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Reform of Practical Teaching of "Linux Operating System Fundamentals" Under the Background of Emerging Engineering Education

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Abstract: With the advancement of the construction of emerging engineering education, the reform of practical teaching has become an important task of higher engineering education. This article takes the course "Linux Operating System Fundamentals" as an example to explore practical teaching reform in the context of emerging engineering education. By analyzing the current situation and problems in course practical teaching, we proposed practical teaching reforms such as online experiments, practical content updates, project-based engineering practices, and diversified evaluation models, and designed corresponding implementation plans. Practice has proved that this reform can improve students' learning interest and engineering practical skills, and cultivate outstanding engineers with innovative spirit and practical skills.

Keywords: Emerging engineering education; Practical teaching reform; Project practice; Virtual experiments

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1. Introduction

The construction of emerging engineering education originated from the Fudan Consensus of "Emerging Engi-neering Education" in 2017, the "Great Action" of emerging engineering education construction, and the "Beijing Guide" of emerging engineering education construction, and was put forward in response to the new opportuni-ties and challenges faced by the new round of scientific and technological revolution and industrial transforma-tion [1]. New engineering represents the development of new science and technology, and it is a new engineering field or cross-engineering field closely related to industries and new economies with development potential. The new engineering construction emphasizes the cultivation of students' comprehensive abilities including in-novative abilities and practical skills, and pays attention to the cultivation of engineering practice and the ability to solve practical problems [2,3]. New engineering refers to the reform and development direction of engineering education oriented to adapt to the development of information technology and social needs. On the basis of tra-ditional engineering, the new engineering focuses on cultivating students' comprehensive abilities such as inno-vative and entrepreneurial abilities, emphasizing interdisciplinary integration and innovative thinking.

Computer science and technology is one of the important subjects in the emerging engineering education system, which plays a key role in the construction of new engineering. Emerging engineering education aims to cultivate innovative engineering talents to adapt to future scientific and technological development and industrial transformation. Computer science and technology, as the core discipline in the field of information technology, are of great significance to the cultivation of new engineering talents [4], providing strong technical support for emerging engineering education. Computer science and technology are needed in the new engineering fields, such as artificial intelligence, big data, cloud computing, Internet of Things, and other directions. Through the application of computer science and technology, data collection, processing, analysis, and visualization can be realized, and technological innovation and application development in emerging engineering education fields can be promoted [5].

Linux operating system is one of the important contents of computer science and technology. As a professional basic course, it plays a vital role in computer science and technology [6]. As a full platform operating system, Linux operating system has been widely used in various fields of information technology, including servers and data centers, cloud computing and virtualization, embedded systems, and other fields. It is open-source and free, stable and secure, highly customizable and cross-platform compatible. In the practice of computer science and technology, Linux operating system is often used as a development and testing environment, and many important software and applications are developed and deployed based on the Linux platform [7-9]. In addition, Linux operating system also provides strong support for the development of computer science and technology. Because of its openness, Linux operating system has become an essential supporting platform for many new technologies and applications. For example, Linux operating system plays an important role in emerging technologies such as artificial intelligence, Internet of Things, and blockchain [10]. The majors involved in information technology (IT) in colleges and universities are shown in **Figure 1**.

