

Exploration and Research on the Engineering Education Model of "Practicing while Teaching with Curriculum Integration"

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Abstract. A new engineering education model "Practicing while Teaching with Curriculum Integration"(PTCI) is put forward based on the concept of "Outcomes-based Education"(OBE). This model can solve the paradox that universities pay more attention to theory over practice while enterprises are more interested in talents with strong practical engineering and technical training. In order to have a curriculum covering vocational qualification standard, after setting up the talent training goals, a training program and the relevant curriculum have been established according to the specific vocational graduating requirements and the corresponding vocational qualification certificates. It has been found that the PTCI model is helpful in improving students' ability for engineering applications and in improving the quality of graduates.

1. Introduction

Marked by China's formal participation to the "Washington Agreement" on June 2nd 2016, engineering education certification has become gradually popular in universities, which provides an operational quality control standard for the cultivation of engineering technical personnel. This paper examines the re-construction of the network engineering major in Shandong Business and Technology University. The new curriculum has implanted the concept of engineering education OBE, in order to solve the problem of the gap between training objectives and industrial needs for network engineering graduates from colleges and universities.

On the basis of investigating the demand of local economic and social development for talents and the development of schools, this paper analyzes and compares the characteristics of professional qualification certification in the network engineering industry, and explains the recent teaching reform method of PTCI in the core courses of network engineering. It is convinced that PTCI is suitable for the training of applied computer networking professionals.

The paper is organized as follows. Section 2 introduces the necessity of engineering education reform. Section 3 explains in detail the methodology that has been proposed to implement the PTCI. Section 4 describes the results obtained and compares the results with the previous practice. Section 5 summarizes the work.

The Necessity of Carrying out the Reform Universities tend to "place more importance to theory over practice", which is not aligned with local economic development in terms of the demand for talents and the development of schools. The overall updating of curriculum system and teaching content is not timely. The social demand and industrial demand change very rapidly. However, curriculum is usually updated every 3 to 4 years. This is seriously out of synchronization and causes numerous problems.



For example, a traditional networking course uses the “Routing and Switching Technology” textbook. The book lists basic commands and operating methods step by step, from easy to more difficult, and pays attention to everything relevant to required knowledge. This approach is not effective because steps are easy to be ignored and easy to forget, and can lead to erroneous operations when students engage in real jobs such as network planning and network administration. If the curriculum “integrates lessons with certificates” and uses network planning and network administration as a course project and have the students work on it over a course, the students will have the opportunity to use network products directly and have stronger professional training, making the training more “applicable” and “efficient”. The selection of teaching content in “integrating lessons with certificates” needs to strive to achieve “what teachers teach is what the industry needs, what students learn is what the certification requires”. The teaching content and the professional standard of the course can be merged and connected with each other, and the teaching content of the course can completely cover the corresponding professional qualification standard, which can enhance the purpose of the students in the process of learning. In this way, the students will eventually master more knowledge and skills than the certificate itself. Through the study by practicing while teaching, taking a certificate, such as a professional qualification exam, is an authoritative recognition of the student's ability to master relevant professional skills in a particular field, which improves the capability of students in competing for employment positions.

Of course, at present, there are some problems in the qualification certification of engineers in colleges and universities, such as too many certificates, lack of teachers, poor effect of practical training and so on. Through careful investigation on the demand of network talents and research of certification quality, the research group all agreed that it was necessary to introduce “H3C, HC” and other vocational qualification certification as the guidance of “integrating lessons and certificates” teaching model. Table 1 shows the research results of vocational qualification certification.

Table 1. Certificates of Professional Qualifications

	Level	Name	Examination content	Remarks
Vocational qualification certificate by the H3C Group	Primary	H3C Certified Network Assistant	Network configuration, operation and equipment maintenance for small and medium-sized enterprises	Computer test, 50 multiple choice questions, a total of 1000 points, 600 points to pass
	Medium	H3C Certified Network Engineer	Planning, design, configuration and maintenance of small and medium-sized networks	
	Senior	H3C Certified Senior Engineer for Routing & Switching	Theoretical knowledge and operational skills of routing, QoS etc, and VPN	
	Top	H3C Certified Internetwork Expert	Familiar with network equipment products and related technology theory	
Vocational qualification certificate by Huawei Technologies	Primary	HCNA-HNTD	Exchange(digital pass) basic knowledge TCP / IP protocol stack basic knowledge etc.	Computer test, 50 multiple choice questions, a total of 1000 points, 600 points to pass
	Medium	HCNP-R&S	Routing protocol, routing control, etc.	
	Senior	HCNP-R&S-IENP	Principle and implementation of MPLS	

