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Training of innovative IT talent based on engineer cultivation

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ABSTRACT: The practical abilities of information technology students at universities in China, especially application-oriented universities, are relatively weak. To address this, a new concept of practical education oriented to engineer cultivation was proposed. This concept of engineer *incubation* or *cultivation*, was applied to engineering and IT training. The model requires the reform of courses, establishment of a practical training system and teaching staff development. Experience has shown that this training model can resolve the so-called *last kilometre* problem of IT employment, i.e. to have all the skills required by an enterprise rather than just most of them. Hence, this provides an innovative training model for engineering IT training.

INTRODUCTION

In 2013, the output of the global IT (information technology) industry reached $180 trillion. Information technology has become the pillar of the global economy. But the shortage of IT professionals has become the biggest bottleneck restricting the development of the IT industry, especially, that of the software industry. Therefore, training a large number of IT engineering professionals is the top priority for the development of the IT industry. At present, IT professionals in China are mainly trained in higher education institutions. However, the undergraduate students training based on traditional elite discipline-oriented education cannot meet the demands of IT professionals.

To solve these problems, many higher professional colleges since 2005 have carried out university-enterprise co-operation programmes and proposed such training models as *order-oriented*, *professional+company*, *2+1* and *1+1+1* [1-3]. However, in China's universities, particularly in the application-oriented universities, there is little research on training models for IT majors involving engineer *incubation* (*cultivation*). Engineer cultivation requires that the university arranges training, so that the students obtain appropriate certificates, which can effectively solve, for student employment the *last kilometre* problem (that of gaining the right skills) [3].

STATUS QUO OF ENGINEERING IT TRAINING

The number of students in higher engineering education in China is the greatest in the world and China has become a country in which engineering education is well-developed [4]. To better promote engineering education, the Ministry of Education initiated the *Plan for Educating and Training Outstanding Engineers* and many universities have introduced the CDIO (Conceive - Design - Implement - Operate) engineering education and university-enterprise co-operative model [3][4].

However, in current IT education, there still exists a lack of diversity and a weakness in practical teaching. Moreover, teaching focuses on the theoretical and overlooks the practical aspect. As a result, students do not meet the demands of industry.

Education in information technology lags behind IT technology itself. The curricula favour theory over practice and application-oriented courses are few. Overall, the curricula are out of date and divorced from enterprise requirements. The teaching does not meet industrial demands and does not appropriately develop students. The solution is the *multi-function educational centre* to provide teaching and technological services. However, in practice, the educational infrastructure is poor and does not reflect the requirements of industry. Therefore, it is difficult for students to join enterprises. Enterprises donate equipment, but promote only their technology instead of cultivating talent to meet industrial demand.

Many teachers, instead of working in enterprises, directly move into higher education after graduation. The proportion of teachers with experience of working in enterprises or on large engineering projects is low. Such teachers can hardly undertake engineering teaching tasks according to the demands of the market. The co-operation between enterprises, universities and research institutes is lacking and enterprises take no account of the training of engineers [5].

To improve the teaching of IT majors in application-oriented undergraduate universities, the engineer cultivation training model has been designed, and is outlined in this article. The model addresses the demands of industry, outdated teaching methods and the need for improved practical teaching.

INCUBATION-ORIENTED TRAINING FOR ENGINEERING IT

Engineer Incubation and Curriculum Reform

Engineer incubation requires curriculum reform that reflects the diversity between enterprises and universities and the building of pilot schemes to establish the dual enterprise-university programme [6]. Co-cultivation combines practical engineering with teaching and can involve enterprises in *learning on a project* or *working and learning*.

Student exercitation in enterprises can improve their capacity for engineering applications. With their immersion in enterprise culture, students improve their professional abilities and employability. With co-cultivation, students can acquire engineering training in enterprises and engineering certification in class.

To reform the curriculum in line with the co-cultivation model, the co-operative enterprise should draw up the teaching plan and syllabus. The NC-MIMPS teaching method and the NC Education Transfer Plan are used [7], which should remove deficiencies, such as out-of-date teaching content.

The current curricula should be further reformed based on the changes in industry and training objectives. The function and requirements of each course should be clarified, with engineering features highlighted. The curricula should be integrated and re-organised to form course modules, so as to reduce repetition of content in different theoretical courses, and to focus on basic and specialty course clusters.

Teachers should upgrade the curriculum based upon technological developments in industry and enterprise demands. The teaching content should also reflect the research of the teachers.

