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# Research on the Teaching Reform of the "Operating System and Security" Course Based on Problem - Oriented and Case - Based Teaching

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## Abstract

**With the rapid development of information technology, the cybersecurity situation in cyberspace is becoming increasingly complex. As the core software of computer systems, the security of operating systems is of crucial importance. The "Operating System and Security" course plays a key role in the talent training system for information security majors. It is a core course that enables students to master the principles, security mechanisms, and application capabilities of operating systems. However, traditional teaching models have many deficiencies in knowledge transfer, practical ability training, and innovation thinking stimulation, and it is difficult to meet the needs of the rapid development of the information security field. This paper takes the information security major of Xinjiang Institute of Science and Technology as the research object and deeply explores the teaching reform of the "Operating System and Security" course based on problem - oriented and case - based teaching. The aim is to improve students' learning interest, practical ability, and innovation thinking through innovative teaching methods and means, and to cultivate high - quality professionals for the information security field.**

## Keywords

**Operating System and Security; Problem - Oriented;Case - Based Teaching; Teaching Reform.**

## 1. Introduction

In today's digital age, information technology has deeply penetrated into all aspects of social life. Operating systems play a fundamental supporting role, whether it is in individuals' daily online activities, enterprises' key business operations, or the guarantee of national critical infrastructure [1]. The "Operating System and Security" course, as one of the core courses for information security majors, aims to enable students to systematically master the basic principles, system architectures, security mechanisms, and related security technologies of operating systems, and to cultivate students' ability to analyze and solve operating system security problems, laying a solid professional foundation for their future work in the information security field. However, traditional teaching models usually center around teachers and focus on one - way teaching of theoretical knowledge. The teaching process lacks vividness and interactivity, and the practical links are relatively weak, making it difficult to effectively stimulate students' learning interest and innovation thinking.As a result, when facing actual operating system security problems, students often lack the ability to think independently and solve problems, and cannot flexibly apply the knowledge learned in class to practical scenarios[2].In response to the above challenges, the information security major of Xinjiang Institute of Science and Technology actively explores the teaching reform path and introduces problem - oriented and case - based teaching methods, aiming to construct a more efficient, interactive teaching model that focuses on practical ability training, improve the

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teaching quality of the course, and enhance students' comprehensive qualities to meet the needs of the information security field for professionals.

## 2. Teaching Reform Design Ideas

### 2.1. Strengthening Basic Knowledge

In the teaching of the "Operating System and Security" course, basic knowledge is the cornerstone for students to deeply understand subsequent content[3]. Operating systems cover numerous complex concepts, principles, and technologies, such as process management, memory management, file systems, device management, and various security mechanisms. To help students firmly master these basic knowledge, diverse teaching methods are adopted in the teaching process. In the classroom teaching session, teachers use multimedia teaching tools to visualize abstract operating system principles through intuitive charts and animated demonstrations. For example, when explaining the state transition of processes, animations are used to show how processes switch between states such as ready, running, and blocked, enabling students to clearly understand the dynamic change process of processes. At the same time, combined with actual operating system cases, such as Windows and Linux systems, the specific implementation methods of process management are deeply analyzed, allowing students to understand the differences and characteristics of different operating systems in process scheduling algorithms and process synchronization mechanisms. Experimental operation is an important link to strengthen basic knowledge. The school is equipped with a dedicated operating system laboratory, providing students with rich experimental equipment and software environments. In experimental teaching, teachers have carefully designed a series of basic experimental projects, such as process creation and control experiments, memory allocation and recovery experiments, etc. Students can not only deepen their understanding of theoretical knowledge but also improve their programming and practical abilities by writing code to implement operations such as process creation, destruction, synchronization, and dynamic memory allocation and release. ### 2.2 Introducing Case - Based Teaching Case - based teaching is a teaching method that uses actual cases as carriers to guide students to apply the knowledge they have learned to analyze and solve problems, which can effectively improve students' practical abilities and innovation thinking. In the "Operating System and Security" course, a large number of real - world operating system security cases are introduced, covering all aspects of operating system security, including vulnerability exploitation, malware attacks, data breaches, etc. In recent years, many large - scale data breach incidents have attracted widespread attention. In teaching, a data breach incident of a well - known social media platform is selected for in - depth analysis. In this incident, attackers exploited vulnerabilities in the operating system to obtain a large amount of personal information of platform users, including names, ages, contact information, etc., posing a great threat to users' privacy. During the case analysis process, teachers guide students to think from multiple perspectives. First, analyze the causes of the incident, including the types of operating system security vulnerabilities, the technical principles of vulnerability generation, and the deficiencies in the platform's security protection. Through research, students found that the vulnerability was due to defects in the user authentication and authorization mechanisms of the operating system, allowing attackers to bypass the normal authentication process and obtain user data. Then, let students consider the possible consequences of the incident, such as an increase in harassing phone calls and fraud risks caused by user privacy leakage, as well as serious damage to the platform's reputation and commercial interests. Finally, students are required to use the operating system security knowledge they have learned to propose solutions to prevent such incidents from happening again. Specific cases are shown in Table 1.

