

Research and Practice on Teaching Reform of Operating System Principles Course based on TBL Teaching Model

Bingxin Bai

Guangdong University of Science and Technology, Dongguan, 523083, China

Abstract: This paper takes the "Operating System Principles" course for the Internet of Things Engineering major in the School of Computer Science as the research subject. Addressing issues in traditional teaching such as passive student learning, disconnection between theory and practice, and insufficient teamwork skills, the TBL (Team-Based Learning) teaching model was introduced. A systematic reform was implemented across four aspects: teaching objectives, teaching content, teaching activities, and teaching evaluation. Through a one-semester teaching practice, comparative data from two rounds of classes were collected. Using a mixed-methods research approach combining quantitative and qualitative analysis, the impact of the TBL model on students' academic performance, practical abilities, teamwork skills, and learning attitudes was thoroughly analyzed. The research indicates that the experimental class significantly outperformed the control class in final exam scores, project completion quality, and teamwork skills ($p < 0.05$). Student satisfaction with the TBL teaching model reached 89.7%, with the highest ratings given for "increasing learning interest", "enhancing practical ability" and "promoting teamwork". This paper also details the specific instructional case design, implementation process, encountered problems, and solutions under the TBL model, providing a referential path and practical basis for teaching reform in core computer science courses.

Keywords: TBL Teaching Model, Operating System Principles, Teaching Reform, Teaching Evaluation.

1. Introduction

"Operating System Principles" is a core foundational course for computer-related majors, possessing strong theoretical and practical aspects. However, the course features abstract concepts, strong theoretical nature, and fragmented content, often leading students to find it tedious and difficult to establish a systematic knowledge structure^[1].

The traditional teaching model predominantly relies on teacher lecturing, with students passively receiving knowledge, making it difficult to stimulate learning initiative and innovative thinking. Especially under the current educational emphasis on practical ability, cooperation skills, and innovation capability, the limitations of traditional teaching methods are increasingly prominent. Therefore, the author utilized the TBL (Team-Based Learning) teaching model to reform the course^[2]. This teaching model, as a team-based, problem-oriented approach, emphasizes student learning through cooperation and growth through inquiry, and has achieved significant results in various disciplines both domestically and internationally. Through structured small-group collaborative learning, this model can effectively enhance student engagement and learning outcomes. In recent years, domestic universities have also begun to experiment with the TBL teaching model in computer science courses, but systematic research and practice specifically for the "Operating System Principles" course remain relatively scarce.

The author conducted a one-semester teaching practice, employing empirical research methods to explore the specific application and implementation effects of the TBL model in the "Operating System Principles" course, aiming to provide data support and practical reference for the teaching reform of core foundational courses in the Internet of Things major.

2. Theoretical Basis and Implementation Framework of the TBL Teaching Model

2.1. Theoretical Basis of the TBL Teaching Model

The TBL teaching model is built upon the foundations of constructivist learning theory and social interdependence theory, emphasizing that knowledge is constructed through social interaction and that learning is an active, social process^[3]. Its core theories include:

(1) Constructivist Learning Theory: Posits that learning is an active process of knowledge construction by the learner, rather than passive information reception. TBL promotes active knowledge construction through team discussions, problem-solving, and other activities.

(2) Social Interdependence Theory: Emphasizes the impact of interdependence between individuals on learning outcomes. TBL fosters cooperation and communication among team members by establishing positive task interdependence and goal interdependence.

(3) Mastery Learning Theory: Advocates that students must master one learning task before proceeding to the next. TBL uses IRAT and TRAT tests to ensure students grasp basic knowledge before engaging in application exercises.

2.2. Implementation Framework of the TBL Teaching Model

In this course, the implementation framework of the TBL model includes the following four stages^[4]:

Stage 1: Pre-class Preparation

The teacher releases preview materials through the Chaoxing Learning Platform, including instructional videos, reading materials, preview guides, etc. Students engage in self-directed learning in groups of 5-7, completing preview tasks. The preview materials focus on explaining basic

concepts and demonstrating simple examples, laying the foundation for classroom activities.

Stage 2: In-class Implementation

Adopts a cyclic pattern of "Test - Discuss - Apply":

Individual Readiness Assurance Test (IRAT): A 15-minute individual test to check the mastery of basic knowledge.

