Construction and Practice of Excellence Talent Training System for Computer Science and Technology in Yunnan University

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***Abstract*—Taking the computer science and technology of Yunnan University as an example, the ideas and methods of training excellent talents are expounded in this paper. This major trains excellent talents from four points: classified training based on course group, collaborative education based on school-enterprise cooperation, computer professional certification and construction of practice innovation base. By setting up three course groups and dividing each course group into application type and research type, the individualized classified training of students can be realized. Through school-enterprise cooperation and education project, the industry enterprises deeply participate in the training process, and the students become industry-recognized talents. Through Certified Software Professional (CSP) organized by China Computer Federation (CCF), talents are trained according to industry standards. Through the construction of practice and innovation base, we will change to "learning by doing" which centers on students and focuses on students' active practice, and strengthen the cultivation of students' engineering ability and innovation ability. It can provide reference for the construction of computer talent training in relevant universities.**

***Index Terms*—computer education, excellent talent training, teaching reform, course group**

I. Introduction

In June 2010, the Ministry of Education of China launched the "Education and Training program for Excellent Engineer", which is an important step to promote China from a big country to a powerful country in engineering education. The plan is guided by social needs and is based on actual projects and engineering technology. Its aim is to train a large number of high-quality engineering and technical talents with strong innovation ability and adapting to the needs of economic and social development [1].

The first department of computer science in Yunnan Province was established by Yunnan University in 1984. It was selected as a national characteristic specialty construction project in 2008. It is the only national characteristic specialty and key undergraduate specialty of computer science in Yunnan Province. As a local university, we strive to build the specialty into an important base for training high-level computer technology professionals in Yunnan Province, and play a demonstration and driving role in the construction and reform of similar specialties in relevant universities in Yunnan Province.

With the goal of cultivating personalized, professionalized, standardized and innovative talents of computer science and technology, the specialty has carried out the practice and exploration of training outstanding talents of computer science and technology by introducing classified training based on course group, collaborative education based on school-enterprise cooperation, computer professional certification and construction of practice innovation base. Through unremitting efforts, the specialty has carried out the practice and exploration of training outstanding talents of computer science and technology, and we have made remarkable achievements in professional construction and talents training.

II. Thoughts on Constructing the System of Training Excellent Talents

The education and training program of excellent engineer has three characteristics: (1) industry enterprises are deeply involved in the training process; (2) the school trains engineering talents according to general standards and industry standards; (3) the students are strengthened engineering and innovation ability. Compared with the basic requirements of excellent talents training, the following problems need to be solved in the traditional computer talent training mode:

- Students' personalized training has not been realized. There are many computer professional knowledge systems. Graduated students have a lot of knowledge, but they are not good at one direction. In the training, there is no sufficient choice for students, and students lack professional skills.
- Talent training is not combined with requirements of enterprises closely. Due to the rapid development of computer industry, the required knowledge is changing with each passing day. The courses opened by universities are relatively old, and graduated students cannot meet the requirements of enterprises.

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- The standardization of students has not been realized. Ability of programming is the most important ability of computer students. But there is a lack of uniform standards in training, and some graduated students lack the ability of programming.
- There is no better way to develop students' innovativeness. Traditional teaching generally is to learn in listening, which is centered to teacher and based on classroom teaching. Students passively accept knowledge, which is not conducive to innovative training.

We adopt the following ideas to reform the training of excellent talents:

- By setting up three course groups and dividing each course group into application type and research type, the individualized classified training of students can be realized.
- Through school-enterprise cooperation and education project, the industry enterprises deeply participate in the training process, and the students become industry-recognized talents.
- Through Certified Software Professional (CSP) organized by China Computer Federation (CCF), talents are trained according to industry standards.
- Through the construction of practice and innovation base, we will change to "learning by doing" which centers on students and focuses on students' active practice, and strengthen the cultivation of students' engineering ability and innovation ability.

The specific idea of reform in this specialty is shown in Fig. 1.

