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Construction of Practical Teaching System for Communication Engineering Specialty Based on Engineering Certification Requirements

Rongqun Peng, Gang Liu, Jian Sun, Chao Fang

School of Computer Science and Technology, Shandong University of Technology, Zibo, China
Email: pengrq@sdut.edu.cn

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Abstract

On the basis of analyzing the necessity and existing problems of practical teaching of communication engineering specialty, a "four levels and two combinations" practical teaching system of communication specialty based on the requirements of engineering education certification is presented in this paper. The system systematizes all links of practice teaching, practice conditions and environment, and makes full use of the experimental conditions in the school and the industry resources outside the school. After nearly two years of practice, the engineering practice ability of students has been greatly improved, meeting the requirements of engineering education certification, which has a good reference for the construction of practical teaching system of related majors in other universities.

Keywords

Communication Engineering, Practical Teaching System, Engineering Certification, University-Enterprise Association

1. Introduction

1.1. Necessity of System Construction

1) Need for communication major

Communication engineering is a major that requires students with great practical ability. In its major cultivating scheme, besides almost every course has a corresponding experimental teaching, some curriculum designs for professional core courses such as "communication principle" and "communication electronic circuit", as well as the communication system software design, the communication system hardware design and the communication system equipment enter-

prise training practice link are set up, which requires that schools should have the practical conditions to cultivate practical ability. The systematic use of experimental conditions in and out of school can train students' practical ability more efficiently.

2) Need for communications industry

Communication industry is one of the pillar industries in today's society, especially with the comprehensive commercialization of 5G technology, the demand for communication graduates is increasing, meanwhile higher requirements for the practical ability of graduates are put forward. In addition to a solid theoretical foundation, telecom operators, telecom equipment manufacturers and telecom engineering service providers require them having the ability to install, operate and maintain commonly used communication equipment when recruiting new graduates. These practical abilities need to be developed during the period of school study.

3) Need for professional certification in engineering education

Engineering education certification has put forward higher requirements for the current talent training, especially for the training of students' practical ability and the ability to solve complex engineering problems. For example, item 4 of engineering certification graduation requirements: research, the ability to conduct research on complex engineering problems in the field of communication based on scientific principles and using scientific methods, including designing and carrying out experiments, analyzing and interpreting data, and obtaining reasonable and effective conclusions through information synthesis; item 5: the use of modern tools, according to communication complex engineering problem, in the processes for the conception, design, implementation and operation of product, development, selection and use of appropriate technology, resource, and modern engineering tools and information technology tools, including the prediction and simulation of complex engineering problems, and understanding its limitations, as in Secretary office of China Engineering Education Certification Association (2020).

1.2. Problems Existing in Current Practice Conditions of Communication Specialty

In general, the professional laboratory set up through the purchase of test chamber in colleges and universities with communication major are able to meet the requirements for in-class experiments of "signals and systems", "communication principle" and other professional foundation course. But for pure professional courses such as "modern switching technology", "the principle of mobile communication", although there are test chamber is available, it is difficult for students to understand the real commercial operation of these communication equipment due to its poor performance without providing the necessary environment for commercial operation and only used in the experiment. Some schools have also invested heavily to purchase large mobile base stations and other equipment

to simulate the actual operating environment, as in Peng et al. (2015), but the investment is too large (several millions CNY) and has poor cost performance, the reason is that with the rapid development of telecommunications technology, this equipment is easy to be obsolete. When existing equipment becomes obsolete, schools generally do not invest a lot of money to buy new equipment to replace it. This problem is especially true for those non-key universities with insufficient funds for experimental equipment.

1.3. Analysis of Research Status at Home and Abroad

There are few literatures about the construction of communication laboratory abroad, but many researches have been carried out in domestic colleges and universities. Zhang, Zhang & Ha (2010) mainly focuses on the practice and thinking of SRTP, electronic science and technology competition for college students, transformation of scientific research achievements into high-quality teaching resources and cutting-edge forum of electronic information technology industry. In Wei et al. (2020), the practice teaching system is redefined under the background of emerging engineering education, intelligence and big data, taking the development of core capability as a starting point, taking the practical teaching system aiming at making communication engineering students majoring in engineering foundation, application ability, competent work and sustainable development as the goal. But the above papers are only theoretical discussion, and did not fall into practice.

