Teaching reform and practice of "Linux principle and application" based on CDIO concept

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Abstract. With the rise of cloud computing, big data, artificial intelligence, cyberspace security and other emerging fields, the application of Linux system is even more indispensable. Despite the demand for Linux related jobs, there are far from enough talent to do them. The traditional Linux principle and applied teaching mode focus on the learning of theoretical knowledge, and pay insufficient attention to the cultivation of students' practical ability and innovation ability. As a result, it is difficult for students to effectively apply the knowledge they have learned when facing practical problems, and related teaching reform is imperative. This paper adopts the literature review method, case study, experimental teaching and data analysis methods, from the course content, teaching methods, evaluation methods are analyzed and give reference ideas, aims to be able to cultivate more innovative thinking and practice ability of Linux system talents, contribute to the industry development and social progress.

Keywords: CDIO, Linux, Teaching reform, Project-driven.

1   Introduction

The CDIO engineering education model is the latest achievement of the international engineering education reform in recent years. CDIO is a combination of the initials of the four core concepts, namely, conception (Conceive), design (Design), implementation (Implement) and operation (Operate)[1]. CDIO engineering teaching mode mainly takes ability-oriented as the core concept, and emphasizes "learning from doing". On the basis of learning engineering theoretical knowledge, students emphasize the training and improvement of personal ability and teamwork ability[2]. In the whole process of project research and development as the carrier, the education link into the practice in the field of engineering, let the students actively participate in practice, cultivate self-study ability and engineering consciousness at the same time, let the students master the basic knowledge of engineering in practice, improve project practice ability and solve the problem of complex engineering and innovative entrepreneurial development ability, a more open mind, have engineering vision[3]. As an engineering course, Linux principle and application is suitable for carrying out teaching reform under the guidance of CDIO concept. The educational reform to cul-

tivate Linux system engineer as the goal, combined with the industry dynamic and enterprise requirements, in view of the problems in the course teaching, by letting the students participate in the project combat, improve the practical ability, stimulate their interest in learning, cultivate the team spirit and innovation consciousness, form in learning, learning, learning of good atmosphere, for the cultivation of engineering talents to provide a replication, the implementation of the ground.The CDIO model includes twelve standards, serving as guidelines and an evaluation system for implementing the CDIO engineering education model, as shown in Table 1.

Table 1. CDIO evaluation criteria

Order number	name	Order number	name
1	The CDIO was used as the environmental background	7	Comprehensive learning experience
2	CDIO, with teaching objectives	8	active learning
3	An integrated curriculum	9	Improvement of teachers' CDIO ability
4	Introduction to engineering	10	The improvement of teachers' teaching ability
5	Design- -Production experience	11	Student CDIO, ability evaluation
6	CDIO, practice place	12	CDIO, and the project evaluation

This paper first analyzes the current situation of Linux Principles and Applications teaching and identifies the key issues of teaching reform. Then, it elaborates on the specific content of the course reform, including the reconstruction of teaching content, the construction of diversified teaching methods, the adoption of diversified assessment methods, and the implementation of project-driven teaching methods. Finally, the implementation path of the reform is summarized, and the future development trend of teaching is prospected.

2 Analysis of the Current Situation of Linux Principle and Application Teaching

With the continuous update and iteration of Linux system, new functional technologies and applications are also constantly emerging, which requires its relevant teaching to keep pace with The Times and constantly update the teaching content and methods to meet the needs of the development of the industry[4], Linux related courses are required courses in many college computer schools, Its teaching effect plays a vital role in the quality of professional talent training, But the current situation is not optimistic enough, Mainly reflected in four points: 1, the course knowledge point is various, Not closely connected enough, It was fragmented, localized, From the software to the hardware, From the single-player to the network, From the client to the server, From operations to development, The content is much and scattered, The main line of some textbooks is not clear enough, The chapters are not closely

related enough, Each chapter only gives a single explanation of the knowledge points involved in this chapter, Lack of macro-level control, It is difficult for students to build the knowledge points into a complete system, It is not conducive to cultivating its overall engineering thinking ability to analyze and solve problems at a higher level.2, the case is relatively lag, the homogeneity, simplification, Linux system as open source operating system, its principle and application involves extensive and in-depth, but part of the teaching materials and teaching materials update lag, only stack of common knowledge points, data content is homogeneity, lack of practicability, failed to timely reflect the latest development of Linux technology, lead to students in the learning process is difficult to contact cutting-edge technology and industry application case, affected the learning enthusiasm and practical application ability[5]. 3, students know more one-sided, most students "development, light system", namely the development skills, the underlying system architecture, this understanding may limit the students' technology development, make it unable to master more technical knowledge and skills, and cannot better cope with complex applications and development requirements.4. The traditional assessment method is mostly "one examination for life", and the assessment method is relatively single, not objective and three-dimensional enough, unable to examine students from multiple angles, multi-dimensional and all-round aspects.