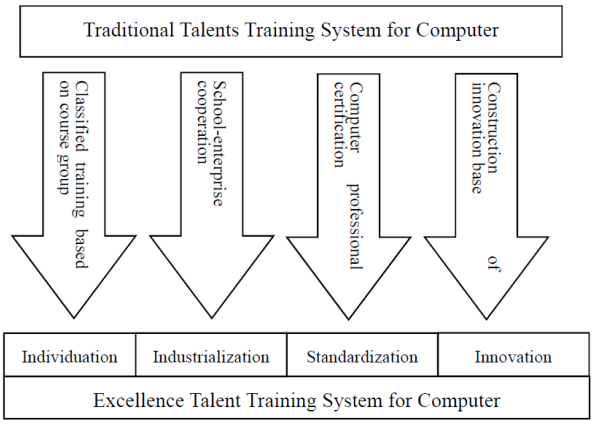

Figure 1. Thoughts on the construction of excellent talents training system for computer science and technology in Yunnan University.

III. Practice of the Reform of Training Excellent Talents

A. Realizing the Individualized and Classified Training of Students

Computer science and technology covers a huge knowledge system. When developing a curriculum plan, we considered the following two points for different students:

- Different employment or postgraduate research directions require students to master different knowledge.
- Students who are directly employed have a bias towards applied courses, while graduate students have a bias towards theoretical courses.

Based on the above two points, we have formulated a classified training curriculum based on the course groups. The curriculum module is shown in Fig. 2.

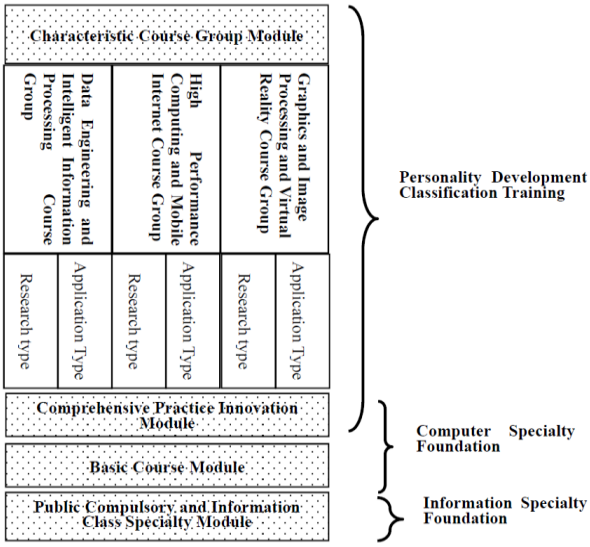

Figure 2. Curriculum system of excellent talents training system for computer science and technology in Yunnan University.

The curriculum module is guided by the IEEE/ACM2005 and “Research Report & Professional Norms on the Development Strategy of Computer Science and Technology in Colleges (Trial)” [2], compiled by the teaching guidance committee of college computer science and technology of the Ministry of Education. In the setting of characteristic course group, the idea of promoting teaching by scientific research and feeding back teaching by scientific research is carried out, and the corresponding three curriculum groups are created: data engineering and intelligent information processing, image processing & virtual reality and high performance computing & mobile internet. [3].

Teachers from the computer science in Yunnan University have gradually formed three teaching and research teams in data engineering & intelligent information processing, image processing & virtual reality and high performance computing & mobile internet. We make full use of discipline advantages, integrate scientific research results into the teaching process, integrate scientific research work with teaching work organically, and create three characteristic course groups. The curriculum is shown in Table I, and the following works are carried out:

- Adjustment of the course content. Combining scientific research, facing the needs, adjusting the course content, adding or deleting appropriately, building the course groups as a whole, organizing rationally in content, and driving by the training

goal, let students accumulate knowledge and skills in the professional direction widely.

- This is a series of three flexible and interactive course, which will help students build unique skills in a computer field. In course learning, students are allowed to adjust flexibly, requiring them to complete at least one of the three course groups.
- Keep up with the frontier of the discipline, hire domestic and foreign experts and technical talents and project managers in high-tech enterprises to give lectures on new technologies for students, and give specific lectures on case analysis.