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**Table 1.** Case Library Design

| Case Name | Function Description |
|---|---|
| User Authentication | Authenticate user identities through usernames and passwords to ensure that only authorized users can access the system. |
| Permission Management | Assign different permissions according to user roles and responsibilities, such as administrators and ordinary users, to restrict users' access to and operations on system resources. |
| File Encryption | Encrypt sensitive data and files in the system to prevent unauthorized access and leakage. |
| Firewall Settings | Configure firewall rules to block unauthorized network access and attacks and protect system security. |
| Security Update and Patch Management | Regularly check for system vulnerabilities and install security updates and patches in a timely manner to fix known security vulnerabilities. |
| Intrusion Detection and Prevention | Deploy intrusion detection systems (IDS) and intrusion prevention systems (IPS) to monitor network traffic in real - time and detect and block potential attack behaviors. |
| Data Backup and Recovery | Regularly back up system data to ensure data security. Be able to quickly recover data in case of data loss or damage. |
| Audit and Log Management | Record system operation logs for tracking and analysis in case of security incidents. Regularly audit the logs to ensure system security. |
| Security Training and Awareness | Provide security training for system users to improve their security awareness and prevention capabilities. |
| Emergency Response Plan | Develop an emergency response plan to clarify the response process and responsible persons in case of security incidents, ensuring a rapid and effective response to security incidents. |

## 2.2. Enhancing Practical Links

Practical links are an important part of the teaching of the "Operating System and Security" course and play an irreplaceable role in cultivating students' practical operation abilities and innovation spirits. To provide students with more practical opportunities, the school has increased the proportion of practical teaching in the curriculum and continuously improved the practical teaching environment and resources. In experimental teaching, in addition to basic experimental projects, comprehensive experiments and innovative experiments have also been added. Comprehensive experiments require students to comprehensively apply multiple knowledge points of the operating system to complete a relatively complex system design or security protection task. Innovative experiments encourage students to choose their own topics and carry out practical projects with certain innovation.

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### 2.3. Diversifying Teaching Means

With the development of information technology, diversified teaching means provide more possibilities for the teaching of the "Operating System and Security" course. The school makes full use of digital teaching resources such as online courses, teaching videos, and Rain Classroom to construct an online - offline integrated blended teaching model, breaking the time and space limitations of traditional teaching and enabling students to obtain knowledge more conveniently. On the online course platform, rich teaching resources for the "Operating System and Security" course are provided, including teaching videos, e - textbooks, and online test questions. The teaching videos are carefully recorded by experienced teachers, covering all knowledge points of the course. Students can watch the videos for learning at any time and according to their own learning progress and needs. The e - textbooks provide students with a systematic course knowledge system, facilitating students to look up and review. The online test questions can help students timely check their learning effects, identify knowledge gaps, and conduct targeted learning. In classroom teaching, teachers use the interactive functions of Rain Classroom, such as voting, quick - answer, and discussion, to increase students' participation and classroom activity. For example, when explaining the security mechanisms of operating systems, teachers initiate a vote through Rain Classroom, asking students to choose the security mechanism they think is the most important and share their reasons in the discussion area, which stimulates students' thinking and discussion enthusiasm. At the same time, Rain Classroom can also real - time statistics of students' learning data, such as answering questions and participating in interactions. Teachers can understand students' learning situations based on these data and adjust teaching strategies in a timely manner.

