Innovation Practice and Ability Cultivation of Software Engineering Professional Competition under the Background of Emerging Engineer

Xiu-jun ZHANG and Li LI

School of Information Science and Engineer, Chengdu University, Chengdu 610106, China

*Corresponding author

Keywords: Emerging engineer, Software engineering, Competition, Innovation, Ability.

Abstract. In this paper, it briefly summarizes the source of emerging engineer and the ability that shall be equipped by graduates of emerging engineer; meanwhile, starting from the angle of the frontline teachers, it gives the guidance opinions for competition innovation practice under the background of emerging engineer for the major of software engineering, and highlights cross-disciplinary teams, creative mining, and practical software project development management process conforming to undergraduate students under the background of emerging engineer. Moreover, in this paper, it further analyzes and summarizes the cultivation effects of competition innovation practice on nine abilities which can be reached by the students who major in software engineering of the emerging engineer.

Introduction

Nowadays, the development of technology leads to the emergence of the new industry. For adapting to the needs of the new-type technology industry’s development, China puts forward the innovation driven development strategy. On May 19, 2015, the State Council officially printed and issued Made in China 2025 Strategy, and put forward the basic guidelines of innovation driven and talent first. [1] The higher education starts from the point of actively adapting to the technology development and industrial reform and supporting and serving the innovation driven development strategy of the country, the Ministry of Education put forward the research and practice of emerging engineer in 2017, so as to solve the problems of lack of inter-disciplinary talents, a new generation of information technology industry talents as well as high-level talents. In February 2017, the Seminar on Development Strategy of Higher Engineering Education organized by the Ministry of Education was held in Fudan University, forming the “Fudan consensus”. In April 2017, the Ministry of Education held Seminar on Emerging engineer Construction in Tianjin University, forming the action route of emerging engineer construction (“The action of Tianjin University”).

In a timely manner, the major of software engineering is constructed serving as the major of emerging engineer. As the big data, cloud computing, “Internet+”, artificial intelligence (AI) and virtual reality (VR) as well as other technologies develop, the corresponding emerging industries put forward new demands on the professional talents of the major of software engineering. The development and emerging of new technology and new industry put forward a clear requirement on the knowledge and ability of students, however, the cultivation of talents is not simply the cultivation of knowledge, and it shall make the university graduates possess with the ability of adapting to the technology changes and industrial changes. Wang Guilin et al. put forward that the students who major in emerging engineer shall equip with ten abilities including complex engineering problem solving ability, multiple disciplinary teamwork ability, innovation and entrepreneurship ability, dynamic adaptation ability, engineering leadership, as well as global competence and so on. [2] Long Fenjie et al. put forward that the students who major in emerging engineer shall equip with the abilities such as engineering thinking ability, cooperative learning ability, cross-border integration ability, integrated innovation ability, internet thinking ability, ethical thinking ability, global thinking ability, as well as lifelong learning ability.
In this paper, starting from the angle of front-line teachers, it reviews the requirements on students’ ability of the major of software engineering under the background of the emerging engineer, summarizes the experience in the practice of all kinds of innovation and entrepreneurship competitions, presents the methods of the competition innovation practice, specifically narrates the promotion effects of the discipline competition on cultivation of the ability of students who major in software engineering under the background of emerging engineer, and puts forward and analyzes nine ability cultivation effects.

**Innovation Practice of Software Engineering Competition**

The competition innovation practice takes the students who major in software engineering as the main objects, and highlights cross-disciplinary teams, creative mining, and practical software project development management process conforming to undergraduate students under the background of emerging engineer. Through these practices, the software engineering project team can conduct the development work of competition project smoothly.

**Trans-disciplinary Team Forming**

When the major of software engineering joins into the competition projects, team members shall allocate according to the project needs. The team scale shall be controlled under 10 persons, generally including art designer, front-end and back-end developers, as well as mobile phone APP development personnel. The developers of database can be served by the back-end developers. As for the projects involving into the intelligent hardware, it needs to match with the students who major in electronic engineering. However, if we apply the projects into the specific industries, it also demands the students at the corresponding industry majors to join in, and for example, the medical projects shall allocate the students from medical college. As for the entrepreneurship projects, it shall also allocate the students who major in business.