In Chen & Li (2021), the comprehensive objectives of personnel training in communication specialty have been determined including aspects of knowledge, ability and quality. Accordingly, the stereoscopic teaching infrastructures are formed integrating teachers, places, resources. Afterwards, the course system is optimized and further implements the new engineering ideas into the construction of specialized courses. The practice shows that the course construction of communication major aiming at training new engineering talents has achieved initial results. In Xu et al. (2020), combined with the characteristics of Measurement and Control specialty and the background of the current engineering education specialty, the authors put forward how to build the "innovative" talent training system which is composed of four parts: the target concept system, the training implementation system, the training support system and the continuous improvement system. However, these papers study the whole curriculum system of communication major or the whole personnel training system, and practical teaching is only one part of them.

The authors in Peng et al. (2021) put forwards a "multi-level progressive" comprehensive experimental system construction scheme for communication specialty in their paper published in 2021, constructing an open, upgradable and extensible multi-level innovative experimental system for communication specialty. However, their plan only involves the construction of an experimental platform on campus, and does not consider the fact that new equipment cannot be

purchased due to the shortage of experimental funds. How to make effective use of the social resources of specialized laboratories and communication industry in school and systematize them, so as to provide places and conditions for the cultivation of college students' practical ability, is a problem worthy of study.

2. Basic Composition of Practice Teaching System

In this paper,on the basis of fully considering the experimental conditions and practical environment inside and outside the school, we summarize the experience of practical teaching in recent years, investigate relevant enterprises in the communication industry, draw on the research results of literature, and finally propose the establishment of a four-level and two-level practical teaching system for communication major (as shown in **Figure 1**). The so-called "four levels" refers to the level of students' practical ability training, starting from the basic level, through the practice level, the application level, and finally reached the highest level, i.e., innovation level. The so-called "combination of two" refers to the combination of on-campus and off-campus training mode, as detailed below.

2.1. Basic Level

In basic level, students can only acquire a simple validation of professional theory knowledge and the most basic practice ability only be cultivated from these verification experiments carried in school laboratory. This level is implemented in various specialized laboratories, such as switching and digital signal processing laboratories, optical fiber and communication principles laboratories, high frequency and signal systems laboratories, etc.

2.2. Practice Level

At the practical level, engineers from technology companies outside the school are invited to guide students to complete some mature projects. Students only need to reproduce existing projects according to the guidance of engineers, so as to cultivate students' basic engineering project development ability. At present, we have established preliminary cooperation with "Huaqing Foresight Technology Co., LTD. Jinan Branch" and "Shandong Core Kinetic Energy Integrated Circuit Technology Co., LTD." and completed the practical teaching tasks for students in recent years. Although the project was not innovative, in the process of completing the project, students mastered the basic process of project development, got familiar with the software platform of project development, cultivated the spirit of teamwork and trained the ability of mutual communication.

2.3. Application Level

This level of practical training is mainly to send students to actual telecom operators and enterprises to visit and participate in the operation and maintenance of telecom equipment and product development and production of enterprises. The first two levels of practical ability, either to test learned theories in

