

Cultivating Innovative & Entrepreneurial Ability of Computer Majors Students in Local Colleges and Universities - Three-Stages Incentive Iteration Method

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Abstract—Aiming at the construction of innovation and entrepreneurial team of college students, this paper proposes to train the innovation and entrepreneurial ability of college students based on the project-driven "Three-Stages Incentive Iteration Method". It divides college students' in-school time into three stages: early stage, middle stage and later stage, corresponding to three goals and tasks such as stimulating innovation and entrepreneurial consciousness, training innovation and entrepreneurial ability, and practicing innovation and entrepreneurial projects, and form a gain iterative loop so as to constantly stimulate college students to keep innovation and entrepreneurial passion as well as constantly improve their abilities.

Keywords—Innovation and entrepreneurial education; Three-stages incentive; College student team; Project-driven

I. INTRODUCTION

It is an important duty for colleges and universities to train and create innovation and entrepreneurial talents. The training of innovation and entrepreneurial ability of college students is not only the direction of teaching reform, but also a difficult problem. To this end, the state encourages colleges and universities to carry out relevant research and exploration, and ensure that such research and exploration are implemented [1] through "Quality Engineering" and other measures. "Excellent Engineer Education and Training Program", and "Engineering Education Certification" both require us to reform the talent training mode [2-5], so as to train the college students in the core ability of solving "complex engineering problems".

School of Computer and Software Engineering of Xihua University (hereinafter referred to as the School) has started the construction work of innovation and entrepreneurial team of college students since 2009. The two majors "Computer Science and Technology" and "Software Engineering" of the School were selected in the "Excellence Program" Major List of Sichuan Provincial Department of Education successively in 2012 and in 2014. The School's practice experience of these years shows that the construction of innovation and entrepreneurial team of college students has a great significance for training innovation and entrepreneurial talents.

The School takes the implementation of "Innovation and Entrepreneurial Team Training Program" (referred to as "Training Program") as the breakthrough, the "Complex Engineering Problems" project development as the drive, the "Three-Stages Incentive Iteration Method" as the way and the students' innovation and entrepreneurial ability as the goal; carries on the complete, long-term training for the students; trains the students for innovation thinking, innovation design and innovation realization ability in solving "Complex Engineering Problems". The School's leadership and instructor team have explored and summarized the experience continuously, and formed an effective management mechanism of the School, and issued relevant policies such as the Construction and Implementation Program for Undergraduate Innovation and Entrepreneurial Team, Performance Assessment Methods for Undergraduate Team Mentors and so on, to ensure the sustainable development of student team and mentor team institutionally. Based on the core of strengthening engineering practice ability, engineering design ability and engineering innovation ability, the main contents are to promote student-centered learning methods and strengthen innovation ability and comprehensive application ability training; its purpose and significance are: to explore and establish a two-way (teachers and students) active interactive innovation and entrepreneurial talent training mechanism based on long-term and complete "complex engineering project" R & D.

II. THREE-STAGES INCENTIVE ITERATION METHOD

This paper proposes the training methods and processes of "Three-Stages Incentive Iteration Method" shown in Figure 1. The whole training process (it's a process throughout the students' four years in school, rather than a short-term project) is divided into three stages in time, namely consciousness stimulation, ability training and project practice; in training connotation, the three stages constitute an iterative loop; as for each iteration, the follow-up stage is the "incentive" of the current stage, so that its connotation obtains gain and sublimation. Consciousness stimulation stage takes project achievements as a case and emphasizes the foundation of knowledge and ability; ability training and project practice

stages also continuously stimulate innovative thinking and entrepreneurial consciousness; ability is the basis for project research and development, and project research and development conversely promotes ability enhancement.



Fig. 1. "Three-Stages Incentive Iteration Method" Training Flow

At the early stage, stimulate innovation and entrepreneurial consciousness. Relying on a number of student team laboratories, let freshmen get in the training environment of "making the old help the new, promoting together", and accept the edification of the thought of "teamwork and pursuit of excellence"; employ senior executives, technical experts, well-known makers to teach the prospects and value of new products and new systems in School, and stimulate the students' early consciousness of innovation and entrepreneurial.

At the middle stage, to train innovation and entrepreneurial ability. Train six kinds of abilities based on the project research and development: investigation and research ability, innovation and conception ability, autonomous learning ability, comprehensive application ability, teamwork ability and expression and communication, to realize the student-centered learning style.

At the later stage, to practice innovation and entrepreneurial projects. Guide students to set up companies and undertake actual projects. At this stage, start-up companies and entrepreneurial talents gradually mature and emerge, specifically shown in company landing, competition winners, publishing papers and patents. It perfects the student knowledge structure and solves the integration of multi-subject knowledge better.