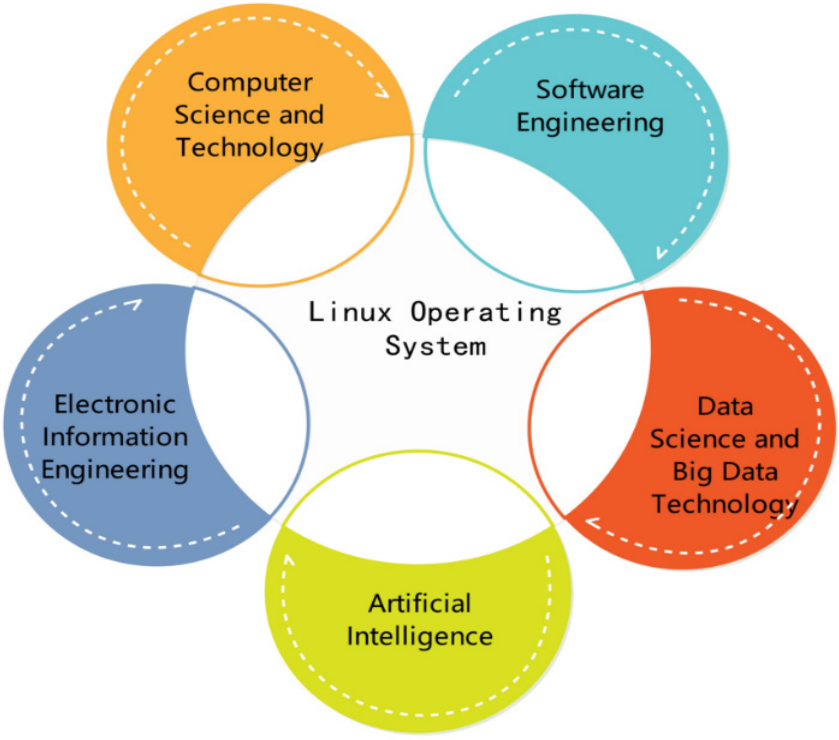

Figure 1. Information technology-related majors of the course

There are five majors in the School of Information Engineering of our school offering the primary school course "Linux Operating System Foundation," and Linux system has important applications in related majors, as shown in **Table 1**.

Table 1. Application of Linux system in related majors

Major	Application direction	Remarks
Computer Science and Technology	Operating system design, driver development, etc.	
Software Engineering	System background development, system operation and maintenance, etc.	
Electronic Information Engineering	Embedded development, data acquisition system, etc.	Internet of things related
Artificial Intelligence	Deep learning, large model training, etc.	Robot correlation
Data Science and Big Data Technology	Cloud computing environment, virtualization technology, etc.	

2. Analysis of traditional practical teaching

With the rapid development of the IT industry, diversified practical needs, and the proposal of new engineering concepts, the practical teaching reform of the Linux operating system has become an urgent need in today's educational environment [11,12]. These backgrounds require that more attention is paid to the cultivation of students' practical operation and innovation skills and teamwork in teaching, so as to better meet the development needs of the information technology industry.

The traditional practical teaching of the Linux operating system mainly focuses on basic operations, commands, and simple system platform construction, such as user management, file and directory management, system management, network configuration, security configuration, text editing, shell scripts, and simple server configuration. However, the actual engineering application scenarios and requirements are very diverse. Under the background of teaching reform, students need to be able to undertake more complex practical tasks such as system configuration, big data environment construction, containerization, and automatic operation and maintenance [13].

3. Content of practical teaching reform

The practical teaching reform of the Linux operating system based on emerging engineering education starts from the following aspects.

3.1. Introducing online practical teaching

With the large-scale popularization of MOOC (Massive Open Online Courses), MOOP (Massive Open Online Practices) came into being, and online practical teaching is an important part of the digital construction of education. Relying on the first practical teaching platform, the basic experiment of the conventional Linux operating system is carried out on this platform. It involves building an experimental platform of the Linux operating system through virtual machines or containers and providing some practical scenarios and cases, such as installing software and configuring networks. Introducing online practical teaching has the following advantages:

(1) High flexibility in time and space: Students can flexibly arrange their studies and experiments according to their own convenience, regardless of the time and location of the laboratory.

(2) Interactive and timely feedback: Online education platforms can record students' operation process and experimental results in real time, and provide feedback to students in time, so as to promote their self-learning and self-management ability.

(3) Resource sharing and collaboration: Students can share resources and collaborate on experiments through the online platform, and get inspiration and help from other students' experiments.

Additionally, experimental contents related to new technologies are added. As a field of sustainable development, Linux operating system is constantly emerging with new technologies and trends. In teaching, we constantly update the technology of Linux operating system and introduce the latest technology and trends, so the content of practical teaching should be adjusted accordingly based on the trend of technological development. By introducing new technologies and tools, and designing practical projects in combination with application scenarios, students are encouraged to study and explore independently. As shown in **Figure 2**, the latest application direction of Linux and strengthening related experiments are the requirements of new engineering teaching.

The practical teaching of the Linux operating system should not be limited to the computer field but should be integrated with other disciplines. It is combined with professional teaching and practical activities, such as network technology, artificial intelligence, and other related courses, to improve the comprehensive interdisciplinary application ability. Practical teaching introduces various technologies and applications in time, such as artificial intelligence, big data, Internet of Things, and so on. Students can improve their technical application and innovation abilities by participating in related projects and practices.

