

Exploration of Assessment and Evaluation Scheme for Logistics System Simulation Course Based on OBE Concept

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Abstract: In the context of engineering education accreditation and the pursuit of enhanced teaching quality, the Outcome-Based Education (OBE) concept has become a guiding principle for curriculum reform. The Logistics System Simulation course, characterized by its strong practical and interdisciplinary nature, requires an assessment system that accurately reflects students' abilities to solve complex engineering problems. This paper explores the construction of a diversified, full-process assessment and evaluation scheme based on the OBE concept. By reversely designing course objectives from expected learning outcomes, redefining assessment points aligned with ability indicators, and integrating formative and summative evaluations, this study proposes a comprehensive evaluation framework. A case study demonstrates that the proposed scheme effectively stimulates students' autonomous learning, enhances their practical simulation skills, and provides a more objective measure of teaching effectiveness, aligning with the core philosophy of student-centered and outcome-oriented education.

1. Introduction

The rapid development of logistics and supply chain management in the era of Industry 4.0 demands that higher education institutions cultivate talents with strong practical abilities, systematic thinking, and innovative problem-solving skills. "Logistics System Simulation" is a core course for logistics management and engineering majors. It typically involves using discrete event simulation software (such as FlexSim, Anylogic, or Plant Simulation) to model, simulate, and optimize complex logistics systems. The course serves as a critical bridge between theoretical knowledge and real-world engineering practice.

Traditionally, the assessment for such courses often relies heavily on final grades—either a final exam or a single end-of-term simulation project. This traditional model suffers from several drawbacks: it emphasizes summative assessment over formative feedback, overlooks the process of learning, and fails to comprehensively measure students' higher-order abilities such as systematic modeling, data analysis, and collaborative problem-solving.

The Outcome-Based Education (OBE) concept, a student-centered educational philosophy that emphasizes what students are expected to do as a result of learning, provides a robust theoretical framework for addressing these issues. Under the OBE framework, the design of teaching activities and assessment systems must revolve around the achievement of predefined learning outcomes.

This paper aims to explore the reconstruction of the assessment and evaluation scheme for the Logistics System Simulation course based on the OBE concept. The objectives are to establish a closer alignment between course objectives and talent cultivation goals, to design a multi-dimensional evaluation index system, and to implement a whole-process assessment mechanism that promotes continuous improvement.

2. Theoretical Foundation: OBE Concept and Its Implications for Assessment

The OBE concept, first proposed by Spady in the 1980s, operates on three core principles: clarity of focus (all decisions are driven by desired outcomes), expanded opportunities (multiple assessment methods to prove success), and high expectations (setting challenging standards to encourage excellence).

When applied to curriculum assessment, OBE shifts the focus from "what the teacher teaches" to "what the student learns and can do." The implications for the assessment scheme in a practical course are as follows:

(1) Reverse Design: The assessment scheme should not be an afterthought but should be designed before teaching activities begin. Course objectives must be derived from the program's Graduate Attributes (e.g., problem analysis, design/development of solutions, use of modern tools).

(2) Outcome-Oriented: Evaluation must verify whether students have achieved the specific learning outcomes. This requires defining measurable performance indicators for each course objective.

(3) Continuous Assessment: Assessment should be a continuous process that includes formative evaluation (e.g., quizzes, project milestones, classroom interaction) to provide feedback and guide learning, alongside summative evaluation to measure final achievement.

(4) Diversification: Since ability is multi-dimensional, assessment methods must be diversified, including exams, reports, project demonstrations, peer reviews, and oral defenses, to capture different facets of student competency.

3. Reverse Design of Course Objectives and Evaluation Indicators

Under the OBE framework, the first step is to clarify the expected learning outcomes based on the program's graduate attributes.

3.1. Definition of Course Objectives

For the Logistics System Simulation course, the course objectives (COs) can be defined in alignment with ability indicators:

(1) CO1 (Knowledge): To master the fundamental theories of system simulation and comprehend their practical application in logistics systems. To develop the capability to construct simulation models for basic logistics problems, and to cultivate students' abilities to analyze and resolve issues within specific logistics systems.

(2) CO2 (Application): To develop the capacity to model, simulate, and apply solutions for various basic logistics systems, foster an innovative mindset, and accumulate experience and skills to support subsequent course studies and graduation projects.

