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A Comparative Study of Mechanical Engineering Talent Training Models under the OBE Concept in Chinese and UK Universities and Its Implications

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Abstract: As a mainstream philosophy in international engineering education, Outcome-Based Education (OBE) has become a key guiding principle in cultivating Mechanical Engineering (ME) talents in both Chinese and UK universities. This paper compares the similarities and differences in ME student training models under the OBE framework in China and the UK, revealing their intrinsic characteristics and implementation outcomes. Based on these findings, this paper proposes an OBE-driven reform pathway for ME talents training, including reinforcing differentiated training target, optimizing the curriculum based on the industry needs, establishing university–enterprise collaborative education platforms, and promoting internationalized training models. These measures aim to enhance the quality of mechanical engineering talent cultivation in China and advance the modernization of higher education.

1. Introduction

With the rapid development of intelligent manufacturing, higher demands have been placed on innovation ability, complex engineering problem-solving capacity and interdisciplinary integration skills in engineering talent. As a traditional discipline of engineering, the quality of mechanical engineering (ME) education directly impacts the development level of manufacturing and high-end equipment industries. Outcome-Based Education (OBE) [1], emphasizing “what students can do” rather than “what teachers have taught”, has been widely adopted by members of the Washington Accord and serves as the cornerstone of engineering education accreditation. China has actively promoted engineering program accreditation, systematically embedding the OBE concept into reforming traditional engineering talent training models. The UK, with its long-established engineering education system, has emphasized industry–academia integration and engineering capacity development, and its training outcomes have been widely recognized internationally [2]. Therefore, a systematic comparison of the OBE-based ME talent training models in China and the UK is of great theoretical and practical significance in reviewing the effectiveness of China’s reforms, identifying deep-rooted issues, and learning from international best practices.

2. The Core Principles of the OBE Educational Concept

OBE is an educational philosophy that takes student learning outcomes as its fundamental orientation [3], with all teaching design and implementation revolving around the competencies that students are expected to acquire. Its core principles include [4-6]:

- **Backward Design:** Teachers first define the competencies required at graduation, then design the curriculum, teaching content, and assessment methods accordingly.
- **Student-Centeredness:** OBE concept shifts the focus from teaching to learning, emphasizing students' individual development and growth.
- **High Expectations:** Teachers set ambitious and challenging goals for all students while providing necessary support for achievement.
- **Continuous Improvement:** Universities collect evidence of learning outcomes through diverse assessments, feed this information back into teaching for optimization, and form a closed-loop mechanism.

3. Comparative Analysis of OBE-Based Mechanical Engineering Talent Training Models in China and the UK

(1) Training Objectives and Graduation Requirements

- **UK Universities:** Training objectives are closely aligned with industry needs and institutional positioning. For instance, Imperial College London aims to cultivate "global industrial leaders," with graduation requirements highlighting design innovation, systems thinking, business insight, and leadership. Intended Learning Outcomes are articulated with specificity and measurability, and they are clearly mapped to courses.
- **Chinese Universities:** With the impetus of accreditation, most universities have formulated OBE-aligned training objectives and graduation requirements, largely covering accreditation standards. However, issues of homogenization persist, with insufficient differentiation and clarity. Some outcomes remain broadly defined, and their links with course-level support are not always explicit.

(2) Curriculum System and Teaching Content

- **UK Universities:** The curriculum is characterized by high modularization, flexibility, and project orientation.
    - *Modular Design:* Students can flexibly combine modules based on interests and career goals.
    - *Project-Driven Learning:* Project-based courses run throughout all academic years. For example, students at the University of Manchester may participate in designing, manufacturing, and testing components for a Formula SAE car, covering design, simulation, machining, cost control, and teamwork.
    - *Cutting-Edge Content:* Courses are closely integrated with emerging technologies such as digital twins, additive manufacturing, and artificial intelligence, with frequent updates.
- **Chinese Universities:** Although reforms are progressing, the system remains knowledge-centered.
    - *Rigid Structure:* Required courses still dominate credit allocation, leaving limited space for interdisciplinary electives.
    - *Practice Deficiency:* While internships and design projects are strengthened, some remain simplified or hypothetical, detached from real-world industry needs, limiting innovation and comprehensiveness.
    - *Lagging Updates:* Teaching materials and content often fall behind rapid technological

advancements.

(3) Teaching Evaluation and Continuous Improvement

- **UK Universities:** Evaluation is diverse, process-oriented, and rigorously standardized.
    - *Diverse Assessment:* Examinations, reports, presentations, portfolios, group projects, peer reviews, and oral defenses are all used to evaluate multiple competencies.
    - *Process Feedback:* Emphasis is placed on formative assessment with frequent feedback to promote improvement, rather than relying solely on summative assessment.
    - *Closed-Loop Improvement:* Institutionalized course and program evaluations, including student surveys and the external examiner system, ensure objectivity and consistency. Data feed directly into annual improvement reports.
- **Chinese Universities:** Assessment is diversifying but remains limited in depth.
    - *Assessment Tools:* Exams and assignments remain dominant; reports and presentations are less standardized in evaluation.
    - *Weak Feedback:* Assessments often serve grading purposes rather than enhancing learning, with formative feedback underutilized.
    - *Improvement Mechanisms:* Although continuous improvement frameworks exist, their effectiveness is limited. Graduate tracking and course evaluation data are not fully leveraged for program adjustments.