### 2.4. Paying Attention to Individual Differences

Each student has differences in learning foundation, learning ability, and learning interest. In the teaching of the "Operating System and Security" course, full consideration is given to students' individual differences, and hierarchical teaching content and assessment methods are designed to meet the learning needs of different students. For students with a poor foundation, the teaching content focuses on consolidating and strengthening basic knowledge, and more basic knowledge explanations and tutoring resources are provided. For example, in classroom teaching, some key knowledge points are explained repeatedly, and simple examples are used to help students understand. At the same time, special learning tutoring materials, such as basic knowledge manuals and learning video tutorials, are provided to help them gradually keep up with the teaching progress. For students with spare capacity, more challenging expansion learning content is provided to guide them to conduct in - depth learning and research. For example, relevant academic papers and professional books are recommended to let students understand the cutting - edge technologies and research hotspots in the field of operating systems and security. Students are organized to participate in scientific research projects, subject competitions, and other activities to cultivate their scientific research abilities and innovation spirits.

## 3. Teaching Reform Implementation Process

### 3.1. Course Introduction Design

Course introduction is an important part of the teaching process. A good course introduction can attract students' attention and stimulate their learning interest. In the course introduction link of the "Operating System and Security" course, a combination of problem - based introduction and case - based explanation is adopted. Before explaining new knowledge points, teachers review the key content of the previous class by asking questions, guiding students to think and review. For example, when explaining the memory management of the operating

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system, teachers first ask students questions about the concept of processes and the state transition of processes, awakening students' memory of the process management knowledge learned in the previous class. Then, by playing a video animation related to memory management, such as the dynamic process of memory allocation and recovery, the theme of this class - memory management is introduced, and some inspiring questions are raised, such as "How is memory allocated to each process?" and "How to avoid the generation of memory fragments?", etc., to stimulate students' curiosity and thirst for knowledge. At the same time, explanations are combined with actual cases to let students more intuitively feel the application scenarios of the knowledge they have learned. For example, when introducing the knowledge points of the file system, the file storage and management of students' personal computers are used as examples to explain the functions and basic principles of the file system. Let students think about how to quickly find the files they need on their personal computers and how files are stored on hard disks, etc., so as to naturally introduce the concept and related knowledge of the file system.

## 3.2. Knowledge Point Design

In the knowledge point design link, attention is paid to combining theoretical knowledge with practical applications, triggering students' thinking through situational teaching, and integrating ideological and political elements into classroom teaching to achieve the organic unity of knowledge transfer and value guidance. When explaining the knowledge points of process synchronization and mutual exclusion in the operating system, a situational case of bank ATM services is designed. Through this case, students can not only deeply understand the concepts and principles of process synchronization and mutual exclusion but also experience the important applications of these knowledge in real life. At the same time, ideological and political elements such as rejuvenating the country through science and technology and the spirit of craftsmanship of a great power are integrated into classroom teaching.

## 3.3. Teaching Process Design

In the teaching process, a combination of multiple teaching methods is adopted to fully mobilize students' learning enthusiasm and improve teaching effectiveness. Asking questions through Rain Classroom is one of the commonly used methods in the teaching process. Teachers can release some questions related to knowledge points, such as multiple - choice questions and fill - in - the - blank questions, through Rain Classroom during the process of explaining knowledge points for students to answer. This method can not only timely check students' mastery of knowledge points but also improve students' classroom attention and participation.