(3) CO3 (Integration): To enable students to synthesize relevant professional knowledge with the

core theories of logistics system simulation, thereby enabling them to model and simulate fundamental practical logistics problems.

(4) CO4 (Affective): To cultivate students' awareness of the value of collaborative learning and teamwork. Through the execution of projects and assignments, students are expected to engage in thorough discussion, maintain close cooperation, coordinate effectively in presentations and defences, and demonstrate appropriate expressions of support and appreciation.

(5) CO5 (Value): To cultivate students' international perspective, enabling them to understand and adhere to professional ethics and standards within the practice of system simulation, while demonstrating a strong sense of responsibility.

(6) CO6 (Learning): To enable students to leverage both online and offline resources for course learning, cultivating their capacity to acquire knowledge via modern information technology. Students are expected to develop the habit and awareness of engaging in autonomous learning before and after class through diverse digital and traditional resources, thereby demonstrating self-directed learning competencies.

3.2. Mapping of Evaluation Indicators

To ensure quantifiable assessment, each course objective is mapped to specific, measurable performance indicators. As show in Table 1

Table 1: Mapping of Course Objectives to Assessment Indicators

| Course Objective | Performance Indicators | Assessment Methods |
|---|---|--|
| CO₁ (Knowledge) | <ul style="list-style-type: none"> • Accurately articulate the basic concepts of system simulation, modeling steps, and principles of random number generation. • Correctly interpret the operational processes, resource constraints, and logical relationships of a given logistics system, and draw a conceptual model flowchart. • Identify key parameters in practical logistics problems (e.g., arrival rate, service time, queuing discipline) and apply theoretical knowledge for qualitative analysis. | <ul style="list-style-type: none"> • In-class Quizzes (multiple-choice/short answer questions) • Conceptual Model Report (flowchart + written description) Exam (theoretical section) • Assignments (theoretical analysis questions) |
| CO₂ (Application) | <ul style="list-style-type: none"> • Proficiently use simulation software to construct, run, and debug basic logistics system models with error-free execution. • Correctly configure statistical distribution functions (e.g., normal, Poisson, exponential) and entity flow logic in the model. • Propose innovative approaches during the modeling process (e.g., model simplification methods, parameter setting optimization). • Submit complete and executable simulation model files with clear structure and standardized naming conventions. | <ul style="list-style-type: none"> • Lab Reports (scored per experiment) • Simulation Model Files (code/software files) • Project Milestones (model implementation phase) • Innovation Description Document • Software Operation Demonstration (in-class spot checks) |
| CO₃ (Integration) | <ul style="list-style-type: none"> • Integrate knowledge from prerequisite courses such as operations research, warehouse management, and production planning to design simulation model solutions. • Design reasonable simulation experiment plans, including scenario settings, variable selection, and determination of replication runs. • Accurately analyze simulation output data, apply statistical methods to validate result validity, and identify system bottlenecks. • Propose feasible and well-justified optimization solutions based on data analysis results, and quantify the optimization effects. | <ul style="list-style-type: none"> • Project Analysis Report (including data analysis section) • Final Project Defense (Q&A on analysis section) • Experiment Design Documentation <ul style="list-style-type: none"> • Case Study Report • Data Analysis Tables/Charts Review |

