Co-cultivation mode of interdisciplinary training in IT-S, based on the principles of engineering education

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ABSTRACT: The information and computer technology specialty (IT-S) is an important course, but most IT-S students have poor employability. This is caused by inadequate attention to hands-on training during practical teaching. In aiming at the problem of how to develop high-quality information and computer technology talent for society, the authors of the study propose in this article a multi-dimensional co-cultivation mode of interdisciplinary training, based on engineering educational principles. Specific reform measures for IT-S training and the curriculum are provided. Finally, the system, which was implemented in the Department of Computer Science at Guangdong Polytechnic Normal University in 2013, has improved the teaching and achieved better results than has the conventional training mode.

INTRODUCTION

Engineering education, which includes preliminary, advanced and specialised training, involves teaching the corpus of knowledge and principles related to the professional practice of engineering [1][2]. Usually, additional examinations and supervised training are required, so as to gain a professional engineering licence. Engineering education has contributed much to China's economic development and social progress. Nevertheless, with the rapid social, economic, scientific and technological developments in China, the employment market for engineers has changed greatly. The existing quality and standard of engineering graduates do not meet the demands of industry. Engineering education is challenged by globalisation, the innovative economy, engineering complexity and the need for sustainable development [3].

The information and computer technology specialty (IT-S) is included in many majors, such as engineering, applied mathematics, information science and computer science. With mathematics as the basis of computing, computers are the tool by which to solve actual problems concerning information and engineering computation. There is a need to adapt the teaching to reflect the requirements of global economic development centred on information technology in the new century.

With the rapid development of IT, general universities must review training objectives, standards and the curriculum of IT-S courses. Teaching reform of IT-S, over the next few years, has been listed as important by the Mathematics and Statistical Teaching Steering Committee of the Institute of Higher Education, Chinese Ministry of Education. Most teachers of IT-S in universities and colleges only have experience teaching mathematics or computer basics. They teach the basics, but pay little attention to practical hands-on ability. As a result, graduates do not satisfy the demands of society [3-6].

To overcome the poor employability of IT-S students, proposed in this article is a multi-dimensional co-cultivation mode of interdisciplinary training, based on engineering education. First are introduced the problems of IT-S teaching, followed by the reform proposals for a multi-dimensional co-cultivation mode of teaching. Finally, specific implementation measures are considered.

PROBLEMS IN IT–S COURSES

According to survey results from IT-S departments, universities and feedback on graduate quality from enterprises, existing IT-S teaching at universities has a number of problems [7-9]:

- Ambiguous professional orientation:

Many universities only have general, overall training requirements and neglect detailed training objectives. They tend to include characteristics and an orientation relevant to their own institution. This results in ambiguous training objectives and orientation.

- Inappropriate curricula:

  The ambiguous professional orientation leads to inappropriate curricula. Most universities only make simple connections between IT-S and the mathematical and computer curricula, without forming a complete and organic curriculum for IT-S.

- Lack of effective practical teaching:

  No authoritative and uniform practical teaching mode has been developed for IT-S departments. There is no mature practical teaching available for IT-S to use.

- Inadequate faculties for IT-S departments:

  Many teachers in IT-S departments are mathematics teachers. Currently, IT-S is taught mainly by mathematics or computer teachers. There is a lack of teachers who effectively combine mathematics with computing. High-quality professional teachers with multidisciplinary abilities are needed urgently in IT-S departments.

- Mismatch between graduate skills and the demands of the marketplace:

  Universities lag behind in developing appropriate curricula to meet market demands. This is the root cause of the mismatch between IT-S graduates and the demands of society.

This situation reflects mainly the ambiguous training objectives and poor training provided by IT-S departments. Considering the increased demand for interdisciplinary talent and the mismatch between training output and demand, IT-S teaching reform and innovation have become imperative. Therefore, IT-S departments at common universities need to innovate further their training, to produce interdisciplinary talent having solid knowledge foundations, strong practical ability, and are of high quality to meet modern social and industrial needs.

ESTABLISHMENT OF A MULTI-DIMENSIONAL CO-CULTIVATION MODE OF LEARNING

Reform Goal

Faced with the abovementioned problems, these reforms are proposed to build an interdisciplinary quality IT-S training system by integrating knowledge with practical ability (see Figure 1). Interdisciplinary knowledge is the basis and key by which to improve the ability of students. Interdisciplinary ability determines whether students are competent for actual work. Interdisciplinary quality focuses on training producing professional quality, occupational quality and good emotional quotient.

The goal of the proposed multidimensional interdisciplinary IT-S training mode is to produce high-quality interdisciplinary IT–S talent, so as to meet the demands of society. By refining the traditional IT-S training system into an IT–S interdisciplinary training system, the latter training is developed into a deep integration of interdisciplinary knowledge, interdisciplinary ability and interdisciplinary quality. Thus, to establish a multidimensional collaborative training system by which to realise the goal of interdisciplinary IT-S training, the development of a knowledge subsystem, an ability subsystem and a quality subsystem, is required.

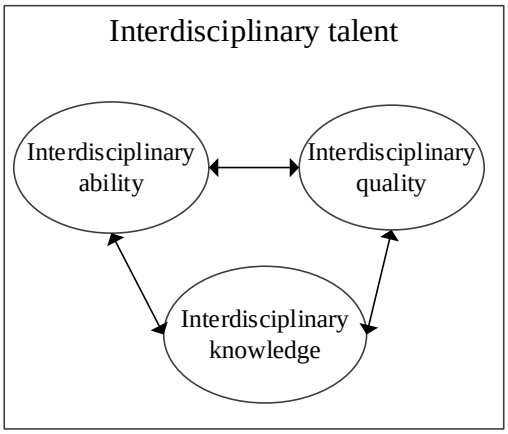

Figure 1: Interdisciplinary IT-S training system.

