate the implementation of triple-loop evaluation and continuous-quality improvement in our educational endeavors.

3.2.4. Reconstruct the OBE-based instructional design of courses to drive the reform of curriculum teaching

By building a robust teaching team, we can propel the revision of an "outcome-based education" course syllabus, where teaching content is dictated by course objectives, instructional methods emphasize students-centeredness, and teaching evaluations prioritize the development of higher-order thinking skills and formative assessment (as illustrated in Figure 3). Additionally, we will refine the two-level review mechanism at the department and school levels to ensure the validity and rationality of basic course evaluation data. Policies will be implemented to stimulate teacher vitality, with research projects, first-class courses, and other university and college two-level policies guiding all teachers to actively engage in teaching reform. Teaching supervision will be put into practice, accompanied by the establishment of teaching assistance policies that leverage student evaluations to enhance course assessment and continuous-quality improvement.

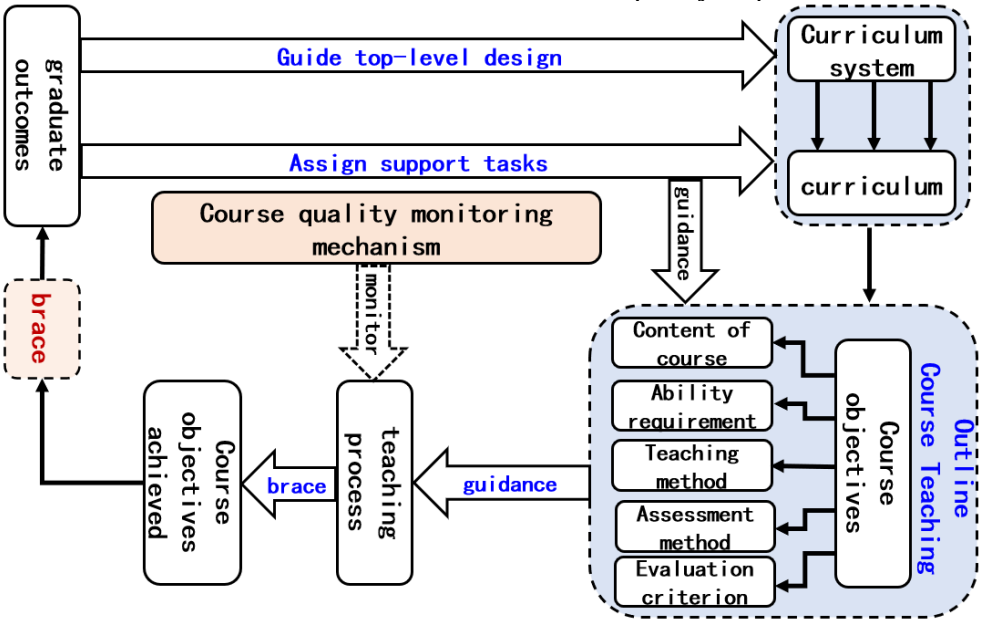

Figure 3: Development, Revision, and Utilization of Course Syllabus

4. Innovative Points and Concrete Achievements of the Reform

4.1. Innovative Points

4.1.1. Optimize evaluation methods

Implement "reducing burden and enhancing efficiency" by streamlining evaluation data, minimizing evaluation steps, optimizing evaluation methods, and reconstructing a continuous quality improvement logical system that originates from educational objectives. This will result in the formulation of a triple-loop evaluation and continuous-quality improvement mechanism tailored to address the faculty shortage in the department, highlighting the distinctive integration of science

and education, adhering to accreditation criteria, and regularly assessing the curriculum system to ensure its ongoing relevance and effectiveness. By implementing "reducing burden and enhancing efficiency," we guide specialties to focus on their core tasks, returning to the original intent of accreditation.

4.1.2. Science-Education Integration Boosts Progress.

We propose the 'Science-Education Integration + Output-Oriented' training philosophy, establishing an integrated teaching staff that combines scientific research and education. Through collaborative platform building and resource sharing, we construct a curriculum system comprising 'specialized direction courses, science-education/industry-education integration courses, and specialty practice courses,' thereby restructuring professional training programs that embody a demand- and output-oriented approach. We implement teaching quality requirements and standards across all aspects, clarifying teachers' responsibilities in enhancing teaching quality and thoroughly implementing the triple-loop evaluation and continuous-quality improvement mechanism.

