Research on the Cultivation Mode of Innovative Talents in Computer Science

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Abstract. In view of the current professional prevalence and advantages of the computer science and technology discipline, current education mode suffers from problems like declining social recognition and weak innovation. To tackle these problems, we put forward a new talent training model for cultivating innovation in the computer science discipline, as a way for educational reform and innovation. This paper discusses the cultivation of innovative talents in computer science from three aspects: constructing new innovative talent training mode, constructing new curriculum system and reforming the experiment teaching system.

Keywords: Innovative Talents, Cultivation Mode, Computer Science

1. INTRODUCTION

Computer science is a discipline formed and developed by a variety of techniques. It is a very technical and practical subject. On the other hand, computer science has seen fast development in more than half a century. Computer science has made significant impact on economy, military, business, entertainment, politics and among other walks of our society. In turn, developments in these areas have also profoundly advanced the computer science discipline. Therefore, how to cultivate innovative talents in the computer science discipline directly relates to social development.

From late 1980s and onwards, computer talent training in China has progressed from an off-peak period to a peak period. In the peak period, almost every tertiary educational institute has a computer science related major. At present, the computer science related professional is arguably the largest in all kinds of professionals. Because of the rapid development of computer techniques, students and parents tend to think this subject is difficult to learn. Meanwhile, due to its wide applications in non-computer professionals, there exists an urgent need of high quality computer professional personnel training. Therefore, how to strengthen the training of computer professionals, improve the innovative consciousness and practical ability of computer science students, has become imperative and is facing extremely difficult challenges. Facing the current professional prevalence in computer science and technology, the declining social recognition, weak innovation capacity and other issues, this paper presents a new training model of innovative talents in computer science, and analyzes it from four aspects: characteristics of the curriculum system, cooperation between industry and academy, practice and international cooperation. This paper also discusses and summarizes some practical experiences in cultivating innovative talents.

2. SHORTCOMINGS OF THE TRADITIONAL TRAINING MODE IN THE COMPUTER SCIENCE DISCIPLINE

With its extensive application and penetration, information and computer technology (ICT) has made profound impact on the world's economic and social development processes, triggering an unprecedented global industrial revolution. Information age brings urgent needs for a large number of high-level ICT professionals. It is estimated that the demand for ICT professionals increases by about one million per year nationwide. On August 19, 2004, at the seventh national Dean's forum of the computer science department held in Tsinghua University, it was agreed that quality of education in the computer science domain had decline considerably. Although the computer science major attracts a large number of good students with high university entrance exam scores every year, the educational quality has unfortunately declined year by year, and possible reasons include:

A. The Curriculum System Need to be Improved.

Computer technologies develop at an unparalleled speed. Capacities of the computer hardware double in less than 18 months. New programming languages, tools, frameworks come out constantly. The rapid development of computer science and technology requires us educational practitioners to include new knowledge units into our teaching and update teaching materials accordingly.

B. Training Objectives, Talent Positioning and

Social Needs Need to be Divorced.
Society requires computer students to have a solid foundation of knowledge, as well as strong learning capability and strong reasoning skills. Students should be capable of quickly solving problems unmet before and mastering new skills quickly. We should take this as the goal, so as to adapt to the rapid development of computer technologies. Meanwhile, limiting students to a certain professional area too early in their learning stage will limit their divergent thinking and the development of innovative ability. This will further narrow students' knowledge, decrease their learning ability, and in general an unclear talent positioning.
Undergraduate education in the computer science discipline should focus on combining application and research, with the major focus on applications, so that undergraduate students can not only engage in jobs in the industry, but also can pursuit further studies if necessary. As the student's career develops into a certain stage, professional and focused training can be performed based on students' interest, their expertise and the social demands. The implementation of this kind of targeted training can avoid the drawbacks of premature professional positioning.

C. Experimental Teaching and Practice Need to be Up-to-date.
Computer science is a highly applied subject, experimental and practical training courses have great importance in ICT education. Students can only master programming through writing programs themselves. Therefore, experimental teaching and practice constantly needs to be strengthened.

Teaching Methods Need to be Updated.
Teaching methods at the moment usually focus on explaining the theoretical knowledge. This usually results in a less interactive classroom: the interactions between teachers and students are usually not enough and this adversely impacts students' initiatives and enthusiasm.