In view of the teaching situation, plans to solve the four key problems, 1, logical level, solve the lack of coherence, classroom teaching content present "fragmentation" problem: partial teaching of knowledge, while teaching a lot of commands, such as Linux directory and file management command, users and user group management command, directory and file rights management related command, but students on the relationship between the knowledge and other subjects knowledge, at the end of the semester of knowledge omission phenomenon, unable to form a complete knowledge framework.2, cognitive level, solve the students common "development, light system" understanding problem: before learning Linux course, students have system learning a variety of development language, especially attention to software development skills, career goals related to this, and the cognition of Linux is one-sided, thought the course useful for development, even useless, study the course is not serious, have mixed credits, cope with the exam.3, the practical level, solve the project case and enterprise job demand, application and professional problems: the practice case in the process of teaching is mostly the simple representation of knowledge and application, students lack of real experience and experience, often lead to classroom teaching (i. e., theory) and practical practice (i. e.) correlation, theory and practice gradually tend to "two skin" phenomenon, classroom lack of authenticity and vividness, the vision of "people match" more.4, the assessment level, solve the assessment method is relatively single, the lack of dynamic, process assessment problems: Linux principle and application as a professional compulsory course, calendar year exam mostly adopt closed machine or closed in the form of written examination, examination method is relatively single, the examination way is difficult to arouse the enthusiasm of students at ordinary times, and "learning as the center, to teach as the leading" of science education[6].

3   Clear Course Teaching Reform Content

3.1   Zero Into the Whole, Teaching Content Integration

In longitudinal, establish the curriculum framework, optimize the course content, and different stages correspond to different content. In the horizontal, the establishment of in-class teaching, the second classroom, cyberspace and other three-dimensional curriculum education space, to achieve the multi-dimensional sports person model[7]. On the basis of the "Operating System principle" and "data structure" courses, the engineering education mode is adopted to reconstruct the Linux course group. The course group includes four courses: Linux Principles and Application, Linux Analysis and Programming, Embedded System Principles and Embedded Linux Programming. These four courses are not synchronized: students can first understand and master the implementation principles of the Linux modules; then familiarize themselves with and use the Linux environment through the experimental unit, and open appropriate modules to program the experimental unit. Secondly, I began to learn the principles of Linux analysis and programming and embedded systems. The former systematically teaches process programming, file programming and network programming in Linux environment, so that students can master the most basic Linux programming skills; the latter systematically teaches the concept of embedded system, various components (hardware part + software part), principles and typical embedded system, so that students can master the basic knowledge of embedded system and the use of corresponding development tools[8]. Since embedded Linux is also a very important branch of Linux, in the fourth academic year, embedded Linux programming in the course no longer describes the basic Linux programming skills, but focuses on the application of embedded Linux in embedded systems.

3.2   Ideological and Political Internal, Ideological Concepts to be Childish

"Dealization" is a relative concept, which means that people get rid of naive and immature ways of thinking or behavior in thinking, expression or action, and gradually become mature, rational and intelligent. Students who learn to develop tend to value development skills while ignoring the importance of the underlying system platform architecture. Therefore, in the daily teaching process, we pay attention to the design and organic integration of ideological and political elements, so that students understand that the system is the cornerstone of development, without the development of the underlying operating system is a castle in the air, the two are an organic whole truth, can not be generalized, the same, to "both hands grasp together, both hands should be hard". Teachers pay attention to the analysis of problems and solving contradictions in the teaching process of emphasizing, cultivate students' tough and mature character, in the process of learning to make academic and career planning in advance, and constantly strive to make progress. While learning professional knowledge, students can also receive ideological and political education, so that their political consciousness can be strengthened, the feelings of family and country can be

cultivated, moral cultivation can be improved, and cultural accomplishment can be nourished.