III. IMPLEMENTATION OF TRAINING PROJECTS

A. To Train Students' Innovation and Entrepreneurial Consciousness at the Early stage, and Conduct Training Based on "Team + Project"

The School has built a number of innovative and entrepreneurial laboratories and workroom equipped with advanced experimental equipment and laboratory personnel by using various types of construction funds. The school has the necessary hardware and software equipment and infrastructure for carrying out project training.

In the "fresh year", it sets up innovation and entrepreneurial courses such as New Technology and Innovation Guidance, and invites experts, professors and enterprise project directors inside and outside the school in the form of lectures to explain hot topics and cutting-edge technologies in all directions of this major as well as their application field, system or products, market prospect, potential value, etc.; invites excellent alumni

and entrepreneurial upperclassmen to introduce successful experiences and spiritual journey, etc. Its purpose is to stimulate students to have the impulse of innovation and entrepreneurship as well as the enthusiasm of studying and exploration in the early stage of university, and it's very helpful to the establishment of students' learning goal and the follow-up course learning. At the end of the course, students are required to form a team (3-5 people) with a clear role and division of labor to complete a new system innovation thinking (just a thinking, not involved in the specific implementation technology) in a professional emphasis such as mobile internet application, virtual reality technology, game development, computer vision and other fields, as well as write a course essay and evaluate the course results accordingly. Its purpose is to enable students to experience innovation process as soon as possible, stimulate innovation consciousness, initially taste the fun of exploring problems and successful conception and make students gain the sense of achievement. The School will select or reorganize these teams, equip with mentors inside and outside the School, conduct project application and approval, as well as make them enter the team laboratory and workroom based on projects.

In this training stage, it allows students to enter the training environment of "making the old help the new, promoting together" in lower grades, carries out the project research and development training (lasting for 7 semesters, entering the team in the 2nd semester, and making project conclusion in the 8th semester), accepts the influence of the thought "teamwork, pursuit of excellence", and stimulates students' innovation and entrepreneurial consciousness and passion at the early stage.

B. Training Project Design and Final Report

1) Project design and mentor selection

- For the complex engineering issues, the design of innovation and entrepreneurial training programs must meet the following requirements:
- Hot technology + cutting-edge technology + complex engineering system research and development (non-low-level, low level).
- Mentor project + checking of the School + selecting mentor (introducing competition mechanism).

2) Project conclusion and credit recognition

- Student R&D papers ≥ 1 article / team, core and the above papers are rewarded additionally.
- Software copyrights and above patents ≥ 1 item / team, additionally awarded according to patent level.
- Discipline competition has won second prize at the provincial level and above ≥ 1 item / team, additionally awarded according to award-winning level.
- All documents submitted for project development / operation include software and hardware systems.

Credit recognition: to determine the relevant course grades according to the level and quantity of students' achievements.

C. "Six abilities" Cultivating

According to the actual situation of college students, the training plan proposes to train students' six abilities for facing the complex engineering problems, namely research ability, innovation ability, learning ability, application ability, collaboration ability and expression ability. Take the project of "Developing the Virtual Reality System for Showing the History and Culture of the Three Kingdoms of Wuhou Temple in Chengdu" (hereinafter referred to as "Wuhou Temple Project") as an example to discuss how to train the students' six abilities.

1) Cultivate research ability

After accepting the project development tasks, the student team will firstly conduct market research and technical research for "Wuhou Temple Project". The market research task is to research market value, product prospect, target customers, potential users, social impact, public welfare value, and write market research reports; Technology research task is to investigate the technical feasibility, including development cycle and development cost estimate, etc., as well as write technical feasibility analysis reports; of which includes looking up technical information, independently studying research materials and other links. Based on the research situations, students may submit a new project application and can change the project only after being reviewed by the School.

2) Cultivate innovative ability

Mr. Li Zhengdao once said: "Being able to ask a question correctly is the first step toward innovation." No problem, no thought; only having good innovative ideas can have good innovative design and innovative system.

Proposed by American creative scientist A.F. Osborne, the "brainstorming method" is an important creative technique. In order to obtain the innovative ideas of the system, the instructors are required to arrange "brainstorming" seminars within the team for many times in the Semester Guidance Plan, carry out unrestricted free association and discussion, and repeatedly conducting the innovative conception process of "questioning - modifying - re-questioning - re-modifying", to generate new ideas, stimulate new ideas and improve the quality of group decision-making. For the case of "Wuhou Temple System", if the idea is designed to be a "virtual tour guide system," it will lack creativity, besides the technology to achieve is relative simple, making it lack the essential characteristics of "complex engineering problems." After many "brainstorming" within the team, the idea was changed to write a number of classic and vivid historical stories to present the magnificent and thrilling historical picture in the history of China with a number of dynamic three-dimensional scenes with dynamic changes, which takes the plot and scene reappearance as the guiding mean, thus the users' senses of presence, history, immersion, and participation will be greatly enhanced; compared with users personally go to Wuhou Temple scene for visiting, such way is more vivid and more interesting. This innovative form of expression well reflects the combination of technology and art, as well as virtual reality beyond the reality of the soul. In 2014, the project was approved by Department of Education of Sichuan Province as an innovative training program (national level). In 2016, it won

the first prize and the Best Virtual Reality Design Award in the finals of the National Three-dimensional Digital Innovation Design Contest; meanwhile, the works were shown both on the official website and the official WeChat, and the experts made some comments on it.