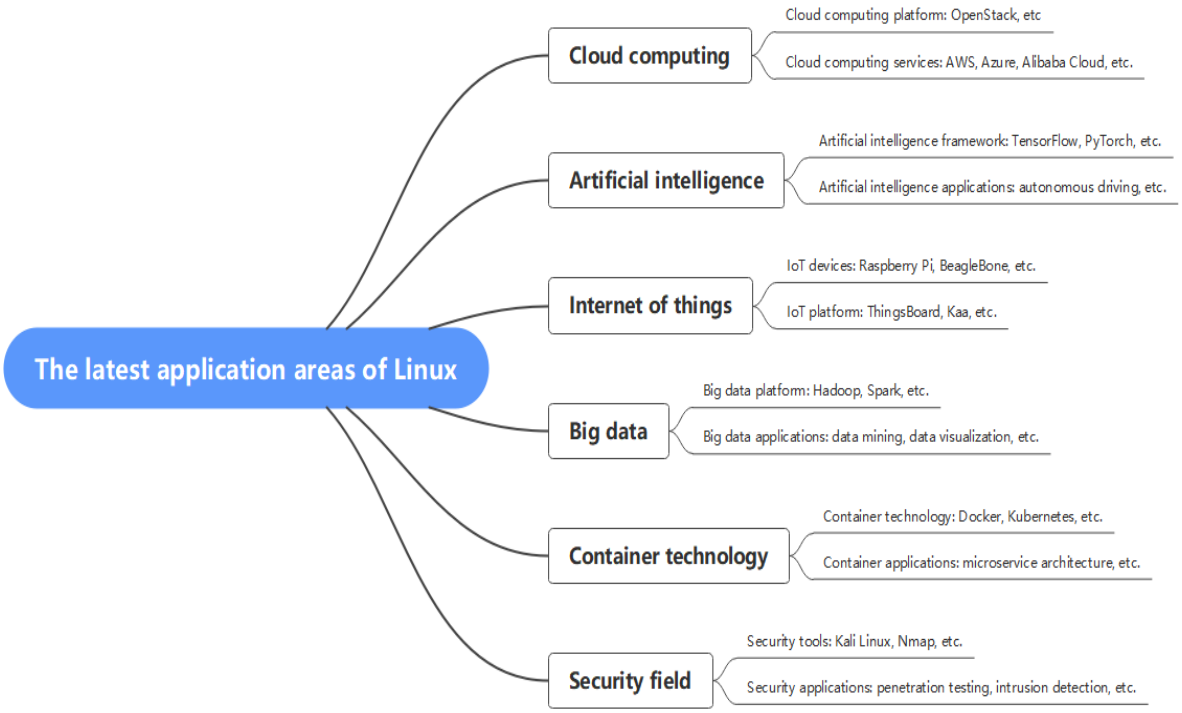

Figure 2. Latest application fields of Linux system

3.2. Strengthening the foundation of engineering practice

The reform of practical teaching emphasizes the solution of real engineering problems and the development of practical products. We should introduce engineering projects and practical cases, and cultivate students' engineering practical skills and problem-solving skills through teamwork and practical operation. Linux operating system is usually used in server and cluster environment, and needs to cooperate and communicate

with other systems, tools, and personnel. Team projects can be set up in teaching to cultivate students' teamwork and communication skills, so that they can cooperate with others to complete complex tasks.

(1) Source code management GitLab server local deployment
(2) Project document management Plone local deployment
(3) Construction and application deployment of LNMP (LoWPAN Network Management Protocol) architecture
(4) Building the development environment of deep learning model
(5) Building Hadoop cluster environment
(6) Building Kubernetes cluster based on virtual machine
(7) Construction of SLAM (Simultaneous Localization And Mapping) development environment
(8) Linux system tailoring and configuration

3.3. Improving students' evaluation methods

Reforming the traditional student evaluation model is conducive to improving students' learning enthusiasm and sense of fairness. Using a diversified practical teaching evaluation mechanism, this paper comprehensively examines and measures the teaching evaluation methods of students' practical operation skills, innovative thinking, teamwork, and problem-solving skills in the process of practical learning of the Linux operating system. Multi-dimensional practical skills evaluation emphasizes not only the degree of students' knowledge mastery but also the cultivation and development of students' comprehensive quality.