In China, teaching materials in the *national-level excellent course* should be integrated and an excellent teaching resource library should be set up, so as to facilitate the sharing of quality education resources created by other universities. Incentive mechanisms should encourage teachers and students to study and develop quality education materials. Modules are developed according to the curriculum. Educational technology should be used to develop high quality teaching resources and students should be involved in teaching resource development.

With globalisation, enterprises attach more importance to professional technology qualification certificates and vocational certification. Therefore, part of the existing curriculum should be combined with mature industrial certification training courses, such as software engineering and network engineering; and academic education should be reformed to include advanced teaching methods.

Seminars, forums such as *Network Era and Telecommunicating Future*, and various academic lectures should be held to expand students' horizons and increase their interest in learning. Students' out of class time can be enriched with extracurricular scientific and technological activities. This also identifies and cultivates excellent talent.

Establishing an Incubation (Cultivation) System for Engineers

Practical training is the foundation for the incubation (cultivation) of engineers. Hence, it is necessary to promote the integration of enterprise-university research and strengthen practical training in universities [8]. Enterprise-like engineer training facilities should be set up in universities covering IT, telecommunications and networks; thus, introducing universities to an enterprise-mode operation.

This would promote the integration of enterprises and universities and explore new options from combining a university's engineering specialties with an enterprise's specialty. A comprehensive practical training base could change the loose relationship between university and enterprise, into a close relationship, which will have a great effect on teaching, scientific research and employment.

The innovative practical teaching system has four levels and five modules, with enterprise-university-research integration at its heart. The four levels are: the basic level, basic skill level, professional skill level and comprehensive training level. The five modules are: quality extension, experimental teaching, practical training, thesis design, and scientific research and innovation.

Building a High-level off-Campus Training Base

An off-campus practical training base should be developed by the university and enterprise based on the enterprise's technology, equipment, human resources and management. Engineering projects can be developed with the enterprise so as to introduce new knowledge, technology and methods in project implementation and practice into the practical training programmes.

According to the training plan, students should complete their practical training tasks in enterprises, with enterprise professionals providing guidance to the students. Thus, the off-campus practical training base connects IT-related majors with enterprises and the market. Finally, the content of the engineer certification examination will have been completed during the practical training process.

Teaching Staff with a Practical Engineering Background

Teachers should be *double-qualified* (academically and enterprise-experienced) to improve their capacity to guide students. Teachers need practical experience at enterprises or experience in practical training centres. They should have appropriate engineering qualifications and have the ability to independently guide students in practical training. New teachers should spend a term at a practical training centre and they should not be encumbered with teaching before they can instruct students' practical training [9].

The practical teaching should be strengthened by teachers co-operating with enterprises in research in related industrial fields. Engineering practice centres for teachers should be established at enterprises to serve as a base for enterprise-university-research co-operation. In the centre, the engineering capability of the teacher should promoted, singly and in groups, and stage by stage. Engineering education should promote double-qualified teacher-engineers.

Teachers should transit smoothly between scientific research and teaching and apply their scientific research knowledge to undergraduate teaching. This interaction between teaching and scientific research helps to overcome the phenomenon of the mutual exclusion and isolation between teaching and scientific research. Enterprises and universities should share resources, and co-operate to overcome prevalent problems between university scientific research and enterprise production.

The cultivation of young teachers should be emphasised, with the focus on improving teachers' scientific research ability. The profession should be promoted by enhancing its academic level.

AN INNOVATIVE TRAINING MODEL OF ENGINEER INCUBATION

Through reform of training oriented to engineer cultivation, students' overall quality and innovative capacity are improved, as well as the teaching and scientific research. Taking Shandong Institute of Business and Technology as an example, from 2008 to 2013, students in IT-related majors won the national-level first and third prizes in ITAT (Information Technology Application Training), the Shandong Provincial level first prize in the National Undergraduate Electronic Design Contest and third prize in the North China Division in the National Undergraduate Students Freescale Cup Intelligent Car Competition.