3.3 Keep Pace with The Times, and the Project Case is Dynamic

With the help of school-enterprise cooperation, students can participate in the production line, so that they can understand the cutting-edge development technology and the latest requirements of enterprises in the Linux field, master the latest relevant tools and methods, and lay a foundation for becoming application-oriented talents. Make full use of the advantages of the developed IT industry in the Guangdong-Hong Kong-Macao Greater Bay Area, Seek the support of relevant enterprises, Get projects you are working on and projects you have done, And various industry-university-research projects, Give students access to more quality practice cases, Team members have regularly updated the case library, Ensure the advancement of the project cases; Let the students learn from the challenge Cup competition, open source software Grand Prix, embedded system design competition and other competition schemes, Combined with industry research, Determine the practice cases; Encourage students to conceive of projects that span multiple courses in the same semester; Students are encouraged to research various open source sites and communities, To their various viable open source software projects, By various means and pathways, Teachers and students work together to build a dynamic practice case library.

3.4 Multi-pronged Approach, Diversified Assessment Methods

The assessment method mainly consists of two parts: 1. Theoretical knowledge: written test, accounting for 20% of the total score.2. Team project design: it accounts for 80%. The process of team conception and discussion accounted for 15%; Team results and display accounted for 40%; Personal ability contribution: 35%, Team design of typical projects, Student detachment, Then make a request, Students provide divergent forms of thinking to complete the organizational design as required, The process is not unique, The answer is not fixed, Through the process of students determining the program, denying the program and optimizing the program to achieve the mastery of knowledge, Complete the design content by grouping, dividing the projects and by stages, Students can gradually master the use of knowledge from the shallow to the deep, Improve the ability to combine theory and practice, To stimulate their interest in learning, At the same time, it can also enable the teachers to more accurately grasp the students' learning attitude and ability.

4   Method Description

This study adopts the concept of course cluster, combining a series of Linux-related courses (such as Linux principle and application, Linux analysis and programming, embedded system principle, etc.) into a coherent curriculum system. By integrating

the syllabus content into the actual project, using the work decomposition structure (WBS) method, the complex projects are decomposed into manageable components, and then these components are corresponding to the teaching knowledge points to help students establish a complete knowledge framework. Using online hybrid teaching mode, the use of super star learning through online education platform, create a syllabus, project resources, teaching courseware, question library, teaching video, comprehensive teaching resources, students can complete learning tasks on the platform, and through the homework practice and test system feedback learning effect. Considering the CDIO mode is emphasized ability standard rather than pure knowledge standard, this study designed the diversity of assessment, in addition to the traditional closed book exam, also joined the project performance assessment, including the quality of the experiment report, the speed of project completion, the performance of group cooperation, project demonstration, etc., to fully evaluate the students' ability and team cooperation level. Using project-driven teaching methods, the four core stages of CDIO (conception, design, implementation, and operation) are integrated. Students conduct online independent learning on the Superstar Learning Pass platform, and teachers guide students to conceive, design, implement and run the project in offline classroom teaching. The whole teaching process is conducted through case projects prepared by teachers, micro-lesson videos and student offline group discussions, to ensure that students can learn and master all aspects of Linux principles and applications from the project.

5   Specific Implementation

5.1   Reconstruction of Teaching Content —— Course Cluster, Multi-dimensional

At the school of computer science undergraduate Linux related courses have Linux principle and application, Linux operating system, Linux server operations, Linux system security, Linux advanced tutorial, embedded Linux system, etc., many courses, involves more wide, different professional students to related knowledge demand focus is different, so aim at specific literacy structure, the nature of a reasonable structure, clear level, connected to each other, cooperate, depth echo of the serial course cluster[9]. According to the actual needs of the post, the syllabus content organic into the typical project, project as the body, using the WBS method for decomposition, top-down, zero, let students can learn knowledge to reflect, thus as an import, then bottom up, zero for the whole, eventually independent knowledge into the project, and complete integration, form an organic whole. Students' mastery of knowledge is no longer a glimpse of the leopard, to test the sea, but the winged sky, a lofty position. Curriculum clusters can make full use of the characteristics of the same series of courses to support and complement each other. From point to line, multiple scattered knowledge points are connected into lines, such as from line to surface, multiple knowledge paths are woven into knowledge, from surface to body, multi-layer knowledge is built into an organic unified whole.