**Digging the Creativity Deeply**

The creativity process of the competition projects is very important. The creativity put forward by the student needs to be polished and refined in 1 to 2 months generally. It is mainly because that the insufficient experience and narrow horizon of student cause that the creativity put forward by the students is realized usually. Therefore, the repeated process of “put forward creativity—rejection of self-criticism—put forward the new creativity” is formed. This process demands the advisers to constantly encourage students, reduces students’ sense of failure and makes students recognize this is a very hard-won training process.

**Management of Development Process**

When the students who major in software engineering join into the competition projects, the students are usually from sophomore year, and the junior students are very rare, which caused that students have the possibility of failing in completing the course of Software Engineering, and even failing in completing the necessary software development language courses. Therefore, a new requirement is put forward for the engineering management of the advisers. In the process of project development, it suggests the team to complete the project original hand sketch at first, including all interfaces of front-end and back-end of WEB and interfaces of mobile phone APP. After the review is passed, the labor is divided to each student to draw the interface sketch again with the tool of VISIO. At this time, the sketch shall be refined to each interface, and it cannot be generalized. There are even more than 100 sketches for a mobile phone APP interface. The major reason why the sketch can be so detailed is that students still have not established the software engineering and product philosophy, and by this method, it can effectively promote students’ unified recognition on the projects, reduce communication errors and improve the communication efficiency. After the review is passed, the art design student shall draw the first WEB and mobile phone APP interface with PS, determining the element styles and hue of the interface. After reviewing again, the art design student can conduct PS
work of all interfaces if it confirmed there are no problems, and when one front-end interface of WEB shows, the cutting is conducted and it will be handed over to the front-end students for front-end development. The back-end development students conduct the design on database according to the reviewed VISIO interface chart. After the design results are reviewed and passed the review, the back-end development students can instantiate and encapsulate all databases. While after the front-end personnel completes one interface, the back-end development personnel can complete the development work of the intermediate business process. In this way, it can realize software project small-scale parallelization and pipelining work, and meanwhile, guarantee that there are no big mistakes in the development process. See details in Fig. 1.

**Figure 1. Simple development procedure.**

**Team Construction**

After the competition team is organized, it determined the good creativity and solved the problem that the development management process cannot guarantee the team to run steadily, and it still needs a certain team construction. The goal of team construction needs to reach the transfer from strange to tacit agreement among team members, and eliminate the behavioral and cultural recognition conflicts caused because of life experience and life habits. The team construction can be conducted by the extracurricular activities of the team, eliminating the sense of strange at first. By enhancing the communication of spare time life, it further improves the familiarity among them.

**Training on Software Engineering Competition Ability**

By the software engineering competition innovation practice, it can make students put into the competition project with all their heart. After the training of the competition projects, the team students can reach the requirements of nine abilities demanded by the emerging engineer, respectively including ability of creative thinking, global thinking ability, dynamic adaptability, work cooperation ability, trans-disciplinary cooperation ability, cooperative learning (team learning) ability, ethical thinking ability, communication and exchange ability as well as document writing ability.

**Innovative Thinking and Global Thinking**

The discipline competition specially highlights the review of innovation points, and therefore, the competition projects are the natural platform for the training of innovation thinking ability of students. The projects can originate from the scientific research of teachers, corporate demands as well as students’ self-discovery. We recommend more that students find out problems in life and conduct the design on projects, which can better stimulate students’ study motivation. In the process of creativity, it needs students to check mass data and conduct self-criticism and constant improvement. In 2016, the student team considered that the intelligent hardware can realize the mobile phone’s switch control on the bicycle lock, and after checking the documents in inner and foreign countries, the student team considered that China does not have the similar business, and foreign countries only have the intelligent bicycle lock of personal use, and therefore, after the creativity analysis, it launches the project “CO-LOCKER”, and in the end, it found that OFO bicycle
enters into the campus in the design development process. It makes students profoundly recognize the
importance of the innovative thinking. In 2017, the project of “intelligent eyes” gained the first prize
of special prize of “Lanqiao Cup” team competition in 2018, and this project also originated from that
students found out problems in life and solved the problem of dead zone when the truck makes a turn.
For the project, when it was denied in the earlier stage of launching, the student team presented a set
of better solutions, and in the end, the solutions were widely recognized by judges. The process of
creativity of this project lasted for more than 2 months, and it reached the goal of innovative thinking
training and improved the innovative thinking ability of students.

