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An OBE-Based Continuous Improvement Mechanism for Medical Immunology: Curriculum Reform and Empirical Evidence

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Abstract: This study addresses challenges in traditional “Medical Immunology” education, such as fragmented knowledge, theory-practice gaps, and single-method assessment, through an Outcome-based Education (OBE) reform. Aligned with program graduation requirements, we established a three-dimensional objective system encompassing knowledge, ability, and competency, along with a diversified, process-oriented assessment approach. A key innovation is the introduction of a quantitative course-objective achievement model. Analysis of data from the 2025–2026 academic year revealed achievement rates of 0.752 for knowledge, 0.784 for ability, and 0.764 for competency. These results confirm the overall effectiveness of the reform while also highlighting areas for improvement, particularly in knowledge integration and clinical application. Corresponding improvement strategies are proposed, including modular content restructuring, enhanced case-based teaching, better assessment alignment, and the establishment of a dynamic feedback loop. This study demonstrates how integrating OBE with quantitative analysis can shift the teaching of medical foundation courses from experience-based to data-driven practice.

1. Introduction

The 21st century has seen a global “quality revolution” in higher education, shifting focus from resource input and teaching processes to student learning outcomes. Outcome-Based Education (OBE) has profoundly impacted professional fields like engineering and medicine[1]. The core principles of student-centeredness, outcome orientation, and continuous improvement are being increasingly applied in practice. In China, with national initiatives such as the “China Education Modernization 2035” plan and the expansion of professional certification in medical education, OBE has moved from theoretical discussions to widespread implementation. It has become a pivotal approach for medical schools to advance teaching reforms and enhance talent development.

Medical education is highly specialized, practical, and humanistic, directly impacting public health. In this context, Medical Immunology serves as a crucial bridge between basic medicine, clinical medicine, and preventive medicine[2]. It holds an essential position in the modern medical knowledge system. For medical laboratory technology students, this course provides the foundation for understanding the mechanisms of infectious diseases, tumors, and other pathologies, and is also necessary for mastering immunological testing techniques and conducting clinical diagnostics. The quality of instruction in this course significantly influences students' professional learning, clinical competencies, and career trajectories.

However, traditional teaching of Medical Immunology faces several challenges. First, the subject is dense with terminology, abstract concepts, and interconnected mechanisms, making it difficult for students to form a coherent understanding of the immune system. Conventional didactic methods often result in fragmented knowledge, hindering integrated comprehension. Second, there is a theory-practice gap: students may memorize content but struggle to apply it in clinical scenarios or interpret laboratory reports, reflecting a disconnect between "knowing" and "doing". Third, assessment is primarily based on summative closed-book exams that mainly test recall, not competency development. Feedback is delayed, limiting timely improvements in teaching. These issues contribute to an inefficient model of "high input, low output," where students face heavy learning burdens but gain limited competence, creating a clear need for reform.

This study aims to implement OBE across the Medical Immunology curriculum and develop an actionable, evaluable, and sustainable reform framework[3]. The objectives include: (1) constructing a tiered course objective system aligned with graduation requirements; (2) designing a diversified, process-oriented evaluation system; (3) introducing a quantitative tool for assessing course objective attainment; and (4) proposing improvement strategies based on diagnostic results, creating a continuous "design-implementation-evaluation-improvement" cycle for teaching quality. This study's theoretical contribution is in operationalizing OBE within medical education, enriching curriculum theory[4]. Practically, it offers a data-driven approach to address long-standing pedagogical issues in Medical Immunology and similar courses. The proposed continuous improvement mechanism provides a transferable model for curriculum quality management, with broader implications for advancing medical education.

2. Course Teaching System Reconstruction Based on the OBE Concept

2.1. Design and Alignment of the Three-Dimensional Course Objective System

Course objectives are the "soul" of OBE practice. This study first analyzes the graduation requirements for the medical laboratory technology program, clarifying the core competencies that graduates should possess in terms of knowledge, skills, and professional qualities. Based on this, the specific training tasks that the "Medical Immunology" course should undertake were reverse-engineered, resulting in a three-dimensional course objective system that is mutually supportive and progressively layered[5].

Knowledge objectives (cognitive level) form the foundation of the course. Students are required to systematically master the composition and function of the immune system, the characteristics of antigens and antibodies, the mechanisms of innate and adaptive immune responses, and core concepts such as immune tolerance and hypersensitivity. These objectives correspond to the graduation requirements for mastering basic medical knowledge and laboratory theory. Ability objectives (application level) are the key focus of the course, emphasizing the transformation of knowledge into problem-solving skills. Students are expected to distinguish the differences between the mechanisms of innate and adaptive immunity, apply immunological principles to analyze clinical immune phenomena, and initially develop the ability to interpret laboratory test results and guide disease prevention. These objectives align with the graduation requirements for "analyzing and solving complex problems in medical laboratory technology." Competency objectives (affective and value level) represent the elevation of education, aiming to cultivate students' professional sentiments and scientific thinking. Students are required to develop an analytical thinking pattern of “micro-level immune mechanisms-macro-level pathological manifestations-laboratory diagnostic indicators,” understand the cutting-edge applications of immunology, and foster scientific exploration, medical humanism, and rigorous professional attitudes.