Team Readiness Assurance Test (TRAT): Team discussion and answering of the same test questions, promoting knowledge exchange and consolidation.

Application Exercises: Design challenging practical problems for groups to solve collaboratively.

Group Reporting and Peer Evaluation: Groups present their solutions and evaluate each other.

Stage 3: Post-class Reflection

Students conduct individual and team reflections, filling out learning logs to record gains and difficulties encountered during the learning process. The teacher adjusts teaching strategies and content promptly based on student feedback and classroom performance.

Stage 4: Multiple Evaluations

Establish a multiple evaluation system including teacher evaluation, team self-evaluation, team peer evaluation, and individual performance evaluation. The evaluation content covers multiple dimensions such as knowledge mastery, practical ability, teamwork, and innovative thinking.

3. Specific Content of Teaching Reform and Practical Case

3.1. Restructuring and Refining Teaching Objectives

Based on Bloom's taxonomy of cognitive objectives, the teaching objectives are divided into the following five levels:

Remembering: Students can recall basic concepts, functions, and components of operating systems, including core concepts such as processes, threads, memory management, and file systems.

Understanding: Students can explain the working principles and interrelationships of various OS modules, understanding the design ideas behind scheduling algorithms, memory allocation strategies, file storage mechanisms, etc.

Applying: Students can apply learned knowledge to solve practical problems, such as designing simple scheduling algorithms, implementing basic memory management functions, writing file operation programs, etc.

Analyzing: Students can analyze methods and strategies for OS performance optimization, evaluate the efficiency and applicability of different algorithms, and diagnose problems in system operation.

Creating: Students can design and implement small OS modules, propose innovative solutions to improve existing systems, and develop applications based on operating systems.

3.2. Instructional Case Design

This paper uses the practice on process scheduling algorithms as an example. Process scheduling is one of the core functions of an operating system, and different scheduling algorithms significantly impact system performance and user experience. This case requires students to understand the working principles and characteristics of various scheduling algorithms through practice^[5].

Implementation process:

(1) Pre-class Preparation: Students preview basic concepts of process scheduling and common

algorithms (FCFS, SJF, Priority Scheduling, Round Robin, etc.), completing a preview test on the learning platform.

(2) In-class Activities:

IRAT Test: 15 multiple-choice questions testing understanding of basic concepts and algorithm characteristics.

TRAT Discussion: Group discussion on IRAT questions, submitting team answers after reaching consensus^[6].

(3) Application Exercise: Each group designs a process scheduling simulation program, requiring simulation of at least three scheduling algorithms and comparison of their performance metrics (average waiting time, average turnaround time, etc.).

(4) Group Reporting: Presentation of program design ideas and experimental results, with evaluation and questioning from other groups^[7].

Through this practice, students not only deepened their understanding of process scheduling algorithms but also exercised their programming skills, data analysis abilities, and teamwork skills. A post-class survey showed that 92.3% of students found this case "very challenging but highly rewarding" and 87.6% of students stated that they "truly understood the differences between algorithms through practice".

4. Research Design and Data Analysis

4.1. Research Methods

This study employed a quasi-experimental design. Two parallel classes of the Internet of Things Engineering major in the academic year were selected as research subjects: Experimental Class (48 students): taught using the TBL model; Control Class (52 students): taught using the traditional lecture-based method. Both classes were taught by the same instructor, using the same textbook and syllabus, ensuring consistency in teaching content and pace^[8].

4.2. Data Collection and Methods

Data was collected through various means:

(1) Academic Performance: Final exam scores, project assignment scores.

(2) Ability Assessment: Evaluating students' programming skills, problem-solving abilities, and innovative thinking through practical tasks.

(3) Questionnaire Survey: Distributing a learning experience questionnaire after the course.

(4) Classroom Observation: Recording student participation, discussion quality, team interaction, etc.

Data analysis was performed using SPSS 25.0. Independent samples t-test was used to compare differences between the two groups, and correlation analysis was used to explore relationships between variables^[9].

4.3. Data Analysis Results

(1) Comparative Analysis of Academic Performance (See Table 1):

The data shows that the experimental class significantly outperformed the control class on all performance indicators ($p < 0.01$), with the most noticeable differences in practical operation and project assignments, indicating that the TBL model effectively enhanced students' practical application abilities.

