Innovative Research on Training Modes of Applied Software Talents

Yinghao Chen, Xiao Fei, Meizhen Gao and Jiaping Hong

ABSTRACT

With the rapid development and wide application of computer technology in the information age, the traditional talent training mode of computer software engineering is difficult to meet the needs of social development, due to the disjointedness between training mode and social needs. Therefore, colleges and universities are actively exploring the reformations and innovations for personnel training mode in software engineering to meet the future development needs. Starting from the integrated competencies of application-oriented software talents, teaching task, commencing with training objective, curriculum system, and inspection appraisal mechanism, and coordinating teacher, students, innovation base, and enterprise, a university in Hubei has explored an application-oriented software talent training mode, with C&C (college and company)combination of production, education and scientific research. The comparison results of training effects between the traditional and innovative modes shows that the significantly enhances are existing innovation one, especially in employment rate, postgraduate examination rate, and salary level.

OVERVIEW

With the rapid development of computer and information technologies, the computer application technology is rapidly injecting into traditional industries. The computer industry, of which the proportion in national economy is increasing year
by year, has become one of the pillar industries of China's industry [1]. The demand of application-oriented software talents in computer engineering is growing. In addition, with the development of computer technology, social requirements for students, whose major is computer, have become increasingly demanding. On the one hand, a huge gap of technologies and talents exists in China's computer software industry. According to the survey in 2015, the large employment needs in Internet, computer software, e-commerce, and financial industries, increase the proportion of social recruitment with more than 88% [2]. On the other hand, although computer sciences has developed rapidly in colleges and universities in China, and boosted the subject education, resulting in rapid progress, the employment rate of computer science graduates is still not optimistic, due to the huge gap between the needs of enterprises and the quality of graduates. There are several main problems in current education. Firstly, paying enough attention to theory, while ignoring practice. The graduates lack competitiveness after entering the workplace. Secondly, the original knowledge structure system cannot keep up with the needs of the market. Thirdly, there are lack of system planning in independent design and implementation of various courses. Fourthly, curriculum setting does not focus on the real problems, which induces students, cannot build the concept of computer systems well. Subsequently, practical courses cannot keep up with the social development seriously, and graduates cannot be integrated into practical work. Finally, some experimental courses are also not focus on the real problems, lack of difficulty and scale of the project, both which induce the students ‘poor competence, especially the practical application and practical ability.

To sum up, experts and scholars of domestic and foreign, universities and colleges under the instruction of the National Committee of Computer Majors have carried out a large number of teaching reforms and explorations. Especially in the teaching mode innovation, they have made a lot of practices and explorations, such as researches on improving student's ability in innovation and entrepreneurship [3], computational thinking [4], systematic research ability[5], operational ability[6], researches on the cultivation of computer application talents[7], education reform research based on the OBE concept [8]. This article describes one of the innovative researches on the training mode of application software talents in a university in Hubei. Through these researches and practices, the requirements of social development have been adapted, and the actual application ability of graduates has been improved, which significantly increase their market competitiveness.

RESEARCH ON THE INNOVATION OF APPLICATION-ORIENTED SOFTWARE TALENTS TRAINING MODE

Analysis of the Competency of Application-Oriented Software Talents

Software engineering is aimed at cultivating advanced application-oriented specialized personnel. In order to achieve the goal of training talents, it is necessary
to pay enough attention to the cultivation of comprehensive quality and engineering practice ability. There is a significant difference between "thick base and wide aperture". It is also significantly different from the vocational ability training. A university in Hubei organized many outstanding software enterprises and the well-known colleges and universities to discuss the quality and ability of application software talents, it had been found that the application software talents should have several abilities, such as solid basic knowledge, software engineering practice ability, rich innovation consciousness, application domain knowledge, teamwork and communication skills, comprehensive quality and professional quality, as well as good autonomous learning ability and physical quality.