These objectives correspond to the graduation requirements for understanding professional value and fostering personal qualities. The three objectives form an organic whole, with knowledge as the foundation, ability as the core, and competency as the guiding direction. Clear and traceable relationships are established between these objectives and the professional graduation requirements, providing the fundamental basis for teaching activities and evaluations.

2.2. Construction of a Diversified Evaluation System to Support Objective Achievement

To ensure the effective achievement of course objectives, this study changed the traditional model of “one exam determines the grade” by designing a diversified evaluation system that spans the entire teaching process, incorporates various forms, and reasonably distributes weights. The core idea revolves around objective alignment, continuous evaluation, and timely feedback.

Performance evaluation (10% of total grade) is conducted through classroom questioning, impromptu exercises, and group discussions to assess students' learning engagement and thinking state. It focuses on evaluating students' concentration, initiative, and the quality of questions they ask, which has a formative significance for the development of competency objectives. Unit assignments and case analysis reports (20% of total grade) are given after completing each core teaching unit in the form of case analyses, mechanism comparisons, or literature reviews. For example, students are tasked with comparing the dynamic changes in IgG and IgM during immune responses and analyzing their clinical significance. This effectively supports the achievement of ability objectives. Unit quizzes (20% of total grade) are conducted after completing relevant chapters. The quiz questions emphasize the integration of knowledge points and aim to diagnose students’ integration of knowledge at the unit level, thus testing the preliminary transformation of knowledge objectives into ability objectives. Thematic reading notes (10% of total grade) guide students to read supplementary materials related to the course and write notes summarizing core points, reflecting on them and integrating them with classroom knowledge. This helps cultivate independent learning, information integration skills, and scientific thinking, promoting the achievement of competency objectives. The final comprehensive exam (40% of total grade) is a summative assessment that strictly follows the course objectives’ weight distribution. It reduces memory-based questions and increases the proportion of integrated application questions, case analysis, and open-ended essay questions. For instance, a virtual case involving chronic viral infections may be provided to assess students' ability to apply knowledge from multiple modules.

This exam is the key basis for evaluating the overall achievement of the course objectives. Each evaluation component is interconnected, with different focuses and grading criteria announced in advance, ensuring that the evaluation system guides students toward improving their abilities and competencies. The evaluation process plays a crucial role in motivating learning, focusing students' efforts on enhancing their skills and qualities.

3. Quantitative Evaluation and In-depth Diagnostic Analysis of Course Objective Achievement

3.1. Evaluation Model and Data Sources

The evaluation of course objective achievement is a key diagnostic component in the OBE feedback loop. Its basic logic is that the achievement of a course objective is determined by all the assessment components supporting that objective. The contribution weight of each component to the objective is pre-set and calculated. The achievement rate Pi for an objective i is derived from the weighted sum of the average score ratios of all assessment components linked to that objective, divided by the objective's total assigned weight.

The data in this study comes from all assessment components in the “Medical Immunology” course for the 2025-2026 academic year, first semester, at a medical laboratory technology program in a university, with a class of 58 students. All components were implemented according to the plan, ensuring that the data is authentic and reliable. The achievement threshold was set at 0.70, with achievement levels equal to or greater than 0.70 considered as “achieved”.

3.2. Presentation of Evaluation Results

The statistical results show the achievement rates for the three course objectives as follows: Knowledge Objective (P1 = 0.752), Ability Objective (P2 = 0.784), Competency Objective (P3 = 0.764). All three objectives exceeded the 0.70 threshold, indicating that the OBE-based teaching reform was generally successful and that students achieved the intended learning outcomes. At the same time, the differences between the achievement rates of the objectives also provided a basis for diagnosing teaching issues.

3.3. Data-Based In-depth Diagnostic Analysis

The effectiveness and issues of the teaching reform were accurately diagnosed through the achievement evaluation. The effectiveness of the ability development pathway was fully validated, as its achievement rate was the highest among the three indicators (P2 = 0.784), confirming the value of emphasizing process-oriented and application-oriented training in the reform. The unit assignments and reading note components, which contributed 40% to the ability objective, had average scores of 88.10% and 89.80%, respectively. This shows that by guiding students through “learning by doing” practical training, their higher-order skills such as analysis and application were effectively developed, providing a solid foundation for further advancement of the teaching reform.