TABLE I. THREE COURSE GROUP MODULES

Course Title	Semester	Credit	Class hour	Course type
Data engineering & intelligent information processing course group				
Computing thinking	4	1	18	Research-based type
Introduction to artificial intelligence	5	2	45	Application Type
Software development tools and technologies	6	2	45	Application Type
Data Warehouse and Data Mining	6	2	45	Research-based type
Intelligent information processing	7	2	45	Application Type
Machine learning	7	2	45	Research-based type
High-performance computing & mobile internet course group				
Network engineering	5	2	45	Application Type
Information security and practice	5	3	63	Research-based type
System integration	6	2	45	Application Type
Mobile internet technology	6	2	45	Application Type
Embedded Systems	6	2	45	Application Type
Multi-core programming	7	2	45	Research-based type
Network Protocol Analysis and Design	7	2	45	Research-based type
Image processing & virtual reality course group				
Digital photography	4	1	18	Application Type
Digital image processing	5	2	45	Research-based type
Computer animation technology base	6	2	45	Application Type
Digital video synthesis technology	6	2	45	Application Type
Visual media computing	7	2	45	Research-based type
Virtual reality and application technology	7	2	45	Research-based type

The curriculum module not only pays attention to students' basic theory and basic skills, but also enables students to have a technical expertise. It also establishes the training mode of scientific research and application-oriented talents, realizes the individualized and classified training, and embodies the educational concept of teaching students in accordance with their aptitude.

B. Training Students Engineering Ability and Industrial Talents through School-Enterprise Cooperation and Collaborative Education Project

Due to the shortage of "double-skilled" teachers, most engineering teachers in universities lack practical experience in enterprises [4] and [5]. But the excellent engineers' training program requires the introduction of industrial enterprises to deeply participate in the training process and to strengthen the engineering ability of students.

We cooperates with famous international and domestic IT enterprises and well-known enterprises in Yunnan, implements the project of school-enterprise cooperation and collaboration in education, selects young teachers to participate in training, obtains the certification of enterprise teachers, actively introduces teachers from off-campus enterprises into university, lets industrial enterprises deeply involved in the training process, and strengthens the students' engineering ability, so as to better meet the requirements of enterprises.

1) Carrying out the project of school-enterprise cooperation and collaboration in education

Our teachers are encouraged to carry out school-enterprise collaborative education projects, and several Ministry of Education school-enterprise collaborative education projects and Google premium course projects have been approved. We have cooperated well with Huawei, Google, Microsoft, Cisco, ZTE, Tedu and other famous enterprises. The projects have played a good role in professional collaborative education.

2) Joining the national information technology new engineering association

In order to obtain further support from the company, we officially applied for approval to become a member of the National Information Technology New Engineering Science and Technology Research Alliance. Relying on the alliance, we can participate in the new engineering research and practice project declaration, and relevant enterprises can actively participate in the new engineering research and practice of this major. The project provides resources and support, promotes industry-university cooperation and collaborative education, and expands and implements the "Excellent Engineer Education and Training Program Version 2.0".

3) Training certified teachers in enterprises

In recent years, our five full-time teachers have obtained Huawei certified teacher certificate and three full-time teachers have obtained the Google Android certified teacher certificate. These certified teachers have offered six courses in Huawei computer network, information security, and Google Android mobile development. At the end of February 2019, Huawei's big data, internet of things, cloud computing, routing exchange, and other certification courses have been offered to students. After continuous learning for two weeks, more than 95% of the students have passed the certification of Huawei related courses.

In addition, we have hired nearly 20 part-time teachers from Yunnan Branch of China Mobile, Yunnan Branch of China Construction Bank, Yunnan Daily Newspaper Group, and many other computer centers of institutions and enterprises to give students more than 40 lectures on internship practice, enterprises frontier technology introduction, and so on. The teachers from off-campus enterprises are invited to participate in the revision of professional talent training program and syllabus. The industrial enterprises are introduced to participate in the training process deeply to strengthen the engineering ability of students.

C. Training Standardized Talents According to Industry Standards through Certified Software Professional (CSP)

1) Development of CSP

The China Computer Federation is the most authoritative and influential computer industry society in China. Its Certified Software Professional (CCF CSP) is an authoritative computer professional qualification certification [6].

In the training of excellent engineers, it is required to train engineering talents according to industry standards. The most important ability of students majored computer science is programming ability. The CCF CSP can test students' practical programming ability. It indicates that the student has reached the training standard and qualified to become an industry-recognized engineer if he or she passes the certification.