1) Solid professional knowledge and software engineering practice ability. The specialized theory knowledge is the basis of the engineering practice of later period, mainly in the freshman sophomore year study. In addition to the theoretical knowledge of computer professional foundation courses such as programming language, data structure, discrete mathematics, database, and still through various channels such as experimental teaching, practice teaching, curriculum design to strengthen the practice ability. Software engineering practice skills need to be cultivated in project practice. The related Courses have software project management, software architecture design, software testing, and software quality assurance, etc. It mainly concentrates on cooperating with engineering projects for studying in the major three or four stages.

2) Rich innovation awareness. Innovation ability is a kind of social practice abilities. As for software engineering students, it is a key to qualify for software development jobs, to meet the needs of enterprise software project development, to solve the actual problems creatively in the project development, implementation and maintenance. The cultivation of innovative consciousness should be carried out during the whole university. Students should strengthen their innovation awareness by participating in various innovative activities, such as college students' innovation and entrepreneurship programs, college students' scientific research, and innovation and entrepreneurship competitions.

3) Application domain knowledge. Software development cannot leave the application domain knowledge, different requirements vary widely in the field of application, familiar with the application domain can bring many convenient for software development, and it is easier to promote the success of a software project. Students should learn and reserve the related applications in the field of knowledge consciously during college, such as enterprise management, education, health care management, and financial management, etc. Students in employment can selectively and purposefully engage in the development of related fields.

4) Teamwork and communication skills. Most software projects are done jointly by the project team. Software development is a kind of abstract thinking. The communication, collaboration between team members is much difficult to be compared with other industry, which requires the software engineering college students have good communication ability. During the period of college, students
should participate in various activities to improve mutual cooperation and coordination communication abilities. This paper introduced the applied software talent training mode which will arrange some large projects, especially in the project, for traction, individual students through the composition form the project team to complete tasks to enhance mutual coordination and communication ability.

5) Comprehensive quality and professional quality. Good comprehensive quality and professional quality is a key for the software engineering graduates to obtain professional achievement. Some qualities such as interpersonal communication ability are learned in the daily life and work, but some of the qualities and abilities are obtained through teaching, including literature information retrieval and utilization ability, expression ability, foreign language application ability, engineering consciousness and innovation consciousness and ability of lifelong learning, etc.

6) Self-learning ability and good physical quality. The computer knowledge is easy to update, and the update is very fast. It requires the software talents to have strong independent learning ability and constantly learn new knowledge and new technologies. The cultivation of independent learning ability should run through the whole university, and teachers can improve students’ autonomous learning ability through task-driven teaching mode. Most of the software talents are faced with healthy physique and good physical quality, which has become the material capital for the competition of software talents.

Innovative Training Mode for Application-Oriented Software Talents

In order to meet the requirement of application software talent ability and quality, at the beginning of 2010, a university in Hubei specially organized a team for the educational reform research, based on the combination of theory and practice, in-class and after-class, combination of universality and individuality, and the combination of schools with enterprises. With the opening mind and seeking truth from facts, we should concentrate on the comprehensive ability training, to create software talent training practice teaching system for the main line. That we can accurate orientation training target, optimize the training scheme, and supporting the construction of a variety of teaching software and hardware facilities, environment and integrate teaching resources. Then we can optimize the management mechanism, and perfecting the evaluation system to meet the needs of society, gradually build up a set of combination of talent training mode.

As shown in Fig.1, the core is how to make the teaching mode and develop programs innovation to achieve the training objectives mentioned above. Around this core, 12 factors including school management, teacher resources, innovation bases, and related companies have begun to carry out reforms and optimizations, so that the four elements of teachers, companies, innovation bases, and management are able to infiltrate and cooperate with each other and form organic links and combined a loop. For example, the use of networked intelligence in management not
only includes traditional student and teaching management, but also includes the management of teachers. Teachers are no longer a single teaching function, but the tutors and team leaders of students throughout the four years. That is, teachers in turn must assist in the management of students and teaching; for example, the role of the company is not to carry out independently. Instead, it is through the cooperation of teachers and innovation bases to develop innovative practices and research on students. Software talent training practice teaching system is shown in figure 2, according to the requirements of the applied software talent ability, practice teaching system structure includes: professional basic experiment, creative thinking training, collaboration, communication, engineering practice training, and comprehensive practice. Each item has a specific training platform. For example, professional basic experiments are mainly carried out in two ways: internships in related computer application companies and professional experiments in basic learning. Table 1 analyzes the main tasks of each stage of the software engineering talent training process, and defines the main activities and requirements of the innovation base and enterprise on the public platform. For example, freshman majors have a clear understanding of their professional and career prospects through special lectures; sophomores start primary practice activities on the basis of professional learning; On the basis of the sophomore, juniors through more intense practical activities will further broaden their horizons and deepen their professional abilities. For seniors, they will build students into qualified software engineering practitioners.