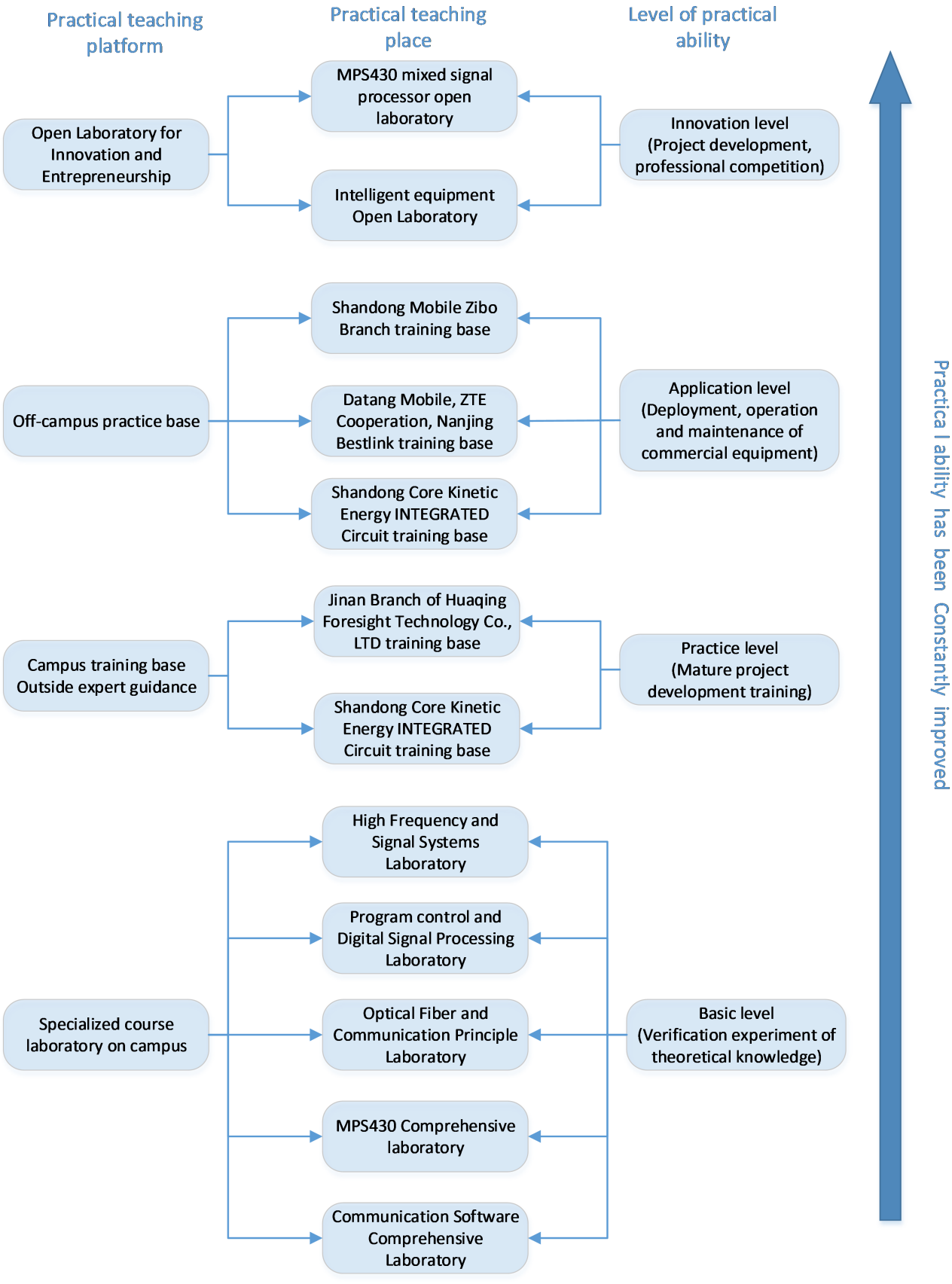

Figure 1. "Four levels and two combinations" practical teaching system for communication major.

the laboratory or to reproduce existing projects, are at the lower level of practical ability. The application level is the operation of real commercial equipment in real environment, or the development and production of real products. In addition to technical expertise, the guarantee of operating conditions of telecom equipment (such as the operator's backup power system), or factors such as product cost, customer demand and market are also needed to consider in this level, which cannot be learned in school. Through the practical training at the application level, it just makes up for the deficiency of teaching and practice conditions in the school.

In addition to the existing training bases such as Datang Mobile, ZTE Cooperation and Nanjing Bestlink Co. LTD., we also reached cooperation with China Mobile Zibo Branch Company last year. Students can go to the core computer room of the mobile company, the computer room of each district and county, and the downstream cooperation company for practical training.

2.4. Innovation Level

Innovation level is the highest level of practical ability training. General Secretary Xi said in his report to the 19th National Congress of the Communist Party of China: "Innovation is the primary driving force for development and a strategic underpinning for building a modernized economy. Innovation is the soul of a nation's progress and an inexhaustible source of prosperity. The fifth Plenary Session of the 18th CPC Central Committee put forward the concept of innovative, coordinated, green, open and shared development, putting innovation first and leading development through innovation, highlighting the extreme importance of innovation." On account of the training of the first three levels, students have been equipped with good practical abilities such as project development, laying a foundation for innovation. Based on the two professional open lab, "MSP430 mixed signal processing laboratory" and "smart equipment laboratory", students can give full play to their enthusiasm, initiative and creativity, participate in the development of enterprise real project, participated in the various game industry, which lay a good foundation for future employment and graduate school for further study.

"Two combinations" refers to the combination of campus and off-campus, including inviting engineers from off-campus enterprises to the school to cooperate instruct students with in-campus teachers, and also including sending students out to enterprises for practice training. The practice of inviting engineers to campus can not only make full use of the laboratory on campus, but also give play to the advantages of the rich project development experience of engineers from off-campus enterprises. At the same time, it can save internship funds and students' living expenses, as well as prevent the occurrence of safety accidents. This approach is more practical especially when large numbers of students are not suitable to leave school during the COVID-19 pandemic. Sending students can complete practical exercise at the application level, broaden students' hori-

zons, and is also a powerful supplement to the shortage of experimental equipment in the school.