The global thinking ability demands students’ creativity projects to face to the whole world, instead
of only facing to China domestic. It can find out problems at both home and abroad, find out solutions
and serve the markets at both home and abroad. Meanwhile, it demands students to equip with the
international competitive awareness, the creativity design shall be equipped with the international
view and the competitive analysis shall in the same way. During the SWOT analysis process of the
project, it can realize the training process of the global thinking.

**Dynamic Adaptability**

Dynamic adaptability puts forward a higher requirement on students’ ability of finding out problems
and solving problems. We know that Codoon Sport is the pioneer and forerunner of intelligent
activities. In 2011, MIUI smart mobile phone started to popularize among students because of its
marketing means and high cost performance, while student team found out that the combination of
acceleration sensor of smart mobile phone and GPS can be used for personal state of sports after
repeat creative digging and brainstorming, and therefore, the project of “colorful sports” was
launched. During the development process of the project, the team members suddenly reported that
Chengdu’s Codoon Sport gained a grand financing of RMB 20 million. At that time, we found that the
thing we were doing was done by others, and therefore, it is obvious that the project creativity is
insufficient. Therefore, it suggests the team to compare both the advantages and disadvantages of
them, and see what else that Codoon Sport has not engaged in, and soon, the team found that Codoon
Sport didn’t get involved into the sports social contact, and the team project introduces the sports
social contact elements on the original basis. In the end, the project won the national second prize in
China college student service outsourcing innovation and entrepreneurship competition in 2012.

**Division of Labor and Interdisciplinary Collaboration Ability**

The development of a software project involves into the development of front-end and back-end of
WEB, mobile phone APP development, database development, art interface design, and also
including requirement document, general design and detailed design document writing. Under the
situation that the student team personnel resources are limited, it needs the students to realize the
division of labor and coordination of the project. The art design students draw the interface chart
according to the requirement documents and send to the front-end and mobile phone APP
development students, the database developers conduct the database physical design and realization
according to preliminary design document, the back-end developers instantiate the database, and
break through the data interaction process between WEB front-end and database, and complete the
overall realization of the project. The whole process has a high requirement on students’ division of
labor and coordination, and the development procedure and input and output interfaces shall be
closely cooperated.

Under the development of “Internet+” and intelligent hardware and software technology, a project
needs to be supported by both software and hardware in the meantime. While each competition
project is associated with different subjects, and therefore, it is insufficient with only the knowledge
of software development. For example, if it needs to provide the mechanical arms for the handicapped
person, it needs the involvement of multiple disciplinary such as medicine, mechanical engineering,
electronic engineering as well as software. Of course, it puts forwards higher requirements on the
teamwork. In 2018, when Huawei mate20 was issued, one app that automatically identifies the
calories of a food by taking a picture was particularly notable. In 2013, the student team wanted to calculate the Calorie content of the foods in virtue of the mobile phone recognition function, naming it as “Shipai” (food photography). This project demands the professional technology of AI artificial intelligence image recognition, and for allowing the application to support patients of weight loss and diabetes and other diseases, it also demands the professional knowledge of medicine. Therefore, the project team members actively sought for the supports from the related teachers and invited the students of the medical college to join in the team. They all reached the requirements of trans-disciplinary collaboration training.

Cooperative Learning

Long Fenjie indicated that the traditional learning mode will reduce the learning interests of the students with middle and low grades, and the learning companions become exclusive mutually. While cooperative learning can solve this problem. Cooperative learning can also be understood as team learning. Cooperative learning can make students supplement each other and progress jointly. Oriented by project problems, when a member encountered problems, the whole team has problems. The student team divides labor and cooperates in terms of a common project, from putting forward of the concept to the realization of the design, it demands each team member to handle their own work well. However, not everyone are the masters of technology, thus the team members need to study from each other and realize the promotion of the overall strength of the team. Meanwhile, the individual knowledge is the team knowledge, the students who mater the knowledge are also very willing to share their knowledge, so as to guarantee the project to proceed normally and avoid the rejection of learning companions.