Shandong Business and Technology University is located in Yantai, while Yantai is in the eastern coastal area, next to South Korea and in the Bohai Rim Economic Circle. Due to its special geographical environment and the implementation of the manufacturing base strategy of the Jiaodong Peninsula, the information technology industry in the Jiaodong Peninsula is experiencing rapid development and there is urgent need for skilled professionals in the front line of production, management and service. It also provides a huge development space for the training of highly skilled personnel. The teaching mode of “practicing while teaching”, which integrates the contents of engineer certification into classroom teaching, makes the key points of knowledge required by the core curriculum, are consistent with the research results of vocational qualification certification, and complies with the needs of regional economic and social development.

2. Implementation of the Teaching Reform Model of PTCI

In recent years, with respect to establishing a practical training system that combines practical teaching with vocational skill appraisal, autonomous learning in case study and simulation experiments, this paper has studied in depth the effective connection between network research and online course learning, the teaching reform mode PTCI had mainly carried out organization and implementation in the following aspects, which had laid a solid foundation for students to obtain vocational qualification certificate.

2.1 Set up a practical training system combining practical teaching with vocational skill appraisal, and solve the problem of single choice of teaching methods and means.

In the new model of engineering education, the practical training system was divided into two parts: experiments and professional practice. The experiment part was divided into verifying experiments, comprehensive experiments and design experiments. The confirmatory experiments focus on training students' basic experimental operation and data processing skills, which was mainly for following the classroom experiments after each course. The comprehensive experiments are used to cultivate students' comprehensive ability to use knowledge. This kind of experiments are carried out by students using knowledge, principles and methods from one or more courses, and they are mainly for curriculum design. The design experiments mainly train the student's effective application ability of knowledge and skills, logical thinking ability, cooperation and communication ability, innovation practice ability, which are mainly for the comprehensive practice at the end of term. Based on the idea of OBE in engineering education, more attention will be paid to the training of students' industry capability, this means there is need to increase the proportion of comprehensive experiments and design experiments. In addition, our major has established off-campus and in-school practical training centers, for example, the Integrated Communications and Network Training Base, IT affiliated factories, Internet of Things Research and Training Center, and the National Information Communication Engineer Training and Certification Center, ZTE Communication NC Joint Education Center, H3C Engineer Training and Certification Center, H3C Training Center, NC Certification Assistant Program Control Exchange Engineer Certification Center" and so on. In accordance with the requirements of the teaching plan, students' practice or practical training should be completed in the industry, and the professional and technical personnel of the companies should undertake or participate in guiding the students' practice, in making sure the conditions for student placement and practice were adequate and effective. The relatively stable and deep cooperative off-campus training base, which made the communication specialty more closely combined with the industry and the market, and fully meets the needs of the productive practice of the students in this major during their study in school and the practice on the job for more than half a year.

2.2 Adopting methods of application case study

The current teaching is mostly PowerPoint slides based. There are many knowledge concepts, class pace is fast, class size is large, content is complex and abstract with strong theoretical emphasis. However, it is difficult for students to grasp clear the knowledge structure. Existing teaching resources are not well integrated with the existing new technologies and new trends. In the whole learning process, it is very difficult for students to get connected with real engineering cases. This paper makes

use of the idea of OBE and case teaching, which let students think about problems, and divides the students into several group discussions to synthesize discussions with "brain storming". The cooperative model with students as the main body and teachers as the guide, students not only practiced oral expressions, but also improved team work. Problems are solved through discussions, which leads to better understanding of the nature of network problems. Taking the "IP Routing Technology" course as an example. By combining with some real problems from H3CNE, H3CSE certifications, and working on real network engineering projects, the teachers made careful preparation of the exchange, routing, wireless, security and comprehensive case studies, which would improve the students' practical ability in network engineering, such as network analysis, debugging and design. The case of Internet of things technology mainly explained the structure and function of perceptual layer, network layer, application layer and related automatic identification technology. The information attack and defense technology cases mainly explained the advanced information network attack and defense technology at home and abroad, including information network, network attack, network defense, network anti-attack technology, etc. The cloud computing technology case mainly explained the concept, service form, and core technology of cloud computing and so on.