3. Construction Process

The whole system construction needs two steps:

1) The school laboratory construction includes two aspects, i.e. professional basic course laboratory construction and the construction of the innovative open laboratory. The construction of specialized basic laboratory is mainly aimed at in-class experiments and depends on the input of experimental equipment budget. Innovation laboratories for communication majors need more consumables such as development boards, components and so on, which need long-term continuous investment, construction and maintenance. The innovation and open Laboratory need to raise funds from various sources according to the characteristics of the school, such as applying for innovation and entrepreneurship projects at all levels.

2) The construction of off-campus practice and training base also includes two aspects. One is to cooperate with electronic information technology companies and invite enterprise engineers to the school to complete the basic development ability training of the project. The other is to cooperate with local telecom operators to send students to complete equipment practical training in a real and completely commercial operating environment.

4. Construction Effective

The practice system proposed in this paper is mainly applicable to the situation that the school is not able to purchase expensive commercial (5G) communication equipment in a short period of time to build a large campus training base due to insufficient experimental funds. Through the practical test in the school in recent years, this practical teaching system can obtain the following construction results.

1) Students' engineering practice ability and innovation and entrepreneurship ability have been comprehensively improved.

With the perfect training system, the practical teaching tasks in the training plan such as in-class professional experiment, concentrated practice, graduation project are systematically completed, and students' practical ability has been improved one by one. In particular, it successfully completed the practical teaching tasks of "Comprehensive Design of Communication Engineering Specialty", "Comprehensive Design of Communication System" and "Practice of Communication System Equipment Enterprise" by using enterprise and social resources. In addition, rely on the professional practice teaching platform, students participated the "Datang Cup" national college students' mobile communication 5G technology competition and other provincial and national games, won a national first prize, two national second prizes and five national third prizes, and won ten provincial level first prize ten items, second prize sixteen items and third prize

25 items, as well as a number of school-level awards in nearly 2 years.

Through the questionnaire survey of graduates and employers, students' satisfaction with engineering practice ability training has been significantly improved than before, and meets the requirements of engineering certification for practical ability.

2) The postgraduate entrance examination and employment competitiveness of students have been improved, and the postgraduate entrance examination and employment rate have been greatly improved.

Since the implementation of training system in 2020, students have taken a great advantage in the practical ability test of the postgraduate entrance reexamination. As a result, the postgraduate entrance examination rate has been increasing year by year and maintained a high level (as shown in Table 1). Meanwhile, students in the graduate recruitment interview can also obtain the favor of human resources interviewers, which leading to the employment rate increased year by year.

For example, in the interview of an employer last year, there was a question about emergency power supply for communication equipment. This year's students just went to Huantai mobile branch to visit a large emergency power supply diesel power generation support equipment, the engineer made a detailed explanation. Therefore, the student did well in the interview, passed the interview and got the offer from the company. According to the feedback of postgraduate students, in this year's graduate second-round exam, there are also interviews experts put forward a lot of communication equipment installation and operational problems, such as the relationship between antenna Angle and coverage range as well as 5G application in industrial production. Due to students have learned the practical knowledge in advance in the practice training, they can calmly deal with it in the graduate examination, and achieve ideal results.

5. Conclusion

In the practical teaching system presented in this paper, the lab on campus and social resources off campus are fully utilized to complete the practical teaching tasks in the training plan, thus solving the urgent problem of the shortage of experimental equipment on campus. However, in the long run, the lack of on-campus experimental conditions, especially the lack of the most advanced laboratories (such as 5G laboratories), is an unavoidable problem. Outside the school is running equipment, can let the students do very little, so that the cultivation of

Table 1. Comparison of postgraduate enrollment rates in recent three years.

year	Number of graduates	enrollment number	postgraduate enrollment rate
2019	128	24	18.75%
2020	150	46	30.67%
2021	153	47	30.72%

practical ability of students will be greatly compromised. In the future, we should actively strive for all kinds of resources and funds to establish advanced technology laboratories on campus, so as to provide enough practical operation opportunities for students.

From the end of June to early July 2021, through cooperation with Zibo Mobile Company, we completed the practical teaching task of "Communication System Equipment Enterprise Internship". However, as it was the first time to cooperate, there were also many shortcomings in the implementation process, such as many links were skimmed the surface without in-depth learning. In future cooperation, we should carefully negotiate the content and links of practice and training, and form a mature cooperation agreement as soon as possible to ensure the effect of students' practice and training.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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