The professional personnel training mode structure, software engineering practice teaching system structure, software engineering personnel training process is the main task of the table at all stages of the three charts which are an organic whole, supporting each other and complementing each other. From the space elements, time processes, and the mainframe, a freshman can be trained into a qualified application software talent with complete ideas and specific plans. In the school’s applied software talent training mode, each element has a specific plan for implementing operations, so that each item can be implemented effectively. For example, on the assistance of enterprises, a long-term co-construction unit was set up with a related company in Wuhan, and many specific teaching practices, such as apprenticeships, trainings, and exchanges, etc.
A university in Hubei used the traditional classroom teaching mode for the cultivation of software talents, students are required to follow the syllabus of the subject system, for each semester participates in and completes the corresponding learning task, obtain the corresponding credits, then they can graduate normally. The university’s positioning itself is a general undergraduate, computer science is relatively disadvantageous in comparison with other engineering colleges, discipline construction, faculty and student quality, coupled with the lag of training mode. And graduating students used to have the problem of poor comprehensive skills, high employment pressure, and insufficient market competitiveness.
| Term stage | Training program                        | Research Office (Team), Innovation Base, Engineering Center                                                                 | Enterprise                                                                 |
|-----------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Freshman  | Public and professional basic education platform | Professional basic course teaching guidance; student seminars, technical lecture activities to cultivate professional interest, professional direction understanding | Opening lectures on industry development, application fields, business needs, corporate culture, etc. |
| Sophomore | Discipline Basic Education Platform     | Assign instructors, carry out innovation education, and set up innovation and entrepreneurship groups                         | Business mentors and teachers guide students in innovative practice activities; carry out professional practice awareness month activities |
| Third grade | Professional Foundation and Core Courses | Participate in large-scale creation projects, discipline competitions, innovation and entrepreneurial competitions; teachers arrange practical projects, group development of students; organize seminars, academic activities, project defenses, etc. exercise collaboration and communication skills | Short-term project training for teachers and students; relying on innovation bases, introducing enterprise projects to innovation bases |
| fourth grade | Comprehensive Practice Platform          | Conduct large-scale projects, exchange of achievements in innovation contests; exchange of graduation design; summary and publication of scientific research results | Software company graduate internship; entry series training; professional literacy training |

**Training Target Design Aspects**

The goal of traditional software engineering is to cultivate students with a certain analytical design capability, as shown in table 2, its main feature is to follow the general pattern of university education, follow the rules, step by step, and to complete the teaching task of the subject knowledge system, objectively cause some students just to aim at graduating from school, instead of improving themselves’ ability and employability. From the freshman to fourth grade, there is a complete set of education programs, students only need to get enough total credits under the outline to graduate. This practice has its benefits, but the result is that students tend to be satisfied with “long lives the pass” in the learning process, which caused lower product yield. And the ability of graduates often cannot meet the needs of enterprises; then after the education reform, abandoned the previous training objectives with the core of subject knowledge system construction, depart from the mode of independent school training, and aiming at adapting to social needs, cultivate the center of practical ability, establish a training mode for C&C (college and company) (showed in Table 1).
The training of the school is based on the newly-built innovative experimental base; the enterprise's training is based on long-term cooperation with well-known companies, relying on the company's human/soft-hard resources. At the beginning of university entrance, students are encouraged to begin their studies in practical courses, and then theoretical teaching is carried out in accordance with the needs of the theory through practical content; and came into contact with construction companies and corporate culture. The main purpose of sophomore year is to lay a solid foundation of software language, through the guidance of enterprise technical personnel, to organize the recovery of larger programs and the simulation of mature small projects to achieve the purpose of learning. From a job-oriented perspective, it should have partially met or exceeded the level of seniors in the traditional mode. On the basis of simulation, juniors have improved their ability to innovate in practice through group modeling/ doing projects, which also have improved their teamwork spirit and ability to co-ordinate and coordinate division of labor. Fourth grade students to complete the actual business projects or internships go mainly through participation in research and development projects, business operations trainee, which will improve their own businesses employability.