Table 1. Comparison of Academic Performance between Experimental and Control Classes(Full Score:100 points)

Evaluation Indicator	Experimental Class (n=48)	Control Class (n=52)	t-value	p-value
Final Exam Score	82.36±6.78	76.45±8.23	3.872	0.000
Project Assignment Score	85.72±5.64	78.36±7.25	5.643	0.000
Practical Operation Score	88.25±4.37	80.18±6.72	6.982	0.000
Comprehensive Score	84.56±5.23	77.86±6.89	5.437	0.000

(2)Ability Development Assessment
Students' ability development was assessed using a practical task evaluation scale(including dimensions such as

programming standards,algorithm design,system implementation,and innovativeness).The results of the ability development assessment are shown in Table 2:

Table 2. Comparison of Ability Development Assessment Results

Ability Dimension	Experimental Class (n=48)	Control Class (n=52)	t-value	p-value
Programming Ability	4.32±0.56	3.78±0.67	4.327	0.000
Problem-Solving Ability	4.25±0.61	3.69±0.72	4.125	0.000
Teamwork Ability	4.56±0.48	3.45±0.83	7.892	0.000
Innovative Thinking Ability	4.18±0.63	3.57±0.75	4.378	0.000
Communication Skills	4.42±0.55	3.63±0.79	5.673	0.000

The results indicate that the experimental class significantly outperformed the control class in all ability development aspects,with the most prominent differences in teamwork and communication skills.

A questionnaire was administered to the experimental class after the course.48 valid responses were collected,a 100% response rate.The student learning experience survey results are shown in Table 3.

(3)Learning Experience Questionnaire Survey

Table 3. Student Learning Experience Survey Results (n=48)

Survey Item	Strongly Agree	Agree	Neutral	Disagree
Increased Learning Interest	58.3%	31.3%	8.3%	2.1%
Enhanced Practical Ability	62.5%	29.2%	6.3%	2.0%
Promoted Teamwork	64.6%	27.1%	6.3%	2.0%
Deepened Knowledge Understanding	52.1%	35.4%	10.4%	2.1%
Improved Learning Efficiency	47.9%	37.5%	12.5%	2.1%
Overall Satisfaction	56.3%	33.3%	8.3%	2.1%

The survey shows that overall student satisfaction with the TBL teaching model reached 89.6% (Strongly Agree+Agree),with the highest ratings for enhancing practical ability,promoting teamwork,and increasing learning interest.

5. Discussion and Reflection

The results of this study indicate that the TBL teaching model achieved significant results in the "Operating System Principles" course,mainly reflected in the following aspects:

(1)Improved Learning Outcomes:The experimental class significantly outperformed the control class in exam scores,project completion quality,and practical ability, proving that the TBL model can effectively promote students' mastery and application of professional knowledge.

(2)Promoted Ability Development:The TBL model is particularly beneficial for developing students' comprehensive abilities such as teamwork, communication, and problem-solving,which are crucial for the career development of computer science students.

(3)Enhanced Learning Experience:Students generally recognized the TBL teaching model, believing that it increased learning interest,enhanced learning initiative,and made the learning process richer and more in-depth.

6. Summary and Prospects

This study explored the application effects of the TBL teaching model in the "Operating System Principles" course through empirical methods.The research shows that the TBL model can effectively improve students' academic performance, practical abilities,and teamwork skills,and enhance their learning experience,making it a suitable teaching model for core computer science courses.

However, this study has some limitations.Firstly,the research sample was limited to two classes in one institution,with a relatively small sample size.Secondly,the research duration was only one semester,and the long-term effects need further verification.Additionally,the differential impact of the TBL model on different types of students (different learning styles,different ability levels) requires in-depth study.

Future research could further explore the following aspects:expanding the research sample and scope for multi-center studies;conducting longitudinal studies to track the long-term effects of the TBL model;exploring the integrated application of TBL with other teaching models (such as Flipped Classroom,Project-Based Learning,etc.);researching innovations in the TBL model supported by technology,such

as using online collaboration tools and virtual experimental platforms to enhance learning outcomes.

In conclusion, the TBL teaching model provides new ideas and methods for the teaching reform of core computer science courses like "Operating System Principles". Through continuous practice and refinement, the TBL model will play an increasingly important role in cultivating the practical abilities, innovative spirit, and teamwork skills of computer science professionals.

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