2.3 Theory study, adopting the method of Independent Learning in Simulation experiments

In order to master the ability of network engineering applications, students can only rely on constant efforts, and do a lot of practical related work. Because of the rapid development of network technologies, it is necessary for students to master new network protocols and algorithms. In the meantime, students are required to have a global perspective and be able to utilize and integrate existing communications and network resources. When it comes to principle verification and engineer certification exams and subject competitions, it can effectively verify the theory and save time with simulation experiments. Students can use Cisco's Packet Tracer and Huawei's eNSP in simulated networks. They can use Wireshark, Sniffer, SpyNet and so on to view data packets, grab bag classes and other training items. The experiment bar simulation platform can be used in network attack and defense information security experiments. eNSP, OPNET, NS and so on can be used in comprehensive simulation.

2.4 The second classroom activity is rich, and has formed good complementary with the classroom teaching

Good results had been achieved through setting up the university student innovation laboratory, the mechanism of university students participating in scientific research activities, famous teacher lectures, the forum of "Network Age and Communication Future", the social practice activities "bring scientific and literacy knowledge and offer medical service to rural areas", subject competitions. These activities improve students' ideological and moral quality and cultural quality at multi-levels and multi-channels. In particular, the subject competition, on the one hand, can understand the latest technology of the network engineering major. On the other hand, it can promote students' sense of professional achievement and enhance their enthusiasm for learning. The college had introduced various measures, such as alternative graduation design, to encourage students to participate in various professional competitions. And the college took an active part in all kinds of competitions sponsored by the Teaching Steering Committee of the Ministry of Education of China, China University Computer Competition, Blue Bridge Cup National Software and Information Technology Competition, etc. "Promoting Education by Competition". The instructional teachers provided professional guidance (comprehensive and abundant theoretical knowledge of network and experimental debugging, such as Comware, etc.) to contestants and provided another perspective of understanding the needs and development trends of network engineering projects. These also provided valuable reference for the teaching reform model of "integrating lessons and certificates".

3. Results

(1) The PTCI model could solve the problem of the optimization of the course system and teaching content of network engineering specialty. The proportion of experimental practical training course had

been raised from 25.8% to 33.50%. On this basis, the proportion of practical courses of other computer related majors had also been greatly improved. As shown in Figure 1. Network Engineering, Software Engineering and Computer Science and Technology are abbreviated as NE, SE, CS respectively.

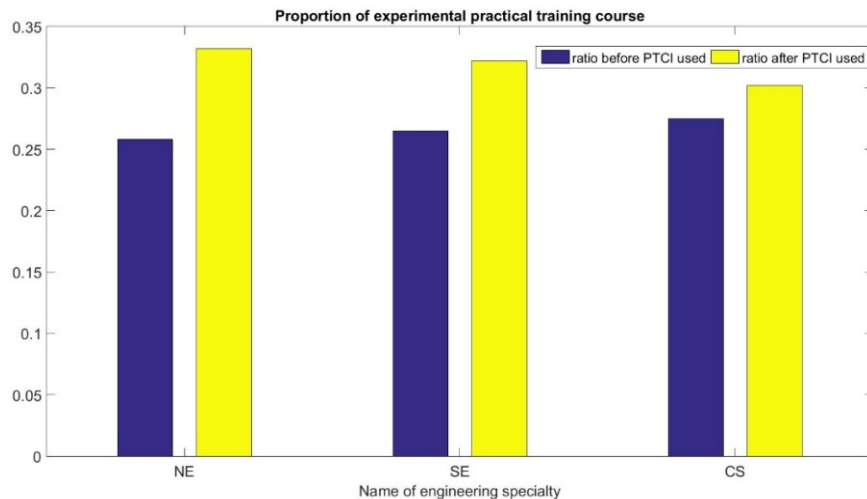


Figure 1. Curve graph of proportional change of practice by specialty

(2)PTIC mode had promoted the students' competition better

In classes we adopt some methods such as double certificates text, case teaching, network experiment and computer simulation authentication. After classes, we take the quality expansion project of the school as the carrier. We had carried out contest guidance, and had made some good achievements. Students had won many awards in the iCAN international innovation contest, Chinese Internet college students innovation and entrepreneurship competition. Many graduates leagued the network backbone enterprises, and some of them had grown into the backbone of the company's business. Taking the students of Grade 15 of Network as an example, 40 of the 52 students in the class had signed up for the online qualification examination.

4. Conclusion

In this paper, the engineering education model based on PTCI is discussed. It has been proved by practice that the reform of the teaching model could effectively solve the problem of the gap between the training goal and the industrial demand of the network engineering students. It has also effectively solved the problem of the overall optimization of the course system and teaching content of the network engineering specialty.

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