Ethical Thinking Ability

The ethical thinking ability demands students to possess the ability of judging whether a behavior conforms to the legal restraint and moral standard, so as to guarantee that students’ value judgment and behaviors after graduation are not offset. It seems to belong to the contents of the ideological and political fields in colleges and universities, but it is also the responsibilities of every teacher. A graduate of our university was under arrest for hacking government websites inspired by the senior executive of the company during internship period, it caused that the student determined and promised that he will never involve into the network safety industry. This case proved the importance of the ethical thinking ability of graduates of emerging engineer again. In 2015, the student team planned to initiate a project after creativity digging, allowing the participants to purchase an expensive commodity with only few money, and this project is named “Ping Gou” (group buying). After the project was put forward, as the adviser, the author considered that the project has the nature of private lottery and it may violate the law, so the author advised the students to consult the teachers and students of law major of the school. Although this project was launched eventually, the legal consultation process in the earlier stage also benefited the students a lot, making students fully recognize where is their behavior bottom line.

Communication and Document Writing Ability

The competition project team is combined by many people with division of work and cooperation, and it demands constant communication and exchange. The major difficulty of the project management is communication. For realizing the unified project goal, the whole team members have to communicate and exchange frequently. While effective communication and exchange abilities are not innate by every student, but are constantly honed in the project. Communication and exchange can happen in both project seminar and coordination of project development process. The software project of engineering management will generate large amounts of documents, including the unified picture of project from rough to meticulous, namely, demand analysis document, preliminary design document, and detailed design document; also including the risk analysis document, all kinds of schedule documents, test cases as well as test reports which are
demanded for realizing the project control; the deploy and training documents and so on for project delivery. Meanwhile, engineering software project documents are also an important means to realize the effective communication. The document writing ability is the basic quality of university graduates. The competition team members realize the improvement of the document basic editing ability by the output of the project documents and also realize the improvement of the software engineering document writing ability. Comparing to the students who complete this training process via the Senior Graduation Design, the communication and exchange and document writing ability of project team members are much stronger.

**Conclusion**

As a comprehensive training platform of the students majored in software engineering under the background of emerging engineer, discipline competition has an indispensable status. In this paper, starting from the angle of the frontline teachers, it presents the guidance opinions on the competition creation practice of the major of software engineering under the background of emerging engineer, and highlights cross-disciplinary teams, creative mining, and practical software project development management process conforming to undergraduate students under the background of emerging engineer. Moreover, in this paper, it further analyzes and summarizes the cultivation effects of competition innovation practice on nine abilities which can be reached by the students who major in software engineering of the emerging engineer.

**Acknowledgement**

This research was financially supported by the Soft Scientific Research Foundation of Science and Technology Bureau of Chengdu (Grant No. 2017-RK00-00061-ZF) and the Higher Education Personnel Training Quality and Teaching Reform Projects in Sichuan Province from 2018 to 2020 (Grant No. JG2018-774 ). The first batch of cooperative education projects between industry and University of the Ministry of Education in 2018 “Construction of Innovative Platform for Collaborative Education between Industry and University at School Level” (201801193140) and “Chengdu University Chenglong Valley B Area "HuiZhiyun" University Innovation and Entrepreneurship Education Management Cloud Platform Construction Project”(201801200044).

**References**

[1] Z. G. Deng, X. L. Li, Y. J. Shen, Research on the Construction Scheme of Automobile Professional Groups under the Background of "Made in China 2025": Central South University Press, Chang Sha, 2016.04, pp. 7.

[2] G. L. Wang, J. C. Lin, X. G. Hu, Exploration of ICT Personnel Training Path in Emerging Engineering under the Integration of Industry and Education [J]. Chinese University Science & Technology, 05(2019) 41-45.

[3] F. J. Long, F. Shao, New Ability of Emerging Engineering Talents and the Training Practice [J]. Research on Higher Engineering Education, 2018(05):35-40.

[4] T. Wang, The Concept and Implementation of Cooperative Learning, China Personnel Publishing House, Beijing, 2003, pp. 28-32.

[5] X. Wang, S. Q. Bai, From Ideas to Practice: Teaching Model for “The Development of Cooperative Learning Competence”, China Higher Education Research, 06(2014), pp. 102-106.

[6] D. H. Zhong, Connotations and Actions for Establishing the Emerging Engineering Education, Research on Higher Engineering Education, 03(2017), pp. 1-6.