4.1.3. Instructional Design Innovations.

We are driving the revision of "outcome-based education" course syllabi, refining the review mechanism to ensure the validity and rationality of foundational evaluation data for courses. Our policies are designed to ignite teachers' enthusiasm for educational reform, thereby fostering engagement and continuous-quality improvement in course evaluation.

4.1.4. Quality Culture Cultivation.

We reconstruct and implement a triple-loop evaluation and continuous-quality improvement mechanism, internalizing the consciousness of continuous-quality improvement into the values and behavioral norms of all faculty and students. This fosters a comprehensive, all-encompassing, and continuous-quality improvement culture that permeates the values and behavioral norms of all faculty and students.

4.2. Specific Examples of Achievements

The School of Electronic, Electrical and Control Engineering has always acknowledged that the essence of transforming engineering education and research accreditation from mere "formal resemblance" to "substantial equivalence" hinges on the thorough implementation of the OBE (Outcome-Based Education) philosophy by both faculty and students, which is manifested in the integration of outcome-oriented education into the classroom. This transformation is predicated on the reconstruction of a quality logic system that begins with educational objectives, establishing a triple-loop evaluation and continuous improvement mechanism that is tailored to the current state of the department, and vigorously focusing on curriculum development and the classroom as the primary battleground.

Using the assessment of the fulfillment of graduation requirements for automation majors as an example, it illustrates the specific implementation of the evaluation and continuous improvement mechanisms established by the department. It explains how to achieve "reducing burden and increasing efficiency" in terms of evaluation processes, methods, and data. According to the department's "Implementation Measures for the Assessment of the Fulfillment of Graduation Requirements for the School of Information and Automation" (Document No. 13 [2021]), the assessment of the fulfillment of graduation requirements includes a combination of internal and external evaluations, as well as quantitative and qualitative assessments, with a particular emphasis

on the role of qualitative assessments. Internal evaluations utilize data from all students who have obtained their graduation certificates, including their regular, supplementary, and remedial examination scores, which constitute quantitative assessments. The data for internal evaluations are drawn exclusively from professional foundational and core courses that robustly support the graduation requirements, thereby reducing the volume of data needed for quantitative assessments and clarifying the discrepancies between the evaluation outcomes and the expected values in line with the distinctive requirements of talent cultivation. External evaluations are based on survey questionnaires from a specific graduating class and employers, which are predominantly qualitative assessments. A combination of internal and external, quantitative and qualitative assessment methods is employed to evaluate the 12 graduation requirements, with the specific results depicted in Figure 4-1, Figure 4-2, and Figure 3.