Teaching Organization and Management

Closely centering around the ability to cultivate practical abilities, reforms and innovations are made in teaching organization, teaching environment, teaching activities, teaching focus, management mode, and operating mechanism.

In the teaching mode, students should change from passive to initiative. And students are the real subject of the classroom, teaching is carried out in the way of project topics, students' practical abilities and independent thinking skills are fully cultivated, and they are encouraged to practice more and participate in various types of software contests. In the competition, the teacher enhances the coaching and guidance so that students do not yaw and cannot leave the team. With respect to the teaching environment, we established a software engineering laboratory and an innovation base, and we regularly organized study tours for top companies at home and abroad, and actively learned good experiences and practices for my own use and advancing with the times; in teaching activities, we will abandon the routine lectures and visits of companies, organize and participate in various discipline competitions and innovation and entrepreneurship contests, and major projects; carry out outstanding talents training plan, invite senior management personnel of the company to teach and experience the development process of the company's software projects, so that students can get rid of the blindness of learning as soon as possible and find the direction and focus of learning. At the center of the teaching, the theory class hours are reduced, the proportion of credits in theoretical courses is reduced, and the weights of experimental courses and course design are greatly increased. The implementation of practical courses and practical training programs is the focus of teaching.
### TABLE II. COMPARISON OF TRAINING OBJECTIVES IN TRADITIONAL MODE AND INNOVATIVE MODE.

| Traditional software engineering professional training objectives | Application software talent training goal |
|------------------------------------------------------------------|------------------------------------------|
| Freshman Basic knowledge of discipline | basic operating knowledge of a subject |
| Sophomore Certain analytical skills | Professional knowledge analysis and design capability |
| Third grade Certain design capabilities | Comprehensive innovation practice ability |
| Fourth grade Certain application capabilities | Self-employment and employability |

### TABLE III. COMPARISON OF TEACHING ORGANIZATION MANAGEMENT IN TRADITIONAL MODE AND INNOVATIVE MODE

| Traditional software engineering training mode | Application software talent training model |
|------------------------------------------------|------------------------------------------|
| Teaching modes Teacher's teaching students' passive learning mode | Combining with experimental course design, students' self-knowledge ability and independent thinking ability, theory and hands-on practice are encouraged, and students are encouraged to participate in various software competitions. |
| Teaching environment Software Engineering Laboratory | Software Engineering Practice Teaching Base, Innovation Base |
| Teaching activities Classroom teaching, teachers bring students, ask enterprise talents to tell students about the status of social software engineering development | Various discipline competitions and innovation and entrepreneurial competitions, Daiso projects; |
| | To carry out outstanding personnel training programs, invite senior corporate management personnel to teach and experience the company's software development process |
| Teaching focus Emphasis on theoretical teaching, too many theoretical lessons | Open hands-on courses and training programs, increase experimental courses and curriculum design |
| Management modes Manual or non-network methods, scattered data, difficult to organize, time-consuming and labor-intensive | Using a web-based educational management system, complete data collection and high efficiency |
| Operating mechanism The teacher completes the teaching content according to the teaching mode; the student completes the course task according to the teacher's request | Conduct a variety of teaching activities and training to promote teacher-student exchanges and develop students' practical ability and innovative spirit |

In order to ensure the effective implementation of teaching practice innovation, the management accordance with their aptitude, to further increase their ability. The efficiency has also been greatly mode and operating mechanism have also been improved and innovated. In terms of the management mode, the traditional manual method of fragmentation is abolished, and a web-based educational administration system is used. The data collection is more complete and the data analysis is more efficient. The score is no longer a pure number for reactive credits, but through a
large amount of statistical data, in-depth analysis and in-depth exploration of students' potential and advantage, in improved. The operating mechanism of the teacher-student relationship in the traditional sense of a breakthrough, the relationship between teacher and student relationship may be teammates, the relationship may be on the leader-member relationship, which can be coordination between different departments, a relationship between the customer and the company, and it can also be a rival relationship (showed in Table 3).