4. Implications for Reforming Mechanical Engineering Education in China

As a foundational discipline in engineering, ME requires students not only to master the complete knowledge system of design-manufacturing-measurement-control but also to possess solid practical engineering skills and the ability to apply theoretical knowledge to solve complex engineering problems. By comparing the OBE-based training models between China and the UK, the following insights can be drawn for the reform of ME program in Chinese universities and even for broader engineering education:

(1) Promoting Categorized and Differentiated Training Target

Universities should develop distinctive training objectives based on their own positioning (research-oriented vs. application-oriented) and service orientation (e.g., aerospace, electric vehicles, advanced manufacturing).

- Research-Oriented Universities should focus on national strategic needs, cultivating future scientists and key engineers with strong theoretical foundations and original innovation capacity.
- Application-Oriented Universities should target regional industries and emerging sectors, cultivating engineers proficient in system integration, process optimization, project management, and real-world problem-solving.

(2) Industry Demand-Oriented Backward Reconstruction of the Curriculum System and Teaching Content

1) Establish a dynamic mechanism of "industry demand-graduation requirements-curriculum system"

- Through the establishment of industry-university collaborative committees, the universities can annually review graduation requirements to ensure synchronization with industry technological developments (e.g., digital twins, AI, low-carbon technologies).
- A "course-graduation requirement" relationship matrix should be built to ensure each course contributes clearly and measurably to ability cultivation.

2) Promote Project-Based Learning (PBL):

- First Year: The school/ faculty should offer introductory engineering courses and invite industry experts to present real-world engineering cases, aiming to stimulate students' interest.

- Second and Third Years: Instructors should set 1-2 core project-based courses per semester, based on simplified or actual enterprise projects, to help students integrate knowledge from multiple theoretical courses.
- Fourth Year: The program ought to implement “real topics and real projects” for graduation design, with topics derived from the technical R&D needs or frontline engineering challenges faced by cooperative enterprises.

(3) Deepening University-Enterprise Cooperation

1) Co-build practical platforms and resources

- Universities should partner with industry leaders or regional key enterprises to establish practice bases.
- Universities ought to introduce enterprise-grade equipment and industrial software to build digital factory laboratories that are synchronized with actual enterprise sites.

2) Promote deep participation of “dual-qualified” faculty and enterprise mentor

- Universities should implement “Teacher Enterprise Training Programs”, selecting young teachers for internships in enterprises to enhance their practical engineering capabilities.
- Enterprises may appoint senior engineers and technical directors as industry professors, who will be responsible for teaching professional courses, providing project guidance, reviewing graduation designs, and participating in the revision of training programs.

3) Innovate cooperation models

- Both universities and enterprises can explore “university-enterprise joint order classes”, where enterprises select students from lower grades, jointly customize courses, and provide scholarships and clear internship/employment pathways.

(4) Emphasizing International Training

1) Integrate international engineering education standards

- Universities should align their curriculum and teaching content with international standards such as the Washington Accord, introducing cutting-edge engineering norms, technical standards, and design concepts.

2) Expand international teaching resources and exchanges

- Universities ought to offer full-English taught programs or course modules to attract international students and create a multilingual, international learning environment.
- Universities are encouraged to establish joint training and exchange programs such as “2+2” or “3+1” with renowned foreign universities.
- Students should be encouraged to participate in international academic conferences and competitions to broaden their global perspectives.

3) Develop cross-cultural communication skills

- Course instructors should incorporate content on international engineering ethics and cross-cultural project management into the syllabus, cultivating students’ ability to collaborate effectively in international teams.

(5) Improving Continuous Improvement Mechanisms

1) Establish a diverse evaluation and feedback system

- Internal Evaluation: Universities should strengthen the analysis of course objective achievement through multiple forms of evaluation such as exams, reports, defenses, and portfolios.
- External Evaluation: Institutions ought to introduce enterprise evaluations in core program links. Industry experts may be invited as main reviewers for graduation design defenses, with their evaluations carrying significant weight in the final grade.
- Long-Term Tracking: Universities should build a graduate career development database and regularly distribute questionnaires to employers and graduates to collect feedback on training

quality.

2) Strengthen the feedback-improvement closed loop

- A "Continuous Improvement Working Group" should be established, consisting of program leaders, key faculty, enterprise representatives, and alumni representatives, to systematically review feedback and implement enhancements.
- The working group regularly (e.g., per semester/year) analyzes all evaluation data (course achievement, enterprise evaluations, graduate feedback, etc.), produces an Annual Teaching Quality Analysis and Improvement Report, and dynamically adjusts training objectives, graduation requirements, course content, and teaching.

5. Conclusion

Chinese and UK universities are at different stages in implementing OBE. UK institutions have internalized OBE into their educational philosophy and quality culture, providing valuable lessons. China's reforms have achieved structural resemblance, but the next stage is to pursue substantive resemblance, shifting from compliance to deep integration. By focusing on distinctive objectives, industry needs-oriented curricula, university-industry collaboration, and internationalized collaboration, China can cultivate mechanical engineering graduates with strong engineering competence and innovative capacity, thereby contributing to its strategy of becoming a world-leading manufacturing power.

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