5.2   Build Diversified Teaching Means —— Online and Offline, Multi-point Flowering

Make full use of a variety of high-quality teaching platforms, according to the actual situation of the school and the characteristics of different courses, to carry out online and offline mixed teaching. For example, using superstar learning to achieve PPT + voice, nail classroom live, MOOC + classroom, synchronous (asynchronous) SPOC + mu classroom (+ live) and other mixed teaching. Build course information resources, teaching text resources, teaching resources such as high quality teaching resources module, mainly including the teaching syllabus, teaching plan, project resources, teaching courseware, electronic lesson plans, question bank, related teaching video, video, small class, animation and other teaching materials, and set homework exercises and test system, students through the platform learning task and evaluate learning effect, feedback, realize the full integration of teaching and learning.

5.3   Adopt Diversified Assessment Methods —— Multi-one, Comprehensive Investigation

CDIO mode is a cultivation mode based on ability, which is fundamentally different from discipline-based knowledge[10]. Therefore, the evaluation methods should be diversified, and the students should be evaluated based on the experiment, project, teamwork ability, including the personal skills, the final completion quality and the intermediate process of the project; including the evaluation of teachers and mutual evaluation among students. Relying on the platform, on the basis of the existing assessment methods, we add comprehensive project results, including experiment report, completion speed and quality, group cooperation, project demonstration, etc., so as to change the previous single assessment methods such as "one test for life".The diverse assessment criteria in the Linux course are shown in Figure 1.
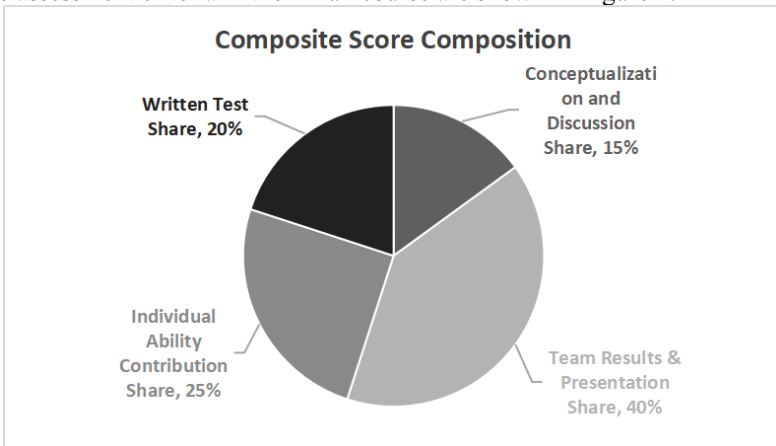

Fig. 1. Performance composition of CDIO assessment method

5.4 Project-driven Teaching Mode —— Double-line Linkage, Four-section Teaching

Project-based learning is a process in which students complete project tasks according to the driving problems and realize the construction of knowledge and ability. Driving problems are the core element of project-based learning and an important index of project evaluation. This teaching reform adopts the mixed teaching mode of online independent learning and offline classroom teaching to integrate the four stages of CDIO. Relying on the "one level three end" (online teaching platform, mobile end, teacher end and management end), it puts the teaching design into practice and improves the effectiveness of teaching. The specific implementation process of CDIO project-driven teaching is as follows: Conception stage: teachers prepare case projects, learning tool micro-lesson videos, release pre-class thinking questions on Superstar, students collect and sort out technical materials related to tasks online, and offline group discussion-practice-feedback. Design stage: the teacher teaches the overall implementation ideas of the project and the specific matters that need to be paid attention to, reviews and reviews the phased results submitted by students, centralized guidance and individual guidance. According to the classroom teaching content, students use the WBS method to realize the content of each part of the project step by step and submit it for review, and receive separate review and guidance from teachers. Implementation stage: Teachers take the classic application scenario project as a case, teach the implementation environment, methods, integration and design of the project, organize students to evaluate each other, students combine the guidance of the teacher, complete the integration and design of each part of the project, submit the phased results, and accept the teacher review and guidance. Operation stage: teachers focus on teaching the problems, improvement measures and methods in the implementation process of the project, implement the submission, defense, performance assessment and evaluation, students combined with the guidance of teachers, further improve the project content and project content, submit and accept the defense question.The students' discussion on the statistical situation is shown in Figure 2.
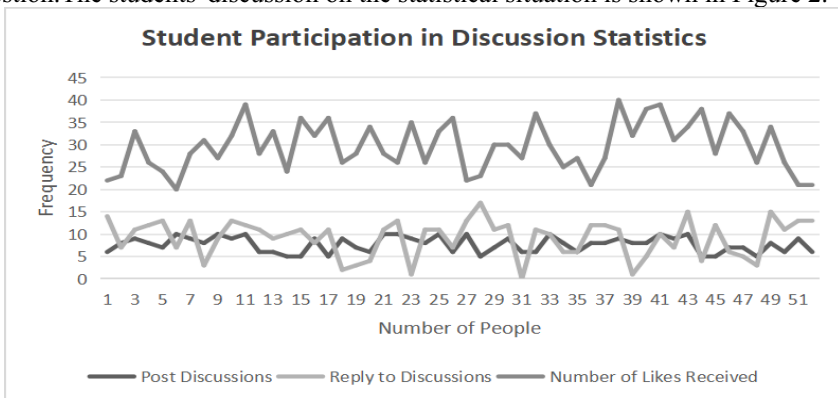