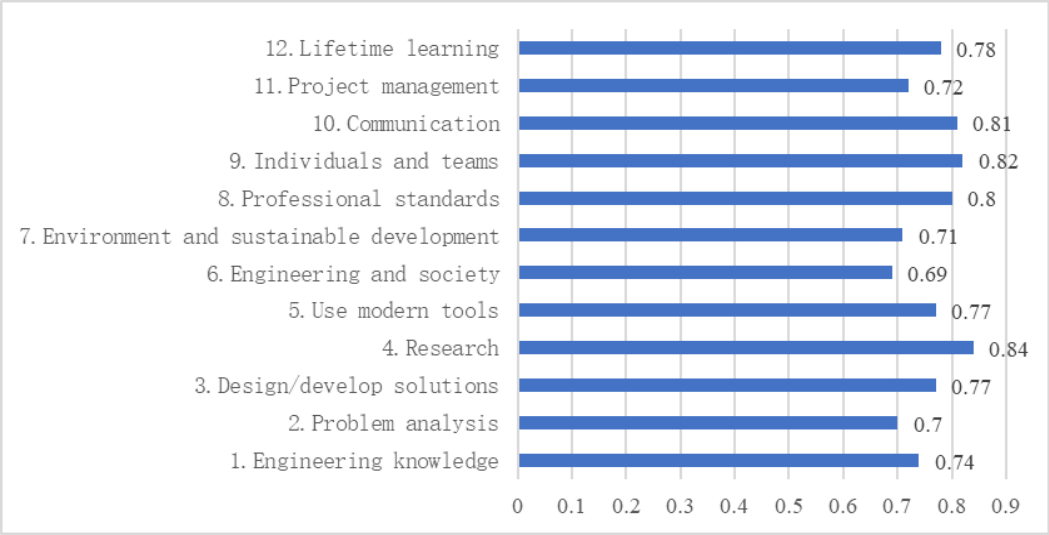

Figure 4-1: Bar chart of the internal evaluation results for the fulfillment of graduation requirements of a particular graduating class.

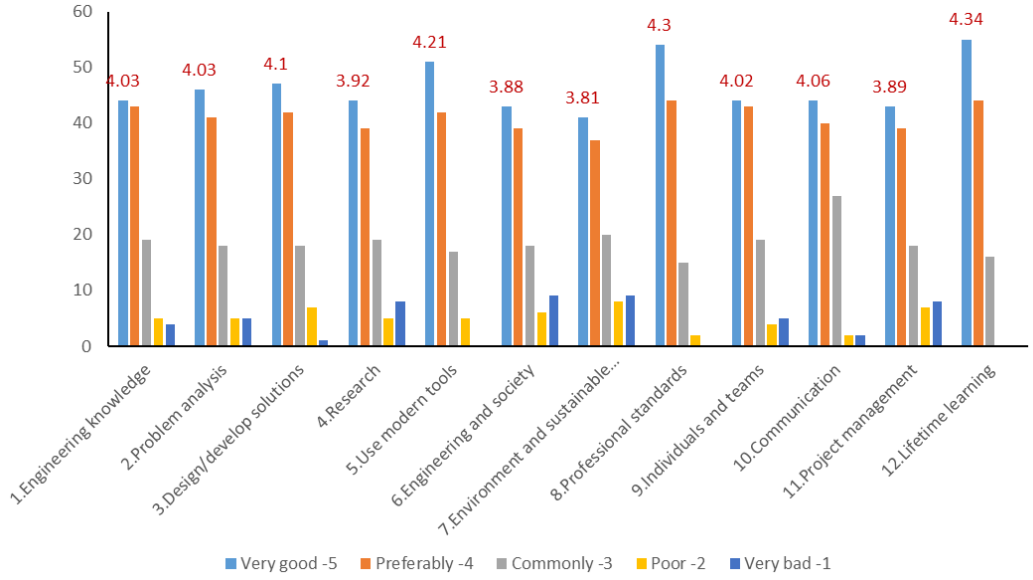

Figure 4-2: Results of the self-assessment by a particular graduating class on the fulfillment of graduation requirements.