3. EDUCATION NEEDS TO ADAPT TO THE REQUIREMENTS OF THE NEW ERA

According to the characteristics of the undergraduate institutions, based on the above analysis of the shortcomings of the traditional education model and on the principles and characteristics of talent development in general, it is widely believed that new requirements should be set for talent development so as to adapt to the new era of talent, quality and teaching.
First of all, high overall talent quality include an innovative spirit, strong practical capabilities and sustainable development capabilities. To obtain these skills, the education programs need to combine both science and humanity courses. Specifically, arranging courses on humanities or increasing teaching content in humanities helps to develop the talent's social capabilities. For example, as a computer professional, a person can integrate into the society nicely, and live peacefully with nature and others. Only when under such circumstances, will a person learn, work, and cooperate with others. Meanwhile, we need to strive to create an environment conducive to the implementation of innovative education. Focusing on developing innovative thinking skills and capabilities, a platform can be built to cultivate such skills and capabilities and facilitate students' growth and professional development.
Secondly, a comprehensive view of education quality should seamlessly integrate the three elements: knowledge, capability and personal quality. Undergraduate education in computer science should focus on combining application and research, with a major focus on the applications, so that students when graduate can well engaged in working in the industry, as well as can pursuit further studies when needed. This requires knowledge, capability and information literacy. Knowledge refers to the basic theoretical knowledge and expertise needed to form a highly skilled person. Capability refers to using a variety of knowledge and skills to solve practical problems in the field. Personal quality include good moral character, strong professional ethics, as well as a healthy mind and a healthy body. Accordingly, two problems need to be solved: Firstly, knowledge, capabilities and personal quality must come from the front line of practices, so as to meet the needs of the community and industry. Secondly, personal quality education needs to be strengthened. Teachers need to provide in their own courses the innovative content, quality education ideas and specific training focus.
Finally, we need to implement the transform from pure knowledge-based education to the education of both knowledge and cognition, from pure skill-based education to focus on the comprehensive professional capability and innovation capability. Impact of the amount of knowledge on the success of a person is getting increasingly smaller, cognitive capability increase to play a decisive role. Students need to be good at learning, thinking, analyzing and solving problems. Therefore, teaching needs to focus on developing students' self-learning ability and their sustainable development ability.

4.BUILD A NEW INNOVATIVE TALENT DEVELOPMENT MODEL

Considering the general characteristics of undergraduate programs, in face of the shortcomings of the traditional talent development in computer science, we have analyzed the knowledge structure, professional competence, personal quality of computer professionals and the training objectives. Based on the overall training objective of sound foundation, extensive employment and sophisticated

expertise, we proposed a three-stage development model for personalized education.

The first stage is the first and second year. In these years, basic courses in computer science and general disciplines, and interdisciplinary courses should be provided to broaden students' basic knowledge. By combining science and humanity courses, students' overall personal quality are developed.

The second stage is the third year. Based on the first two years of basic knowledge learning, the first diversion from basic courses to professional courses will occur. Students' professional knowledge will be further expanded. The third stage happens in the fourth year. Students choose their future career directions. At present, for computer science and technology graduates, the possible career directions include computer applications, software engineering, network engineering, information security and so on. Before graduating, students usually undergo specialized training according to their career choices. When graduated, students usually have two kinds of choices, working in the industry or entering postgraduate education, corresponding to theoretical research and engineering technology in general.

A. Engineering Technology.

Professional directions that are related the computer science and technology major can be categorized into three areas in general: computer applications, software engineering and security. Computer application includes database technology, multimedia technology, computer control and intelligent information processing. Software engineering includes software project management, software engineering, and software testing technology. Security-related direction include network and communications security, computer security, and cryptography theory and technology.

B. Theoretical Research.

Usually only students with good undergraduate performances will apply and be admitted to further postgraduate studies, and to pursuit theoretical research. For these student, they usually have acquired the basic knowledge in computer science, and usually also have good command of one foreign language. Through postgraduate training, they will become specialized talent in a certain direction. Therefore, courses for these students should firstly be elective, so that students can choose according to their own professional directions. Students can also choose an appropriate topic for their final graduation project, according to their choice of professional directions. Instructors can arrange courses from different disciplines to provide personalized developing programs to different students.