| Course Objective | Performance Indicators | Assessment Methods |
|--------------------------------|---|---|
| CO ₄ (Affective) | <ul style="list-style-type: none"> Actively speak up in team discussions, offer constructive suggestions, and take responsibility for assigned tasks. Maintain effective communication with team members and negotiate solutions promptly when issues arise. Demonstrate seamless coordination with team members during project presentations, ensuring cohesive delivery. Express gratitude to team members for their support and assistance in project summaries. | <ul style="list-style-type: none"> Peer Evaluation (anonymous mutual evaluation) <ul style="list-style-type: none"> Team Collaboration Records (meeting minutes/communication logs) Instructor Classroom Observation Records Presentation Coordination Score Individual Reflection Report |
| CO ₅ (Value) | <ul style="list-style-type: none"> Adhere to the principle of data authenticity in simulation practice, avoiding falsification or alteration of simulation results. <ul style="list-style-type: none"> Understand the impact of simulation model results on real-world decision-making and recognize the responsibility associated with model bias. Reference international simulation standards or exemplary cases from abroad in projects or assignments. Submit assignments and project deliverables on time, taking full responsibility for assigned work. | <ul style="list-style-type: none"> Professional Ethics Reflection Report <ul style="list-style-type: none"> Case Study Discussion (ethics-related cases) Defense Q&A (questions on responsibility awareness) International Case Citation Check Timeliness of Submission Record |
| CO ₆ (Learning) | <ul style="list-style-type: none"> Utilize online resources such as MOOCs, official simulation software tutorials, and academic databases to supplement learning. Complete pre-class preparation tasks (e.g., watching videos, reading materials) and submit preparation notes. Proactively consult materials after class to solve technical challenges encountered during modeling. Demonstrate consistent habits of autonomous learning throughout the course. | <ul style="list-style-type: none"> Online Learning Platform Records (viewing duration/completion rate) Submission of Pre-class Preparation Notes Resource Utilization Report (student self-report) <ul style="list-style-type: none"> Self-Assessment of Autonomous Learning Ability Extended Learning Outcomes (e.g., self-initiated models) |

4. Construction of a Diversified Full-Process Assessment Scheme

Based on the reverse design, the assessment scheme is structured to cover the entire learning process, combining formative assessment (70%) and summative assessment (30%) to motivate students continuously.

4.1 Formative Assessment (Process Evaluation) - 70%

Formative assessment is embedded throughout the semester to monitor learning progress and provide timely feedback.

Lab Assignments (20%): After each major module (e.g., basic modelling, data fitting, output analysis), students complete individual or paired assignments. These are graded with detailed rubrics focusing on software operation skills and logical correctness. This ensures that students do not fall behind.

(1) Phase Deliverables for Course Project (30%): The final project is broken into phases to ensure steady progress.

Phase 1: Problem Statement & Conceptual Model (5%): Students submit a report describing the system logic and modelling assumptions. Feedback is provided to ensure the project scope is appropriate.

Phase 2: Model Implementation (10%): Students submit the runnable simulation model file. The focus is on technical accuracy, aesthetics, and efficiency of the model.

Phase 3: Experiment & Analysis Report (15%): Students submit a comprehensive report

detailing the experiment scenarios, statistical analysis, and optimization suggestions. This phase assesses analytical and writing skills.

(2) Classroom Interaction and Quizzes (10%): Unannounced quizzes on theoretical concepts (e.g., random number generation, confidence intervals) and active participation in discussions account for a small percentage, incentivizing consistent engagement.

(3) Peer Evaluation (10%): At the end of the project, team members evaluate each other's contributions. This helps ensure fair individual grading within teams and cultivates professional accountability. Use 20-point type for the title, aligned to the left, linespace single with a bold style and initial letters capitalized. No formulas or special characters of any form or language are allowed in the title.

4.2 Summative Assessment (Final Evaluation) - 30%

Summative assessment evaluates the overall achievement of course objectives.

(1) Final Project Defence (20%): Instead of a traditional final exam, students present their final project in a defence format. Each team gives a presentation (10-15 minutes) followed by a Q&A session. The defence evaluates oral communication skills (CO₄) and their depth of understanding (CO₃). Faculty ask probing questions to verify individual contributions and mastery.

(2) Final Report (10%): The final polished report, submitted after defence, incorporates feedback from the Phase 3 submission. This ensures that learning from feedback is demonstrated.

4.3 Comprehensive Evaluation Rubric

To ensure objectivity, a rubric is developed for the project report and defence. Table 2 provides an example rubric for the analysis report.

Table 2: Example Rubric for Project Analysis Report (CO₃)

| Criteria | Excellent (90-100) | Good (75-89) | Satisfactory (60-74) | Unsatisfactory (<60) |
|-------------------|--|--|--|--|
| Experiment Design | Scenarios designed logically and comprehensively to test hypotheses. | Scenarios designed but lack depth or comprehensiveness. | Simple scenarios with limited analytical value. | No clear experiment design. |
| Data Analysis | Accurate use of statistical tools; clear interpretation of results; identification of bottlenecks with data support. | Use of statistical tools with minor errors; reasonable interpretation. | Basic data analysis; superficial interpretation. | Incorrect or missing data analysis |
| Optimization Plan | Innovative, feasible, and well-justified optimization solutions with demonstrated effect. | Feasible optimization solutions with basic justification. | Vague or impractical optimization suggestions. | No optimization or irrelevant suggestions. |

5. Construction of a Diversified Full-Process Assessment Scheme

The implementation of this scheme requires a supporting mechanism to ensure its effectiveness and sustainability.