## 3.4. Experimental Setting

Experimental setting is an important part of the teaching of the "Operating System and Security" course. Through reasonable experimental settings, students can deepen their understanding of the course content and improve their practical abilities. In experimental teaching, a series of experimental projects closely related to course knowledge points are designed. For example, after learning the knowledge points of process management, a producer - consumer problem simulation experiment is arranged. This experiment requires students to use the semaphore mechanism to achieve synchronization and mutual exclusion between producers and consumers to ensure the correct use of the shared buffer. During the experiment, students need to analyze the problem, design algorithms, write code, and debug. Through this experiment, students can deeply understand the concepts and implementation methods of process synchronization and mutual exclusion and master the application of semaphores in process synchronization.

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# 4. Teaching Effect Evaluation

## 4.1. Classroom Assessment Classroom assessment is an effective way to grasp students' understanding of knowledge in real - time.

Through Rain Classroom, in - class tests are released to check students' preview effects before the course starts and understand their cognitive level of new knowledge. During the teaching process, in - class exercises can immediately examine students' absorption of current knowledge points. In - class exercises cover a variety of question types. Multiple - choice questions focus on the discrimination of basic concepts; fill - in - the - blank questions require accurate filling of key knowledge points to strengthen memory; short - answer questions focus on examining the comprehensive application and analysis ability of knowledge. If most students make mistakes in questions about process synchronization mechanisms, teachers can increase example explanations or organize group discussions to deepen students' understanding of this knowledge point, as shown in Figure1.

**Figure 1.** Classroom Assessment

## 4.2. Chapter Tests

Chapter tests comprehensively evaluate the depth and breadth of students' mastery of course content in a phased manner. With the help of the PTA project - based teaching design, students can exercise their practical abilities in practical projects and deepen their application of theoretical knowledge. For example, in the file system chapter test, students are required to design and implement a simple file system with basic permission management functions. From planning the file storage structure, designing the permission control logic, to writing code to implement file creation, reading, writing, and permission verification, the entire process covers many core knowledge points of the file system. This project - based test allows students to transform abstract theoretical knowledge into practical and runnable programs, not only examining their understanding of file system concepts and principles but also testing their programming implementation ability, problem - solving ability, and comprehensive application ability of knowledge. Teachers can comprehensively understand students' mastery of chapter content by evaluating the project results submitted by students, scoring from multiple dimensions such as functional integrity, code standardization, and algorithm rationality, providing a strong reference for subsequent teaching and enabling targeted reinforcement teaching for common problems among students.

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### 4.3. Feedback from Industry Experts

The feedback from industry experts is an important external basis for evaluating the effectiveness of teaching reform. Inviting senior industry experts to evaluate the teaching reform and accepting the supervision and evaluation of professor - level supervision groups can obtain professional opinions and suggestions. Experts, with their rich industry experience and cutting - edge professional knowledge, evaluate from multiple aspects such as the fit between teaching content and industry needs, whether students' practical abilities meet the actual work requirements of enterprises, and whether the course training objectives are in line with industry development trends. For example, experts may point out that the course should add explanations of emerging operating system security technologies, such as container security and cloud operating system security, to keep up with the pace of industry development; or affirm the school's achievements in cultivating students' practical abilities, believing that students show strong problem - solving abilities in actual operations and are more in line with enterprise needs. These feedbacks provide directions for the continuous optimization of teaching reform. The school can adjust teaching content and improve teaching methods accordingly to make the course teaching better adapt to the development needs of the information security industry.