**Assessment and Evaluation Mechanism**

The main problems with traditional student assessment are shown as follows: 1. the content structure of the assessment is not perfect. The assessment of traditional students is mainly based on a single assessment of knowledge and skills, and it is easy to overlook the spirit of innovation and practical ability. 2. There is a deviation in the understanding of the meaning of intellectual education. In the evaluation of intellectual education, people often unconsciously regard curriculum education as their entire content, and simply place an equal sign between course achievement and intellectual education. Ultimately, learning results have become the only standard for evaluating students' pros and cons, which is detrimental to students' ability to develop and improve their quality. 3. Ignore personality characteristics. In order to adapt to the needs of the applied software talent training mode, the school of computer science in college also made adjustments to the student’s assessment mechanism: 1. Abandoning the previous mode of a single course assessment, adopting a diversified evaluation mechanism marked by diversified goals, multiple standards, and multiple modes, inspiring the potential of students and teachers, and promoting students and teachers' ability to apply innovation. Reform the content and form of the pen and paper evaluation, what’s more, make the paper and the pen examination maximize the context; implement a combination of written examinations, oral tests, realistic examinations, practical examinations, situational examinations and other comprehensive evaluation methods. For example, the designs of examination propositions are real issues in the real situation. They do not design the nature of “fake big empty” and guide students to discover and solve problems in the real world. They also enhance their understanding of real problems and their ability to solve problems, and innovation capabilities.

**COMPARISON OF EFFECTS OF TWO CULTURE MODES**

**Longitudinal Comparison**

By the continuous tracking of students with the majors of software engineering in university of Hubei in 2009, 2010, 2011, and 2012. All of students, just at the old and the new training mode alternately are under trained graduates, the 2009’s and 2010’s students adopted the traditional training mode. The 2011 and 2012 students
adopted an innovative ability training mode. The situation is quite typical, but also has a certain degree of comparability. The scores of the entrance exams for these four students are basically about 10 points above the general undergraduate admission line in the province. Faculty and staff are relatively stable, and import-output of teacher talents is relatively small. We have set up some evaluation and assessment projects such as employment rate, examination rate, and provincial award rate (showed in Table 4 for details). Through tabular data, it can be seen that graduates who adopt innovative application software talent training modes have advantages in all indicators, and from these data, in particular, the winning rate, the percentage of top 100 software companies, and monthly income. Levels and other data can be seen that the overall quality and ability of students cultivated under this innovative application software talent training mode are more obvious, and they are more adaptable to the needs of social development and to adapt to market competition.

### TABLE IV. LIST OF EMPLOYMENT RATE, AWARD RATE, ENTRANCE EXAMINATION RATE, ETC. OF SOFTWARE ENGINEERING MAJOR FROM 2009 TO 2012.

| Training mode         | Grade | Total number | Employment rate (%) | Provincial award rate (%) | PubMed rate (%) | Number of top 100 software companies (person) | Average salary (RMB/month) |
|-----------------------|-------|--------------|---------------------|--------------------------|----------------|-----------------------------------------------|-------------------------------|
| Traditional training mode | 2009  | 40           | 95.0%               | 10.0%                    | 10.5%          | 23                                            | 5500                         |
|                       | 2010  | 34           | 91.2%               | 11.8%                    | 12.9%          | 18                                            | 5800                         |
| Innovative training model | 2011  | 47           | 100.0%              | 19.1%                    | 19.1%          | 42                                            | 7200                         |
|                       | 2012  | 53           | 98.1%               | 24.5%                    | 25.0%          | 48                                            | 7500                         |