5.1 Continuous Improvement Loop

The OBE concept emphasizes continuous improvement. After each semester, the assessment data is analyzed to measure the achievement of each course objective. The formula for calculating the achievement degree of a course objective is:

$$\text{Achievement Degree} = \frac{\text{Average score of all assessment points for CO}_i}{\text{Total score of all assessment points for CO}_i} \quad (1)$$

If the achievement degree for a specific objective (e.g., CO₂: Tool Proficiency) falls below the target threshold (e.g., 0.75), it indicates a deficiency. Teaching strategies—such as increasing in-class demonstrations, adding tutorial sessions, or adjusting the lab assignment difficulty—are revised in the next cycle to address this gap.

5.2 Information Technology Support

To manage the complexity of this diversified assessment, a Learning Management System (LMS) such as Canvas, Moodle, the class of Lan Moyun, Rain classroom or a university-specific platform is utilized. The LMS is used to:

- Publish clear rubrics for each assignment in advance.
- Collect phase deliverables automatically.
- Track student performance data for continuous analysis.
- Facilitate peer evaluation through anonymous review tools.

6. the Achievement Analysis and Continuous Improvement of Practical Teaching in the "Logistics System Simulation" Course

6.1 Objectives and Assessment System

Based on the achievement data of the teaching cohort, the teaching effectiveness is analyzed from six dimensions. The course objectives closely support the graduation requirements, with six specific objectives designed around the three levels of cognition, ability, and competency:

CO1 (Knowledge): Master the fundamental principles of logistics system simulation and the Anylogic simulation method;

CO2 (Application): Be able to use simulation software to analyze typical logistics systems;

CO3 (Integration): Comprehensively apply multidisciplinary knowledge to construct complex simulation models;

CO4 (Affective): Cultivate a rigorous engineering attitude and team collaboration spirit;

CO5 (Value): Understand the value-driven role of simulation technology in intelligent logistics;

CO6 (Learning): Develop the ability for independent inquiry and continuous learning.

The assessment methods include formative assessment (attendance and learning performance 35%, regular assignments 35%) and summative assessment (final project 30%). The weight distribution of each course objective in the assessment items is shown in Table 3, reflecting balanced support for the knowledge and application dimensions, as well as a special weight design for the affective objective (CO₄).

Table 3 Weight Distribution of Course Objectives in Assessment Items

| Course Objective | Attendance and Learning Performance | Regular Assignments | Final Assessment | total |
|------------------|-------------------------------------|---------------------|------------------|-------|
| CO ₁ | 0.35 | 0.35 | 0.30 | 1.00 |
| CO ₂ | 0.35 | 0.35 | 0.30 | 1.00 |
| CO ₃ | 0.35 | 0.35 | 0.30 | 1.00 |
| CO ₄ | 0.00 | 0.54 | 0.46 | 1.00 |
| CO ₅ | 0.35 | 0.35 | 0.30 | 1.00 |
| CO ₆ | 0.35 | 0.35 | 0.30 | 1.00 |

5.2 Overall Course Achievement Analysis and Data Profile

Based on valid samples from 23 students in the teaching cohort (highest score 95, lowest score 65, average score 81.87), the achievement of each course objective was calculated using the achievement formula (weighted average score / weighted full score), and the results are shown in Table 4. The overall course achievement is 81.5%, and the achievement of all six objectives exceeds 80%, indicating that the teaching has reached a good to excellent level, and students have successfully achieved the intended learning outcomes.