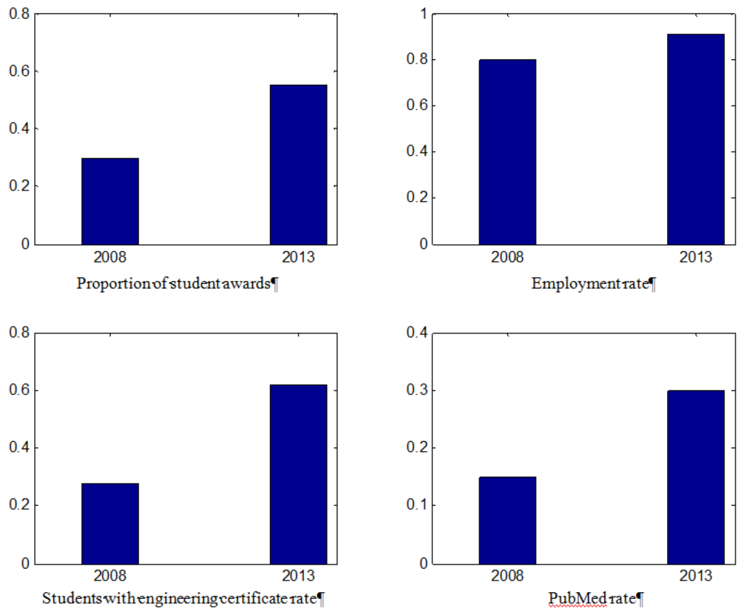

Figure 1: Engineering IT training model implementation results.

The graduate employment rate is more than 90%. Figure 1 shows the changes in the award rate, employment rate and success rate in examinations for postgraduates and the proportion of students with engineering certificates, from 2008 to 2013.

As shown in Figure 1, at the Shandong Institute of Business and Technology from 2008 to 2013, the proportion of students with certificates of engineering in IT-related majors rose from 25% to 68%. The certificates were for Network Engineer, Software Testing Engineer, Database Systems Engineer, SEO (search engine optimisation) Engineer, Exchange Engineer and Hardware Engineer. The awards rose from 28% to 55% and several were awarded the national-level first prize.

Successful entries into competitions have included the Wi-Fi mass balance eco-pods, Cola Mine Information System, Fishery Water Environment Monitoring and Early Warning Platform, and the Internet of Things (where objects are connected by network and can send and receive data), some of which have been productised. The employment rate went from 81% to 92% over the period and some students were employed by top enterprises, such as Huawei and ZTE Corporation.

Some students went into research and development after graduation. The success rate in examinations for postgraduates rose from 18% to 27% and some students were accepted by Peking University and other higher education institutions, including some in North America and Europe. Therefore, engineer cultivation has improved substantially the quality of training and positively impacted on outcomes.

CONCLUSIONS

Engineer cultivation in undergraduate education is the most effective way to meet the social demand for talent. It is also the most effective way to adapt to technological change in enterprises. Universities implement the education required to cultivate engineers, and the teaching content and methods are updated according to the demands of industry. Engineer certification is introduced to promote students' practical capabilities. Teachers and students strengthen their practical abilities to better meet the needs of society.

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REFERENCES

1. Cai, Y., Wei, H. and Yan, Z., Effects analysis and risk prevention of orders style training model. *Heilongjiang Educ.*, **1**, 51-54 (2014).
2. Ren, T. and Song, X., Practice of school-enterprise cooperation of IT majors based on *professional + companies*. *Chemical Vocational and Technical Educ.*, **04**, 10-13 (2011).
3. Guo, X., Running mode of *1-2-1* Sino-foreign cooperation and culture of internationally talents. *J. of Sichuan Normal University*, **03**, 101-105 (2007).
4. Liu, J., Revelation of German applied sciences university mode for the implementation of *outstanding engineer training scheme. China Higher Educ. Research*, **06**, 50-52 (2010).
5. Sun, Y., Chen, S. and Yang, Y., Realistic thinking and countermeasures resistance of promoting excellence in engineer hatch. *Research in Higher Educ. Project*, **05**, 40-45 (2011).
6. Wang, C. and Zhang, J., Exploration and practice of implementation of *double certificates* system in colleges. *China Electric Power Educ.*, **300**, 9-10 (2014).
7. Yang, Q., Research of MIMPS pedagogy based on Engineering Binding Mode. *China Electric Power Educ.*, **125**, 57-59 (2008).
8. Hou, X., Liu, H. and Xu, Y., Productive campus training base construction based on combined engineering. *Times Educ.*, 12, **8**, 17-19 (2012).
9. Huang, J., Jiang, J. and Gao, Z., Exploration and practice of software engineering excellence engineering training mode. *China Educ. Innovation Herald*, **01**, 54-56 (2013).