#### Horizontal Contrast

In order to demonstrate the effectiveness of the innovative training mode further, we compared two majors (software engineering, computer science and technology) in that university of Hubei in 2011 and 2012. The professional nature of computer science and technology is pedagogical specialized field, and the training goal are teachers of information technology in primary and senior schools, therefore, the training mode has continued the traditional training mode of disciplinary knowledge systems. Similarly, the scores for the two college entrance examinations are basically about 10 points above the general undergraduate admission line in the province, and the faculty and staffs are also relatively stable. The output of teacher talents is relatively small, so it is also comparable and representative. We also set up some assessment and assessment projects such as employment rate, entrance examination rate, and provincial award rate (see Table 5 for details). Taking into account the different nature of the profession, there is no comparison of the top 100
software companies and their salaries. It can be found through the tabular data that after adopting an innovative application software talent training mode, each index occupies a great advantage over the traditional training mode of the curriculum knowledge system.

| Grade | Name of major                                  | Total number | Employment rate (%) | Provincial award rate (%) | PubMed rate (%) |
|-------|-----------------------------------------------|--------------|---------------------|--------------------------|-----------------|
| 2011's | Computer science and technology               | 18           | 94.4%               | 11.1%                    | 16.7%           |
|       | Software engineering                          | 47           | 100.0%              | 19.1%                    | 19.1%           |
| 2012’s | Computer science and technology               | 55           | 92.7%               | 10.9%                    | 12.7%           |
|       | Software engineering                          | 53           | 98.1%               | 24.5%                    | 25.0%           |

CONCLUSIONS

With the development of science and technology, software engineering has become a publicity card for universities in Hubei, which has become a key and popular specialty of the university. The innovative research on the applied software talent training mode has not only improved the teaching quality, but also cultivated a large number of applied talents adapted to the needs of society. The gradual maturity and improvement of this mode has also created a successful way for the reform of university education. It also has the significance of promotion and reference in the cultivation of other types of professionals in colleges and universities and in the process of teaching reform.

Although the training mode of applied software talents in a university in Hubei has achieved some successful experiences and achievements, it is only the “tip of the iceberg” of many reforms of the talent training mode. Computer software engineering is a discipline that closely follows the progress of the times. With the advancement of science and technology, the development of disciplines, how to adapt to the needs of development, to innovate better and better training modes, and to cultivate more applied talents adapted to the needs of society, it is still a long way to go to innovate personnel training and reform. Only by adhering to the principle of seeking truth from facts, advancing with the times, keeping up with the pace of development of the times, uphold the concept of popular entrepreneurship and innovation, and actively explore the talent cultivation mode in a spirit of reform to cultivate another group of highly qualified software talents.
REFERENCES

1. Huang Chao, Explore and Practice the Culture of Innovation and Entrepreneurship Computer Science Students --- Yulin Normal University [J]. Technology Information, 2013 (13): 164-165.
2. Jihui Shen. In 2015, the Internet Industry Was the Most Destitute, With Over 20% of IT Personnel Earning Over 10,000 Yuan OneMonth.[EB/OL].[2017-03-15].http://biz.zjol.com.cn/system/2015/02/13/020512035.shtml.
3. Lan Wang. Research on the Model of Innovation and Entrepreneurship Education for Computer Majors in Colleges [D]. Cheng Du: Southwest Jiao Tong University, 2011: 12.
4. Mingjin Ai. To Calculate the Thinking Ability of Curriculum Reform as the Core of the University Computer [J]. Computer Education, 2014: 5.
5. Weidong Liu. the Construction of Computer Professional Curriculum System for Developing System Ability [J]. Chinese University Teaching, 2014: 8.
6. Fuwen Hu. Research and Exploration of Laboratory Open Platform Construction Based on Maker Culture [J]. Experimental Technology and Management, 2015: 32.
7. Yujian Wang. Computer Science and Technology Professional Application Talents Training Model Reform [J]. Computer Education, 2015: 23.
8. Hua Jiang. The Construction of A Talented Personnel Training System for Information Management and Information System [J]. Computer Education, 2015: 3.