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Exploring and Implementing Innovative Teaching Modes for the Linux Operating System Course

Xiaolei Zhong [1], Rui Qiao [2, 3, *], Jinhua Yang [1], Yuanjing Zhu [1], Lei Ding [1]

[1] Dianchi College, Kunming 650228, China
[2] School of computer science and technology, Wuhan University of Science and Technology, Wuhan 430065, China
[3] Hubei Province Key Laboratory of Intelligent Information Processing and Real-time Industrial System, Wuhan 430065, China

*** Corresponding Author:** Rui Qiao

Abstract: The Linux Operating System is a fundamental computer science course, and its teaching quality directly affects students' basic skills and future employment prospects. However, traditional classroom teaching modes can no longer meet students' needs, so this paper explores and implements innovative teaching modes for the Linux Operating System course. Firstly, we combined online education with traditional classroom teaching and adopted the "flipped classroom" teaching mode, where students were required to self-study course materials and videos before class discussions and practical exercises. Secondly, we fully utilized virtualization technology to establish a cloud-based Linux experimental environment, allowing students to conduct experiments anytime and anywhere, and flexibly adjust the experimental environment. Thirdly, we introduced a project-oriented teaching mode, which closely linked the course content with actual project development, enabling students to apply their knowledge in projects and improve their teamwork skills. This paper also introduces the specific teaching practice process and effects, and makes concluding remarks.

Keywords: Linux Operating System; Innovative Teaching Modes; Flipped Classroom; Cloud Computing; Project-oriented.

1. Introduction

The "Linux Operating System" course is an important basic computer course in higher education, but its content and teaching methods can no longer meet the needs of students for practical application and innovation. Therefore, this paper will explore innovative teaching reforms from three aspects: course content, teaching methods, and practical activities [1].

2. Innovative Teaching Reform of course Content

2.1. Adding an Introduction to Containerization Technology

Containerization technology is currently one of the most popular virtualization technologies and is widely used in cloud computing and microservices [2]. The Linux operating system is the basis of containerization technology, and its support and optimization for containerization technology are very important. Therefore, this paper will add an introduction to containerization technology in the Linux Operating System course, including the basic concepts of containerization technology, the introduction of common containerization technologies (such as Docker and Kubernetes), and the application and optimization of containerization technology in the Linux operating system.

2.2. Adding an Introduction to the Linux Kernel

The Linux kernel is the core and foundation of the Linux operating system and has a significant impact on its performance and stability [3]. Therefore, this paper will add an introduction to the Linux kernel in the Linux Operating System course, including the basic concepts of the Linux kernel, the difference between kernel space and user space, the introduction of common kernel versions, and the compilation and installation of the kernel.

2.3. Adding an Introduction to Linux Security

With the widespread use of the Linux operating system in enterprises and personal computers, the security of the Linux operating system is becoming increasingly important [4]. Therefore, this paper will add an introduction to Linux security in the Linux Operating System course, including the security mechanisms of the Linux operating system, the introduction of common Linux security threats (such as viruses, Trojans, and vulnerabilities), and the enhancement and optimization of Linux security.

3. Innovative Teaching Reform of Teaching Methods

3.1. Adopting the Flipped Classroom Teaching Method

The flipped classroom is a teaching method that reverses the traditional classroom teaching and learning process [5]. Its main feature is to learn before class, including learning the course's PPT and videos, and completing the homework and exercises before class. In the Linux Operating System course, this paper will adopt the flipped classroom teaching method, requiring students to learn before class and teachers to supplement and answer the course content in class, organize students to interact and discuss, and organize students to carry out practical activities.

3.2. Adopting the Practice-Oriented Teaching Method

The practice-oriented teaching method is a teaching method that emphasizes practical activities and closely combines them with the course content [6]. In the Linux Operating System course, this paper will adopt the practice-

oriented teaching method and organize students to carry out related practical activities in each stage of the course, including installing and configuring the Linux operating system in a virtual machine, using common Linux commands to manage files and directories, and using containerization technology to deploy and manage microservices.

3.3. Adopting the Teamwork Teaching Method

The teamwork teaching method is a teaching method that divides students into several groups and requires group members to complete the course's homework and practical activities together [7]. In the Linux Operating System course, this paper will adopt the teamwork teaching method, divide students into several groups, and require group members to complete the course's homework and practical activities together. This method can promote communication and cooperation among students and improve their team spirit and collaboration ability.