## 5. Achievement of Teaching Effects

### 5.1. Students' Experimental Effects

According to the carefully designed experimental arrangements, teachers guide students to deeply analyze the code and gradually complete the experimental tasks, achieving a 100% experimental completion rate. With the help of a complete - function experimental teaching platform, students can conveniently carry out experimental operations and project practices. Taking the memory management experiment as an example, students write code to implement memory allocation algorithms, such as the first - fit algorithm and the best - fit algorithm, and compare the differences in memory utilization and allocation efficiency of different algorithms. During the experiment, students not only master the basic principles and algorithm implementations of memory management but also can analyze the advantages and disadvantages of different algorithms based on the experimental results and think about how to optimize the algorithms to improve memory management performance. This practical operation allows students to have a more intuitive and in - depth understanding of memory management, laying a solid foundation for subsequent learning of advanced operating system features.

### 5.2. Students' Test Results

Take Class 2 of Information Security as an example. There are 42 students in the class. In the tests after the teaching reform, the excellent rate (above 80 points) is approximately 95%. This achievement benefits from the PTA project - based teaching design, which effectively improves students' practical operation abilities and prompts students to deepen their understanding and application of theoretical knowledge in practice. In a comprehensive test covering the principles and security knowledge of operating systems, the questions involve multiple aspects such as process scheduling, memory protection, and file system security. Relying on the experience accumulated in project practices, students can flexibly apply the knowledge they have learned to solve practical problems. For example, in a question about the analysis and repair of operating system security vulnerabilities, students can accurately identify the type of vulnerability, analyze the causes of the vulnerability in detail, and propose reasonable repair solutions, fully demonstrating a solid knowledge foundation and strong practical abilities. This

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also reflects that the teaching reform has achieved remarkable results in enhancing students' knowledge acquisition and application abilities.

## 5.3. Interaction Effects

The teaching reform of the course takes students' interests as the starting point, selects things that interest them as the source of problems for problem - oriented learning, which greatly mobilizes students' enthusiasm for participating in the classroom. The interaction activity level reaches about 80%. Diverse interaction methods such as classroom discussions, group collaborations, and interactive games create more opportunities for students to participate in the classroom. When explaining operating system security vulnerabilities, students are organized to conduct group discussions to analyze major security vulnerability incidents that have occurred recently, such as the Log4j vulnerability. Students actively participate in the discussion, deeply exploring aspects such as the vulnerability principle, impact scope, attack methods, and preventive measures, and expressing their opinions freely. In the interactive game session, an "Operating System Security Knowledge Contest" game is designed. Through forms such as quick - answer and mandatory - answer questions, students can consolidate the learned security knowledge in a relaxed and pleasant atmosphere and improve their learning interest. These interaction methods make the classroom atmosphere more active, enhance students' learning experience, and improve teaching effectiveness, as shown in Figure 2.


**Figure 2.** Display of Classroom Interaction Effects

## 6. Conclusion

Through the teaching reform of the "Operating System and Security" course based on problem - oriented and case - based teaching, students' learning interest has been significantly enhanced. They have changed from passively accepting knowledge to actively exploring knowledge. In terms of practical abilities, through a large number of case analyses, experimental operations, and project practices, students can skillfully apply the knowledge of operating systems and security they have learned to solve practical problems, and they have strong hands - on abilities and innovative thinking. In terms of teaching effectiveness, students' scores in classroom assessments and chapter tests have increased significantly. The quality of experimental completion and the level of report writing have also been remarkably improved. At the same time, students have demonstrated good professional qualities in exchanges with industry experts and have been recognized by the industry. In the future, the teaching content and

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methods will continue to be optimized. On the one hand, closely follow the development trends of the information security industry, and timely integrate emerging technologies and hot issues into the teaching content, such as the integration of artificial intelligence and operating system security, and the impact of quantum computing on cryptography and operating system security, to ensure the forefront and practicality of the course content. On the other hand, further explore diversified teaching methods, such as virtual reality (VR)/augmented reality (AR) - based experimental teaching and blockchain - based course assessment methods, to provide students with a more diverse and efficient learning experience, and continuously improve the teaching quality of the "Operating System and Security" course, so as to cultivate more high - quality professionals for the information security field.

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