Through numerous consultations between Yunnan University and China Computer Federation, the CSP center of Yunnan University was formally established. After many certification examinations, the average score of students' certification has been continuously improved. Students' programming ability has been significantly improved in the subsequent professional courses and postgraduate studies.

2) Embeding CSP into talent training program

In the revision of undergraduate talent training program, we have made the CSP one of the conditions for undergraduate graduation. In the comprehensive practice module of the training program, the course of programming ability test has been added, with 2 credits, which is a compulsory course for practical training. Students are required to achieve a certain scores in the CSP or pass any level of the national computer software proficiency test, in order to earn the credits.

Through this measure, students can be guaranteed to have a certain level of programming ability, to be competent for the work of software engineers and to meet the standards of qualified engineers.

3) Effectiveness of CSP

After many certifications, the achievements are as follows:

- Inspiring students' interest in programming and achieving good results in various programming competitions. After implementation of the certification, the final grades of programming courses have been significantly improved, the students' enthusiasm about participating in various programming competitions has been high, and more than 50 provincial and ministerial level awards have been won in various programming competitions.
- Promoting students' employment. According to the professional internship and work intention submitted by the students when they sign up, more than 60 certified high-scoring students have received internship invitations from famous domestic IT enterprises such as Baidu, Tencent, Alibaba, and DiDi. More than 20 students have arrived the company to participate in internship during the holiday, understanding each other and signing the contract with these famous IT enterprises after they are satisfied.

D. Strengthening Students' Engineering Ability and Innovation Ability through the Construction of Internship and Innovation Base

In the long-term teaching practice, there is a general situation of "learning by listening", which is teacher-centered, classroom-based lectures, and theory-based tests. In the context of training excellent talents, the engineering teaching mode should shift to student-centered teaching mode that emphasizes students' active learning and practice, and carry out "learning by doing" to integrate theory and practice. This requires students to go to enterprises, industries and other departments for practical teaching, including production internships, in-post internships, and other forms [7]-[9].

1) Construction of practice and innovation base

We have established seven practice bases of off-campus internship in several large state-owned enterprises and private enterprises in Yunnan Province, introducing social resources and providing more platforms for students' practice.

We have built large-scale cloud desktop laboratory, innovation base, and cloud computing training laboratory. We purchased Dell network storage, server, handheld 3D laser scanner, graphics workstation, and 3D motion capture system. These equipment have greatly improved the experimental and practical conditions of undergraduates.

2) The achievements in establishing internship and innovation base

- Cloud desktop laboratory receives about 8,000 exams and experiments each year, involving more than 10 kinds of exams; Cloud desktop laboratory is located on the overhead floor of the information academy building, covering an area of more than 300 square meters, with 200 cloud terminals. The CSP was carried out in the newly built cloud desktop laboratory. In addition, Huawei ICT contest, laboratory safety knowledge exam, school discipline exam, and various programming competitions were all completed in the cloud desktop laboratory.
- Innovation and internship base serve more than 600 students each year. Innovation and internship

base cover an area of more than 200 square meters, and can accommodate more than 80 people at the same time. There are good conditions for enterprises to establish the on-campus internship base during the holiday. More than 50% of undergraduates in this major have established research groups. Undergraduates have obtained more than 20 national, provincial or school-level scientific research projects. Undergraduates have published more than 20 papers, obtained more than 10 national invention patents, and owned more than 40 prizes in various science and technology competitions.

IV. Conclusion

Based on the basic principles and ideas of training excellent engineers, this paper expounds the practice of the computer science and technology of Yunnan University, including classified training based on course group, collaborative education based on school-enterprise cooperation, computer professional certification and construction of practice innovation base. It can provide a reference experience for continuous training of innovative excellent talents.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

In this work, Guowu Yuan conducted the whole research; Xutao Yang, Kun Yue, Guowu Yuan and Wenhua Qian are respectively responsible for the classified training based on course group, collaborative education based on school-enterprise cooperation, computer professional certification and construction of practice innovation base. Guowu Yuan and Gaifang Luo wrote the paper.

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