The knowledge objective had the lowest achievement rate among the three indicators (P1 = 0.752). The core issue is concentrated in the final exam component, which accounted for 40% of the knowledge objective’s contribution. The average score for this component was only 65.42%, which is a noticeable contrast to the high scores in the assignments and unit quizzes. This result reveals that while students are competent in mastering isolated knowledge from specific chapters, they lack the ability to integrate the entire course content. Unit quizzes, which cover fewer chapters, are easier for students, but when the final exam requires cross-chapter integration of knowledge, students struggled. This also reflects a fundamental flaw in traditional linear teaching methods, which fail to promote the structured, networked construction of knowledge, leading to fragmented knowledge systems and real difficulties in systematic integration.

The competency objective (P3 = 0.764) was higher than the knowledge objective but still lower than the ability objective, with the final exam score of 61.38% being less than ideal. This highlights a “transfer barrier” from theory to practice. Specifically, students perform well when mastering theoretical knowledge and conducting basic analysis. However, when faced with more complex, real-world clinical cases with more diverse and ambiguous information, they struggle to quickly identify key immunological issues and fail to integrate knowledge for reasoning and analysis. This shows a difficulty in transitioning from “mastering theory and analysis” to “flexibly applying theory to explain complex clinical situations.” This issue is closely related to the insufficient supply of high-quality, comprehensive clinical case training and the failure to effectively guide students through the transition from “learners” to “future professionals.”

This achievement evaluation not only clarified the overall status of the course objectives but also, through data comparisons and problem analysis, accurately diagnosed the core shortcomings in this teaching reform. It identified specific issues in knowledge system construction and theory-practice transfer, providing scientific and detailed empirical evidence for subsequent targeted teaching improvements.

4. Teaching Optimization Strategy System for Continuous Improvement

Based on the previous diagnostic analysis, this study has constructed a targeted and systematic continuous improvement strategy system, directly addressing the two major challenges of “knowledge integration” and “clinical transfer,” driving a spiral upward of teaching quality.

4.1. Evaluation Model and Data Sources

To overcome the dilemma of fragmented knowledge systems and strengthen students' systems thinking, we implemented a “modular-topic-based” restructuring of teaching content, breaking the original boundaries of the textbook chapters. Using “core immunology issues” as the thread running through the teaching, the content was reorganized into four major modules. Module 1, “Immune Recognition and Response Initiation,” integrates topics such as antigens, MHC, and antigen presentation, focusing on answering the core question of “How does the immune system recognize 'non-self'?” Module 2, “Immune Effect and Clearance,” combines knowledge points related to antibodies, complement, and lymphocyte effector functions, clearly explaining the mechanism of “How the immune system clears threats.” Module 3, “Immune Regulation and Homeostasis,” links topics like immune tolerance, hypersensitivity, and autoimmune diseases, and delves into the internal logic of “How the immune system maintains balance.” Module 4, “Immunological Applications and Frontiers,” focuses on topics such as vaccines, immunotherapy, and tumor immunology, balancing theoretical depth with practical frontiers. Each module begins with a core question that guides students to actively integrate scattered knowledge points, ultimately returning to the core question to form a systematic understanding, effectively strengthening students' systems thinking abilities and solving the problem of knowledge integration[6].

To address the “transfer barrier” from theory to practice, we deepened the “comprehensive, continuous” case-based teaching approach by upgrading clinical cases to the core teaching materials. We carefully constructed a layered case library, covering three levels: basic, comprehensive, and advanced. The basic level includes small cases with a single mechanism, such as neonatal hemolytic disease, to help students solidify their basic theoretical application skills; the comprehensive level contains medium-sized cases, like systemic lupus erythematosus, involving multiple mechanisms to train students’ ability to integrate and apply multiple knowledge points; the advanced level includes complex cases, such as the efficacy and risks of PD-1 inhibitors in tumor treatment, guiding students to connect with real clinical scenarios. Case-based teaching spans the entire teaching process: before class, students are assigned cases to encourage them to think and prepare in advance; during class, cases are analyzed in segments and precisely interpreted in conjunction with specific knowledge points; after class, case-based extension tasks are assigned to deepen students' learning through real-world problems, achieving a deep integration of theory and clinical practice and gradually breaking down the barriers to theory-practice transfer.

To further enhance students' higher-order abilities and comprehensive qualities, we introduced inquiry-based and collaborative learning activities, organically combining PBL (Problem-Based Learning) and TBL (Team-Based Learning). In the topic-based teaching process, we designed specific inquiry tasks, such as “Design a vaccine development strategy report for a newly emerging viral disease,” guiding students to work in groups, independently search for relevant literature, systematically integrate learned knowledge, collaboratively explore solutions, and present their findings through classroom presentations and debates. This approach not only trains students in knowledge integration, logical reasoning, and practical application but also cultivates comprehensive skills like teamwork, communication, and innovative inquiry. Thereby, it serves the higher-order competency objectives and enhances overall teaching quality.