Diversified evaluation includes the following aspects:

(1) Basic practical literacy evaluation is the foundation that evaluates the basic practical mastery of Linux operating system, such as file operation, user management, process management, network configuration, and management of Linux operating system.
(2) Process evaluation is a management tool. Students' participation, problem-solving strategies, iterative improvement process, and teamwork performance are evaluated in the whole practical teaching implementation process.
(3) Evaluation of innovation ability is the key. Students' innovative consciousness is encouraged and evaluated, such as whether they can think independently, propose unique solutions, or innovate under the existing technical framework.
(4) Self-evaluation and mutual evaluation introduce students' self-evaluation mechanism, so that students can reflect on their own learning process and achievements. At the same time, peer evaluation is carried out, and the ability to communicate and understand others is improved through mutual scoring among team members.
(5) The demonstration and defense of practical projects is to arrange the writing of practical reports, organize the project defense links, and examine students' expression and demonstration skills and response level when facing problems.
(6) The evaluation of values and professional accomplishment is a comprehensive consideration of students' professional ethics, honesty, and awareness of intellectual property protection in practice. As shown in **Figure 3**, the multi-dimensional evaluation model of students' practical skills is displayed.

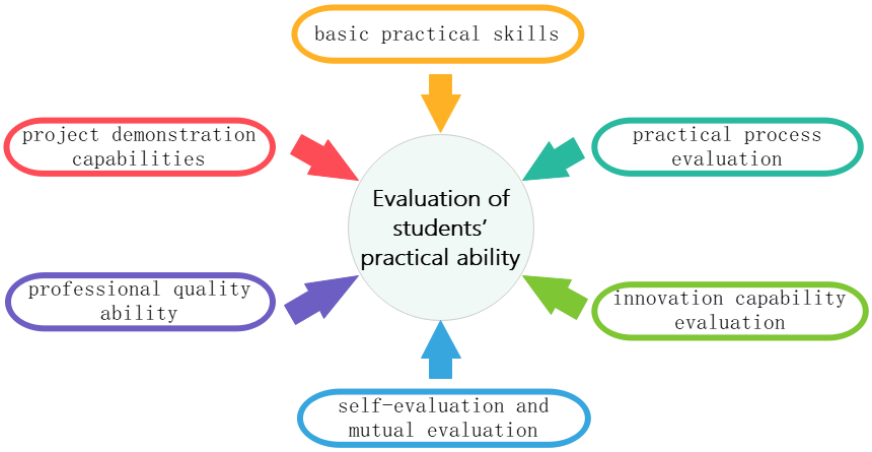

Figure 3. Multi-dimensional evaluation of students' practical skills

4. Conclusions

The reform of practical teaching has improved students' engineering practical skills and innovative spirit. Through diversified practical teaching mode, students can better understand and apply Linux operating system. At the same time, these reform measures are also helpful to cultivate students' teamwork and independent problem-solving skills.

(1) Students' engineering practical skills have improved. After the reform, computer practical teaching pays more attention to cultivating students' practical skills and ability to solve practical problems. Through various forms of teaching activities such as projects, case analysis, and online virtual experiments, students can closely combine theoretical knowledge with practical operation and improve their practical skills in engineering development and application.

(2) Students' learning interest and innovative spirit are stimulated, achieving remarkable results in innovation and entrepreneurship. After the implementation of the reform, the teaching content is richer and more diversified, and more cutting-edge technologies and development trends are integrated, which is conducive to stimulating students' interest in learning and desire to explore and cultivating their innovative consciousness and ability. In the past two years, the number of students participating in various innovation and entrepreneurship competitions has increased significantly, and more and more students have applied for and participated in innovative scientific research projects. These reflect that practical teaching reform has a good effect on stimulating students' innovative abilities.

(3) Students' satisfaction has improved. Through the teaching reform, a large-scale survey of students' satisfaction is conducted, and it is known that students' recognition of practical teaching reform is high, and their sense of gain and suggestions are generally good.

However, the reform of practical teaching is a gradual process, and there are still some shortcomings. First of all, for students of different levels and backgrounds, the applicability of practical teaching mode requires further discussion. Secondly, effectively integrating the practice teaching of the Linux operating system with other professional courses to better serve the training goal of new engineering talents still needs further study. In the future, we can further expand the connotation and extension of practical teaching mode and introduce more innovative practical elements, such as artificial intelligence, cloud computing, and other emerging technologies, so as to better meet the needs of talent training under the background of new engineering.

In a word, through the practical teaching reform of Linux operating system course, it provides a new idea

and method for talent training under the background of new engineering. However, further research and practice are needed to continuously improve and innovate the practical teaching mode and better serve the construction of emerging engineering education. At the same time, the reform of digital empowerment practical teaching is an important trend in the field of education, which plays a positive role in improving students' practical skills and innovative spirit. In the future, we can further deepen the reform of digital empowerment practical teaching and explore more reform measures and methods to better meet the needs of modern education and cultivate more high-quality talents with practical skills and innovative spirit.

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Disclosure statement

The authors declare no conflict of interest.

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