Table 4 Statistics of Achievement of Each Course Objective

| Course Objective | Evaluation | Achievement | Grade |
|----------------------------|------------|-------------|-------|
| CO ₁ | | 81.7% | Good |
| CO ₂ | | 81.7% | Good |
| CO ₃ | | 81.7% | Good |
| CO ₄ | | 80.4% | Good |
| CO ₅ | | 81.7% | Good |
| CO ₆ | | 81.7% | Good |
| Overall Course Achievement | | 81.5% | Good |

The grade distribution shows: 5 students (21.74%) achieved Excellent (≥ 90), 10 students (43.48%) achieved Good, 6 students (26.09%) achieved Average, 2 students (8.70%) achieved Pass, and none failed. The grades follow a normal distribution, indicating that the assessment difficulty is appropriate and students have achieved a solid mastery of the content. Based on the comparison of achievement of each course objective in Figure 1 and the grade distribution in Figure 2, it can be concluded that the achievement levels are generally around 81%, showing overall balance. The combined proportion of Excellent and Good grades is 65.22%, reflecting outstanding overall course performance. Figure 3 shows the comparison of average scores across assessment items; CO₄ scored relatively high in both regular assignments and the final assessment, indicating that the affective objective was fully achieved in practical activities. Figure 4 presents a radar chart of the six-dimensional objective achievement, which approximates an equilateral hexagon, suggesting coordinated development across all dimensions.

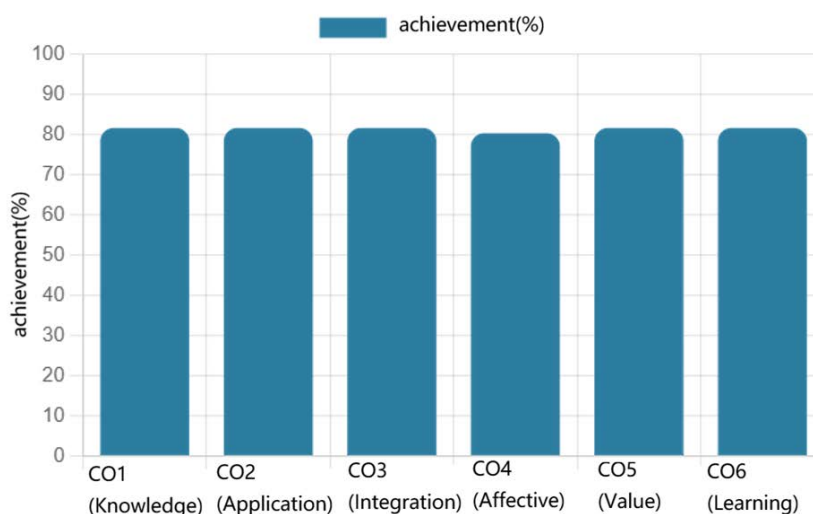


Figure 1. Comparison of Achievement of Each Course Objective

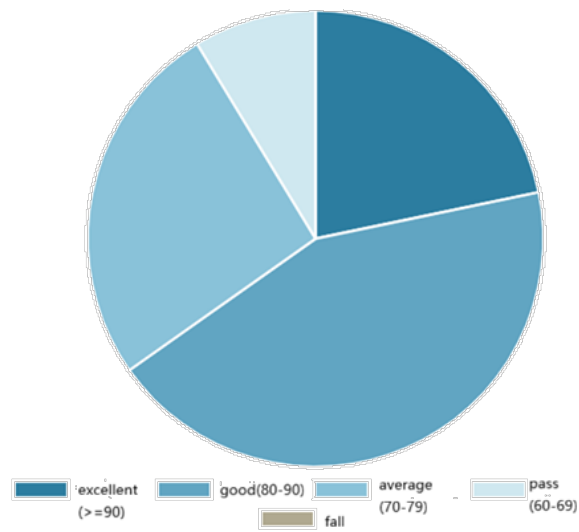


Figure 2. Grade Distribution (by Number and Percentage)

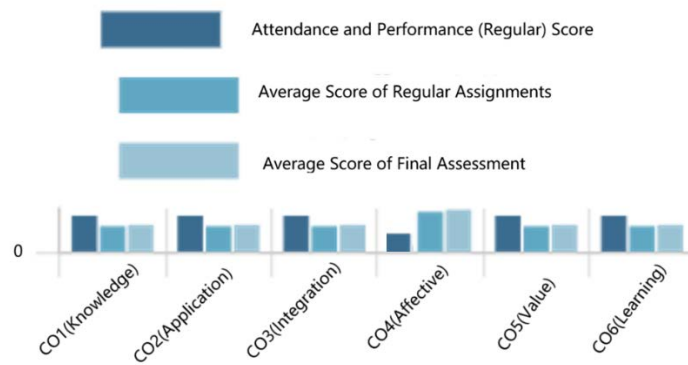


Figure 3. Comparison of Average Scores of Assessment (by Objective)