Accordingly, we propose a talent training model based on reforming the current curriculum system and the experiment teaching system.

5. REFORMING THE CURRENT CURRICULUM SYSTEM

A. Set Up a Dynamic Curriculum System with the Principles of Talent Development.

The rapid development of computer science and technology requires new knowledge units being introduced into teaching in a timely manner. The curriculum system should reflect advancements in applications and research. With the development of MOOC courses, shared teaching materials is increasing at an unprecedented speed. This facilitates traditional in-classroom teaching in that teachers can easily keep track and incorporate new technology advancements into their classroom teaching.

B. Set up a Curriculum System with the Principle of Openness.

Computer education should be oriented to the world, so as to cope with the future development of science and technology and the trend of global economic integration. International perspective of the teaching personnel is increasingly important, for teachers to participate in international competitions and for students to have an international viewpoint. In the curriculum system, teaching methods, teaching materials, and many other aspects should also be kept up-to-date, so as to reflect the developments in computer science and technology worldwide.

C. Establish Bilingual Courses.

Inadequate communication skills is also an important factor that hinders students' professional development. Especially for computer science, many advancements have been in the English language. Therefore, strengthening English teaching in university courses and developing students' capability of applying English language skills has great importance to improve education quality in the computer science discipline.

D. Develop Training Courses that Combines Theory and Practices.

To strengthen the basic theory, it is necessary to open enough core courses so as to ensure that the depth and breadth of teaching content. Meanwhile, it is also important to emphasize developing students' practical capabilities. This cannot be accomplished by the experimental classes alone, in contrast, we should combine both theoretical and experimental teaching. For example, course projects, course reports, case studies can all become valid and valuable forms of teaching.

E. Revise Teaching Plans and Syllabuses Constantly.

Not only the faculty in university, but also practitioners in the business community can participate in the design, development and revision of the teaching plans, teaching syllabus, and teaching content. One advantage is that the teaching content can closely follow the forefront of technology development worldwide, as a way of keeping close contact with applications and practices.

6. REFORM THE EXPERIMENT TEACHING SYSTEM

In view of the new mode of talent development, we need to make an appropriate arrangement of the experimental courses and projects, together with other teaching environments, so as to adapt to the characteristics of the curriculum system.

A. Build Experiment Teaching System.

We can construct the experiment teaching system from four levels: the basic level, the analytical level, the comprehensive level and the innovative level. These levels reflect different requirements of professional directions. The teaching system should be applicable to different professional directions, different grades and different courses. Through this system, students' experimental design capability and innovation capability should be improved, so as their engineering consciousness and team spirit.

B. Improve the Content of Experiment Courses.

Following the "Basic Requirements of Teaching Computer Courses" developed by the Computer Course Teaching Steering Committee of the Ministry of Education, it is necessary to emphasize the cultivation of practical application capabilities. In combination with the new experimental teaching mode and the actual situation of our school, the following approaches can be taken: increase the proportion of experiments in normal courses; add more optional experiments for students with good command of course content; and include more cases in both classroom teaching and experiments.

C. Construct Innovative Materials for Experiment Teaching.

This mainly refers to the experiment manuals or tutorials. For example, one can incorporate the open teaching materials in the national and international award-winning coerces. On the other hand, measures can be taken to encourage and reward teachers who achieved outstanding results in reforming the current teaching methods and systems.

D. Create A New Type of Experimental Guidance.

In the traditional experiment classes, students usually need to complete an experiment in a specified period of time, and the subject of the experiment is designated. We need to allow and encourage students to do simple experiments, or change the order of the experiment projects, or to choose or design new experimental projects.

CONCLUSION

The reform of curriculum content and teaching model has become an inevitable requirement and trend of cultivating innovative talents of computer science at present. With the development of science and technology, the course content should always be adjusted accordingly, while reforming the traditional teaching mode in order to lay a good foundation for cultivating innovative talents for computer science.

ACKNOWLEDGEMENTS

Fund Project: This study was funded by Yangtze University's Teaching Research Funding (No. JY2014032) and Young Scholar Funding (No. 2015cqn52).

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