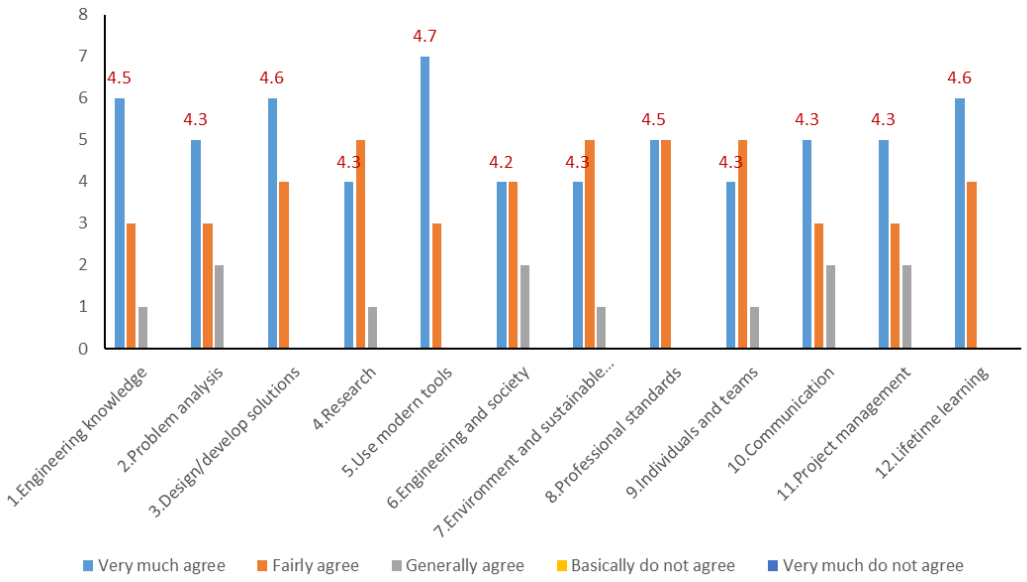

Figure 4-3: Bar chart of the evaluation results from employers on the fulfillment of graduation requirements for a particular graduating class.

The department revises the curriculum system based on the achievement of graduation requirements, emphasizing the integration of the OBE (Outcome-Based Education) philosophy into the classroom, and promotes continuous improvement in course quality under the premise of implementing the evaluation of course objectives. In the past three years, the department has achieved fruitful results in curriculum construction, as shown in Table 1.

Table 1: Course Construction Status in the School of Electronic, Electrical and Control Engineering

3. Achievement-Oriented Curriculum Teaching Design 齐鲁工业大学（山东省科学院）

3.5Curriculum Construction Status

High-Level Course Category	National Level	Provincial Level	School Level
First-Class Undergraduate Courses	《Circuit Principles》 《Process Control》	**《Communication Principles》** 《Signal Analysis and Processing》 《Virtual Simulation Experiment of Automatic Control in Pulp and Paper Process》 《High-Frequency Electronic Circuits》 《Electronic Circuit Design II》	《Modern Control Theory》 《Remote Control》 《Signals and Systems》
Ideological and Political Demonstration Course	《Electrical Machinery》	《Circuit Principles》 《Digital Image Processing》 《Process Control》 《Electrical Control and Programmable Logic Controllers》	《Communication Principles》
Online Courses		《Circuit Principles》 《Electrical Technology》 《Communication Principles》 《Fundamentals of Electromagnetic Fields》 《High-Frequency Electronic Circuits》 《Analog Electronics Technique》 《Microprocessors and Applications》 《Signal Analysis and Processing》 《Modern Control Theory》 《Process Control》	
Curriculum Map/Smart Courses		**《Circuit Principles》 《Communication Principles》 《High-Frequency Electronic Circuits》 《Digital Image Processing》 《Signals and Systems》 《Digital Signal Processing》** 《Signal Analysis and Processing》 《Process Control》	

5. Conclusion

In light of the current situation where local colleges and universities face challenges such as weak faculty strength, insufficient scientific and educational resources, and inadequate inter-institutional collaboration, and in response to issues like the complexity of evaluation data, cumbersome evaluation processes, and overly complicated evaluation methods that fail to truly

reflect the effectiveness of accreditation, as well as the insufficient implementation of the OBE (Outcome-Based Education) philosophy by both teachers and students, the School of Electronic, Electrical and Control Engineering at Qilu University of Technology has reconstructed a continuous quality improvement logic system that starts with educational objectives. This system establishes a triple-loop evaluation and improvement mechanism encompassing educational objectives, graduation requirements, and course objectives, and implements it in daily teaching. By using the integration of the OBE philosophy into the classroom as a lever, the school has made significant efforts in course construction, aiming to engage students actively, strengthen the capabilities of teachers, and enhance the quality of the majors.

Acknowledgements

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Qilu University of Technology Bidding Category (Major) Teaching Reform Research Project "Student-Centered, Outcome-Oriented - Triple Loop Evaluation and Continuous Improvement under Engineering Education Professional Accreditation" (No. Z202202).

Qilu University of Technology (Shandong Academy of Sciences) Key University Project "Research and Platform Construction of 'Comprehensive, Open, Collaborative, Personalized, and Blended' Practical Teaching Models under the Background of New Engineering - Taking the National First-Class Major of Electronic Information Engineering as an Example" (No. 2019ZD04).

Qilu University of Technology (Shandong Academy of Sciences) School level Teaching Achievement Award "Exploration and Practice of Practical Teaching System for Electronic Information Majors in Innovative and Applied Local Colleges with Demand Orientation and Multi party Collaboration" (No. CGPY2405).

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