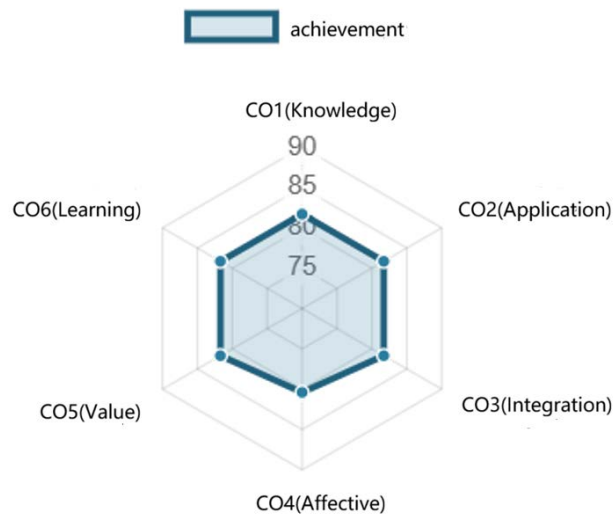


Figure 4. Six-Dimensional Goal Achievement Radar Chart

5.3 Analysis of Existing Problems and Causes

Although the overall achievement level is satisfactory, two key weaknesses were identified based on detailed data and an analysis of the final report quality: 1) Insufficient ability among some students to integrate and apply knowledge: modeling was incomplete for certain complex simulation cases (e.g., multi-agent complex modeling, dynamic path planning), and the scoring rate for higher-order applications in the final major project was low, indicating ongoing obstacles in the transition from theory to practice; 2) Insufficient learning initiative among individual students: two students submitted their regular assignments late during the process-oriented assessment. Although they completed them after supervision, their study habits and self-discipline require strengthening, suggesting that process management needs to be more refined. Furthermore, the achievement rate of 80.4% for Goal 4 (Affective) was slightly lower than that of the other goals, indicating that some students still have room for improvement in teamwork and the understanding of engineering ethics.

5.4 Continuous Improvement Measures and Optimization Strategies

In response to the above issues, based on the OBE continuous improvement mechanism, the following improvement measures are proposed:

(1) Strengthened Integrated Project-Based Teaching: Introduce a "Simulation Comprehensive Training Week" within the course, requiring students to complete a full-process project in small groups, covering data collection, modeling, simulation experiments, and decision-making optimization, followed by cross-defense sessions in class to enhance knowledge integration and transferability.

(2) Personalized Learning Support System: For students with weak foundational skills or those who submit assignments late, establish a "support group + individualized instructor guidance" system. Utilize the Learning Platform (e.g., Xuexitong) to set progress alerts and push resources, thereby increasing process engagement.

(3) Explicit Evaluation of Affective Goals: Incorporate a "self/peer evaluation of team contributions" component into regular assignments, and include a section on engineering ethics reflection in the final report, with appropriate weight adjustments to strengthen students' sense of responsibility and collaboration awareness.

(4) Development of a Digital Simulation Resource Library: Build a multi-level simulation case library (Basic-Advanced-Challenge) to meet the personalized learning needs of students at different levels and stimulate intrinsic motivation for self-directed learning.

6. Results and Discussion

The analysis of the achievement of the "Logistics System Simulation" course based on the OBE concept demonstrates that students have achieved remarkable outcomes in knowledge acquisition, application ability, and value recognition, with all six course objectives meeting expectations. Through the six-dimensional data profile and the improvement loop, the directions for enhancement in integrated application and process management have been clarified. In the future, teaching strategies will be continuously optimized to strengthen the integration of project-based learning and digital resources, cultivating logistics professionals with greater innovation capabilities and engineering competence, thereby providing solid support for engineering education accreditation and the development of top-tier courses.

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