Fig. 2. Statistics of students participating in mutual evaluation and discussion

6   Summary

The educational reform will CDIO concept mode into the educational goal, "do" + regression engineering, emphasize ability standard, around Linux system application and development technology, combined with the industry development needs, using the whole life cycle of project development form, make students to master Linux platform related project conception, design, implementation and operation. Strive to improve the traditional teaching and a single practice classroom mode, abide by the cognitive principle at the same time, starting from the development of the students, in the choice of teaching methods, pay attention to stimulate students 'curiosity, cultivate their autonomous learning ability, consider can effectively and students' existing cognition, so as to better achieve the cultivation of its high order ability. In the future, Linux principle and application teaching will show a more diversified and integrated development trend. With the rapid development of cloud computing, big data, artificial intelligence and other technologies, Linux, as a representative of open source operating systems, will be more and more widely used in these fields. Therefore, in the future, teaching will pay more attention to the development of practical application, online and offline integration, and interdisciplinary integration. Through continuous innovation and improvement of teaching methods and means, more high-quality and innovative talents will be cultivated, so as to make greater contribution to the development of China's information technology industry.

Fund Project

References

1. Susan K. Conceive-Design-Implement-Operate: Pedagogical Innovation to Enhance Attainment, Engagement, Satisfaction and Employability in Political Science[J].Journal of Political Science Education,2024,20(2):240-252.
2. Crawley, E.F., Malmqvist, J., Brodeur, D.M., & Edström, P.(2020).The CDIO Standards: A Framework for Curriculum Development in Engineering Education – An Update.International Journal of Engineering Education, 36(1), 1-12.
3. Grecia A ,Simon I R ,J.F T , et al.The evolution of sustainability in engineering education research: a longitudinal analysis through bibliometrics and the CDIO initiative[J] .International Journal of Sustainability in Higher Education,2023,24(6):1266-1289.
4. Bennedsen, J., & Skulmoski, G.J.Implementing CDIO in a Global Engineering Program: Lessons Learned.Journal of Engineering Education [J], 2021, 110(3), 321-334.
5. Tao Yufei, Guan Zengjian. Research on the Development of Practical Teaching in Higher Engineering Education in China (1990- -2019) [J]. Journal of Shanghai Jiao Tong University (Philosophy and Social Sciences edition), 2021,29 (05): 156-166.

6. Lu Dong, Zhu Baicheng, Cui Guimei, et al. Exploration of embedded system teaching based on CDIO concept [J]. Laboratory Research and Exploration, 2019,38 (01): 183-185.
7. Yang Yuanyi. Design study of driving problems in project-based learning [J]. Teaching and Management, 2024, (09): 71-74.
8. Yang Yanhua, Fu Yonggang, Li Binqi. Exploration of cultivating computer professional talents based on OBE-CDIO mode [J]. Journal of Jimei University (Education Science Edition), 2024,25 (02): 46-54.
9. Sun haimin. Teaching design of software development course for computer majors under the CDIO concept [J]. Computer Education, 2023, (10): 185-191. DOI:10.16512/j.cnki.jsjjy.2023.10.035.
10. Xiao Mingyao. Application of hybrid teaching mode based on CDIO in computer curriculum [J]. Journal of Changchun Normal University, 2024,43 (06): 168-173.