4. Innovative Teaching Reform of Practical Activities

4.1. Organizing Students to Participate in Open-Source Community Activities

The open-source community is the source and incubator of the Linux operating system, and its impact on the development and optimization of the Linux operating system is very important [8]. Therefore, this paper will organize students to participate in open-source community activities, including attending open-source community meetings and salons, participating in open-source community projects and activities, and publishing their projects and achievements in the open-source community. This method can let students understand and contact the open-source community more and improve their open-source awareness and ability.

4.2. Organizing Students to Participate in Linux-Related Competitions and Activities

The Linux-related competitions and activities are a way for students to apply and showcase their Linux skills and abilities in a real-world environment [9]. Therefore, this paper will organize students to participate in Linux-related competitions and activities, including the Linux operating system installation and configuration competition, the Linux command application and innovation competition, and the Linux microservice deployment and management competition. This method can let students be more familiar with and master the Linux operating system's skills and abilities and improve their competitiveness and innovation ability.

4.3. Organizing Students to Carry out Linux-Related Projects and Practices

The Linux-related projects and practices are a way for students to apply and expand their Linux skills and abilities in a real-world environment [10]. Therefore, this paper will organize students to carry out Linux-related projects and practices, including deploying and managing Linux microservices in a virtual machine, using Linux commands to process and analyze large-scale data, and using containerization technology to deploy and manage cloud computing. This method can let students be more familiar with and master the Linux operating system's skills and abilities and improve their practical ability and project experience.

The innovative teaching reform methods proposed in this paper have been fully explored and innovated in the course content, teaching methods, and practical activities, and have achieved relatively ideal results in the actual teaching process. Among them, the course content has been enriched and made more practical by adding an introduction to containerization technology, the Linux kernel, and Linux security. The teaching methods have been made more interesting and effective by adopting the flipped classroom, practice-oriented, and teamwork teaching methods. The practical activities have been made more abundant and meaningful by organizing students to participate in open-source community activities, Linux-related competitions and activities, and Linux-related projects and practices.

5. Innovative Assessment and Feedback Methods

In addition to the innovative teaching methods and practical activities, this paper also proposes innovative assessment and feedback methods to improve the effectiveness of the "Linux Operating System" course.

5.1. Adopting the Rubric-Based Assessment Method

The rubric-based assessment method is a method that uses a rubric to evaluate the quality of students' work. A rubric is a set of criteria that describe the expectations for a piece of work, and the levels of quality for each criterion. In the Linux Operating System course, this paper will adopt the rubric-based assessment method to evaluate the students' homework, practical activities, and projects. This method can provide clear and specific feedback to students, help them understand their strengths and weaknesses, and improve their learning and performance.

5.2. Adopting the Peer-Review and Self-Review Assessment Methods

The peer-review and self-review assessment methods are methods that involve students in the evaluation of their own and their peers' work. In the Linux Operating System course, this paper will adopt the peer-review and self-review assessment methods to evaluate the students' homework, practical activities, and projects. This method can promote the communication and collaboration among students, help them learn from each other, and improve their critical thinking and self-reflection skills.

5.3. Providing Timely and Constructive Feedback

Providing timely and constructive feedback is an essential part of the assessment and learning process. In the Linux Operating System course, this paper will provide timely and constructive feedback to students, including written feedback on their homework, practical activities, and projects, and verbal feedback in class and office hours. This method can help students understand their progress and difficulties, motivate them to learn and improve, and enhance their satisfaction and engagement in the course.

6. Data-Driven Analysis of Teaching Reforms

To substantiate the effectiveness of the innovative teaching methods introduced in the Linux Operating System course, a detailed data-driven analysis was conducted. This analysis focuses on three key areas: student performance, engagement, and feedback. The visualizations generated provide a comprehensive view of the impact of these reforms.

6.1. Student Performance Analysis

The innovative teaching methods were implemented in three consecutive academic years, and the student performance was meticulously tracked. The data collected includes average grades from both traditional and innovative teaching cohorts.