3) Cultivate Learning Ability

To innovatively design and implementation the Wuhou Temple Project, it is necessary to learn new knowledge, new methods, new technologies such as the application of Unity3D, Unreal Engine, CryEngine and other large-scale commercial engines, high-precision rigid body modeling, real-time rendering of flexible body model, light and shade changes, real-time rendering, physics collisions, particle effects and other basic principles and development techniques. However these contents cannot be learned thoroughly only relying on classroom teaching, as some contents are not in the teaching plan. Therefore, the tutors not only need to reasonably arrange the study plans and contents of each stage, but also guide the students to learn independently. For tutors, the key point is to cultivate students' independent learning ability, rather than to replace the students to complete, to achieve the transformation from teacher-centered teaching mode to student-centered learning mode.

4) Cultivate Application Ability

In order to complete the comprehensive development of the case of "Wuhou Temple project" case, it is necessary to master a variety of advanced development tools and development technologies and apply them comprehensively, besides the multi-faceted knowledge and skills are required to be mastered. For example, in order to obtain good physical performance, the knowledge of light transmission, collision detection, fluid, image processing, 3D graphics, DX development technology and programming technology, etc. must be applied comprehensively, thus, the students' knowledge system can be perfected and their comprehensive ability to solve complex engineering systems can be developed.

5) Cultivate Collaboration Ability

Team collaboration ability is not only the professionalism of professional technical personnel, but also one of the necessary qualities that enterprises value. To complete project development by the means of team requires team members to collaborate. Through collaboration, students' ability to communicate and organize can be trained at the same time. In a team, there not only be collaboration, but also division, the members can play their own roles, such as project manager, modeling, procedures, testing, operation or maintenance etc.

6) Cultivate expressive ability

The student teams are required to conduct multiple periodic reports to fully exercise students' verbal, written and mathematical abilities. For some advanced technologies, the students need to purchase and learn foreign language materials to improve their foreign language reading ability. In addition, the original foreign language version of development tools are used, which can help to cultivate students' foreign language reading ability. The outstanding teams or individuals may be arranged to read foreign materials, and be encouraged to write foreign research papers, etc.

D. Experience Innovation and Entrepreneurship Process to Enhance Ability

Relying on the college students' innovation-entrepreneurship incubation base, the school has invited business executives, industry experts, and well-known makers to give guidance on the establishment of student start-up company, company operations, contract projects, and introducing their social resources to create more entrepreneurial opportunities, platforms, projects, etc. for students' teams, which can directly spawn the landing of student team companies and the actual projects.

The open of compulsory course "students science and technology innovation practice" is established in the teaching plan, requiring each student to join in the innovation or entrepreneurship team for project development, and the credit is awarded only after the project is completed. To this end, the college develops a Credit Determination Standard, covering student papers, patents, competition awards, professional qualifications, team projects, and self-employment and so on.

Arrange students with strong innovative awareness and ability to join in the laboratory of the postgraduates, and join the project R & D team of postgraduates' tutor to carry out scientific research and practical training, which is not only conducive to cultivating innovative thinking and ability of undergraduates, but is also conducive to the cultivation and management of college postgraduates reserve talents.

IV. CONCLUSION

Over the past few years, the college has set up more than 90 student project development teams (these projects were established by college with special mentors) and won the project of "Innovation and Entrepreneurship Training Program for Undergraduates" organized by the Department of Education of Sichuan Province for many years, incubated more than 20 start-up companies and more than 60 entrepreneurial talents. Representative Zhang Tianfu, who was nominated candidate of "Annual Figures of Chinese University Students in 2012", set

up the Chengdu Micro Interaction Technology Co., Ltd., undertook more than 20 projects when he was at school; Representative Yao Changhong, although he is crippled, he still led students to start the difficult road on innovation and entrepreneurship, initiated the establishment of Chengdu Blue Sky Technology Co., Ltd, as a result, he won the "Chinese University Students' New Oriental Self Strengthening Scholarship in 2010;". These achievements have a strong demonstration role in the students, which can promote low-grade students to spontaneously form development teams or studios, initiatively seek guidance from teachers. How commendable the enthusiasm is.

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