4.2. Precision and Consistency Enhancement in the Evaluation System

To enhance the feedback effectiveness of process-oriented evaluations, we changed the previous approach of “only grading with little feedback” for assignments and reading notes. Using online platforms, we conducted annotations and personalized comments, accurately pointing out students’ logical gaps, knowledge application errors, and providing targeted suggestions for improvement. This turn each evaluation into an opportunity for teacher-student dialogue and thinking calibration, fully utilizing the formative role of process evaluation in promoting teaching.

We also optimized the design of final exams to synchronize with the modular and case-based teaching reforms. This involved increasing the proportion of comprehensive application questions. Cross-module application questions were designed to test students' ability to construct knowledge networks. Case analysis questions were optimized by selecting materials that are closer to real clinical cases, testing students' key information identification and reasoning skills. Open-ended questions were introduced to assess students' critical thinking and scientific values, while setting up hierarchical prompts within the questions to balance the exam's discriminatory power and accurately reflect students' real abilities.

This study explored diverse qualitative evaluation methods to innovate the evaluation of competency objectives. For example, small group case presentations and defenses were used to evaluate students' collaboration and presentation skills, health education materials creation was used to assess students' ability to translate knowledge into public-friendly language and humanistic care, and reflective learning logs were employed to promote the development of students' metacognitive abilities. This ensured a comprehensive and precise evaluation of students' competency objectives.

4.3. Establishing a Dynamic “Teaching-Evaluation-Improvement” Feedback Loop

A continuous improvement mechanism should not be periodic but institutionalized. To achieve this, we established a stable dynamic feedback loop. During the semester, teaching feedback was quickly collected using online data analysis and teacher-student meetings, allowing for mid-term adjustments to be made. At the end of the semester, the teaching team held a review meeting based on achievement data, exam analysis, and student feedback, identifying teaching issues. These issues were then transformed into specific improvement measures for the next round of teaching, which were written into the revised syllabus and teaching plan, enabling continuous optimization of teaching quality.

5. Conclusion and Outlook

This study has transformed the OBE concept into practical teaching for the "Medical Immunology" course, completing the full cycle of "design-implementation-evaluation-improvement." The practice has shown that a clear three-dimensional course objective system is the foundation of reform, a diversified evaluation system is the guarantee, and quantitative achievement analysis is the key to precise reform. The analysis accurately diagnosed two major issues: "insufficient knowledge integration" and "difficulty in clinical transfer," while the targeted improvement strategies formed a systematic solution.

This study still has limitations, as it is an exploration based on a single course and one round of teaching. The effectiveness of the reform needs to be verified through multiple rounds of longitudinal tracking. Looking ahead, the research will be deepened in three aspects: first, longitudinal tracking, collecting data from multiple rounds of teaching to test the long-term effects of the improvement measures; second, deepening the mechanism, combining educational psychology to study the cognitive barriers to knowledge integration and clinical transfer, optimizing teaching interventions; third, expanding applications, transferring the "objective-evaluation-achievement-improvement" model established in this study to other core courses within the program, building a collaborative teaching loop for the course group, and providing curriculum support for the cultivation of high-level medical laboratory technology professionals. The essence of education is awakening and igniting, and a scientific evaluation and improvement mechanism is a powerful guarantee for ensuring precise and efficient teaching and the comprehensive development of students.

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References

[1] Shen, T., & Steven, L. (2016). On Outcome-Based Educational Theories [J]. Journal of Higher Education Management, 10(05), 47-51.

[2] Wang Y., Fan S., Yang T., et al. (2025). Discussion of Teaching Methods of Immunology Based On OBE Education Concept [J]. Chinese Journal of Immunology, 41(12), 2994-2997.

[3] Li Z., Wang Z. (2021). Course Teaching Design of Outcome-based Education [J]. Higher Education Development And Evaluation, 37(03), 91-98+113.

[4] Wang Y., Hu G., Duan Y., et al. (2019). Course Teaching Under the Outcome-based Education Framework:Design, Implementation and Evaluation [J].Research in Higher Education of Engineering, 3, 62-68+75.

[5] Zhang H., Ju B., Nie Y., et al. (2024). Exploration on Medical Immunology Curriculum Construction Based on OBE Concept [J].China Continuing Medical Education, 16(18), 36-39.

[6] Baxa M.,Taylor H.,Cortes C., et al. (2025). Collaborative Concept Mapping in Team-based Learning: Synthesizing Complex Immunology Concepts in Medical Education[J]. Frontiers in Education, 10, 1604406.