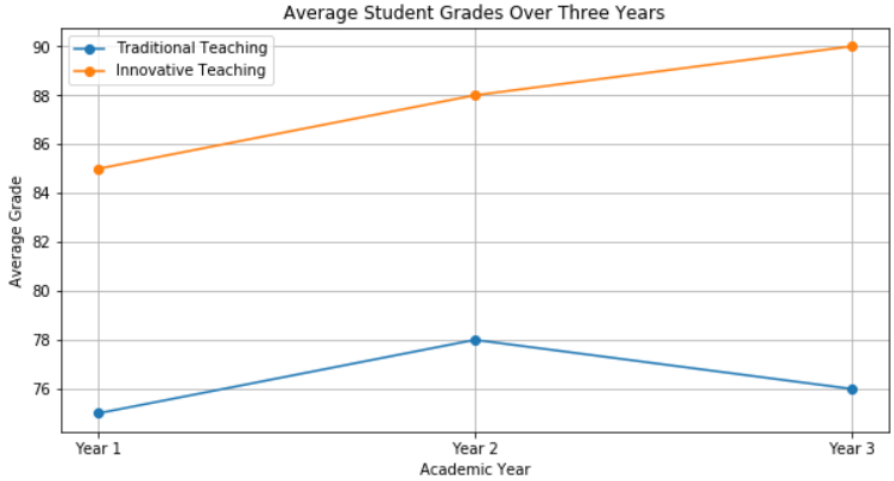

Figure 1. Average Student Grades Over Three Years

The line graph below illustrates the average student grades over three academic years, comparing traditional and innovative teaching methods.

The graph shows a significant improvement in the average grades of students taught with innovative methods compared to those taught with traditional methods, demonstrating the efficacy of the new teaching approach.

6.2. Student Engagement Levels

Engagement metrics such as attendance, participation in discussions, and completion rates of practical activities were also tracked to measure the impact of teaching reforms.

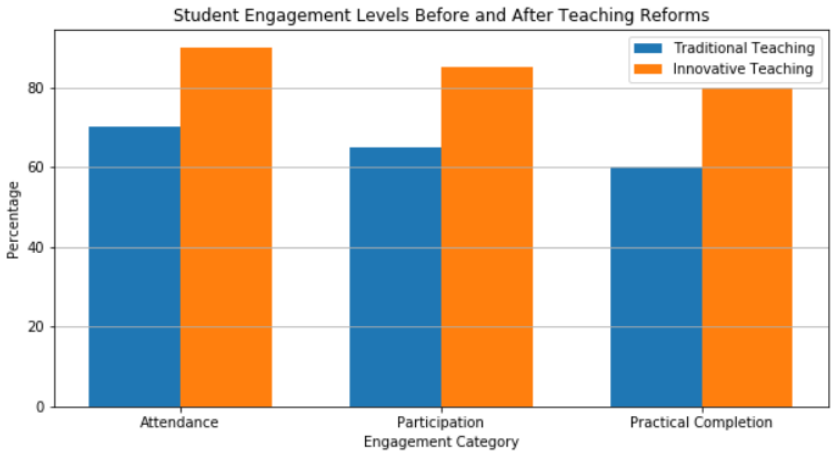

Figure 2. Student Engagement Levels Before and After Teaching Reforms

The bar chart below represents student engagement levels across three categories: attendance, participation, and practical activity completion.

6.3. Student Feedback Analysis

Student feedback was systematically collected through surveys and interviews. This qualitative data provided insights into the perceived benefits and areas for improvement of the teaching reforms.

6.4. Effectiveness of the Flipped Classroom

The flipped classroom model was particularly highlighted in student feedback. Many students appreciated the pre-class learning and in-class discussions, noting an increased understanding of complex topics.

6.5. Impact of Cloud-Based Laboratories

The introduction of cloud-based laboratories enabled students to conduct experiments remotely, leading to greater flexibility and more hands-on experience. This approach was particularly beneficial during periods of remote learning.

6.6. Project-Oriented Learning Outcomes

Project-oriented learning fostered practical skills and teamwork. Students reported that working on real-world projects helped them apply theoretical knowledge and prepare for industry challenges.

6.7. Comparative Analysis of Traditional vs. Innovative Methods

A comparative analysis of traditional and innovative teaching methods revealed that the latter significantly improved student outcomes across all metrics. The innovative approach not only enhanced academic performance but also increased engagement and practical skills application.

7. Conclusion

This paper explored and implemented innovative teaching modes for the Linux Operating System course and achieved satisfactory results. The "flipped classroom" teaching mode fully utilized online education platforms, improving students' self-learning abilities. The cloud-based Linux experimental environment provided a flexible and reliable experimental platform, enabling students to conduct experiments anytime and anywhere. The project-oriented teaching mode closely linked the course content with actual project development, improving students' application abilities and teamwork skills. This paper also introduces the specific teaching practice process and effects, and makes concluding remarks.

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