Reforms to address the problems concerning IT-S training at universities, have the following aspects:

- Amend the training plan and set clear training objectives:

  The new programme and training plan divides the IT-S curriculum into professional knowledge, integrated education and associated knowledge. Attention is paid to the combination of curricula and extra-curricular activities in universities and enterprises. The teaching is strengthened and the knowledge structure optimised. High quality practical resources are developed outside the university and professional IT-S laboratories developed inside the university. Also, it sets up and perfects a university-industry co-operative practical teaching system to provide multiple channels for training the students.

- Reform the curriculum to build an interdisciplinary curriculum:

- The professional norms and teaching standards, for IT-S departments, issued by the Mathematics and Statistical Teaching Steering Committee, of the Institution of Higher Education, at China's Ministry of Education, inform the teaching modules for IT-S departments, as well as adjusting and optimising the curriculum structure according to market demand and regional development. It can eliminate a curriculum that lacks professional support or introduce new teaching programmes. It highlights interdisciplinary knowledge and abilities for IT-S talent and has established a curriculum for interdisciplinary IT-S training. These are organically incorporated into the four-year undergraduate curriculum.

- Change the teaching mode and improve the practical teaching:

  To enhance the practical training of students, the practical teaching programme should be changed from the traditional *spoon-feeding* teaching, viz. change the teacher's role from authoritative to partner; change the student's role from a passive listener to a active participant; change the teaching process from knowledge transfer to guidance.

Implementation

The following should be implemented to realise the goals of interdisciplinary IT-S training:

- Clear training objectives:

  The training objectives, thus, shift toward emphasising interdisciplinary training, with a broad scope of knowledge, strong practical ability, high quality and high adaptability. The aim is to produce students with high-quality innovative ability and solid professional knowledge.

- Explore the training mode:

  A co-cultivation mode of interdisciplinary IT-S training was explored. The study included collaborative knowledge instruction, collaborative ability training and collaborative quality training measures.

- Perfect the curriculum system:

  Develop courses in collaboration with enterprises, other universities and other departments at the university. Students should combine professional knowledge with practical ability and occupational experience.

- Enrich teaching content:

  More attention should be paid to the analysis and understanding of real problems and case studies. There should be an increase in the proportion of in-school and out-of-school practical teaching. The education and training should integrate knowledge with practical training, while promoting quality, so as to provide students with all-round comprehensive education.

- Improve the teaching:

  Change the traditional *spoon-feeding* teaching mode and adopt a more innovative approach, so as to stimulate a student's thirst for knowledge and allow them to achieve their potential. Universities should apply heuristic and flexible discussion, as well as participatory teaching methods to encourage students to think independently and to freely explore knowledge, as well as being innovative. They should combine learning with thinking, and knowledge with behaviour.

- Expand the out-of-school training:

Universities should strengthen students' out-of-school and innovative entrepreneurial practice. Connections should be set up with enterprises, so as to build training bases outside the university. These develop the students' quality and skills. Excellent students should be sent regularly to outside training, to participate in actual work within enterprises.

- Strengthen team-building:

  Interdisciplinary training cannot occur without high-quality teaching staff. Interdisciplinary training is a great challenge for teaching staff. Universities need a plan for teacher development, so as to meet the requirements of high-quality interdisciplinary training. Efforts should be made to enhance the professional training of existing teachers, e.g. by providing incentives and encouraging teachers to gain practical experience in enterprises. Young teachers with good potential could be chosen to participate in programme implementation in enterprises. In addition, experts from industry with rich practical experience could be invited to be part-time teachers and, thus, expand the interdisciplinary teaching team.

IMPACT ANALYSIS OF THE NEW TRAINING MODE

The new training mode described above has led to many improvements in IT-S training. Graduates from the IT-S course at the Guangdong Polytechnic Normal University achieved an employment rate of 86% in 2011 compared with a rate of 75% in 2010. Meanwhile, the average salary of graduates has been rising year by year, from 2,241 RMB in 2011, to 2,649 RMB in 2012, 3,461 RMB in 2013, and 3,596 RMB in 2014. This represents an average rate of increase of about 20% year on year.

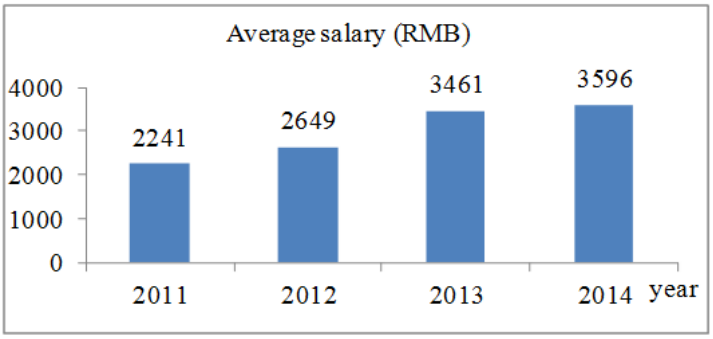

Figure 2: Average salary of graduates in recent years.

Figure 2: shows the average salary of IT-S graduates in recent years. The salary level of graduates increased by 18% in 2012 compared with 2011; by 31% in 2013 compared with 2012; and by 4% in 2014 compared with 2013.

Students improve their practical ability through training. They have shown excellent competence in many competitions, e. g. the Mathematical Contest in Modelling sponsored by COMAP (the Consortium for Mathematics and its Applications), where the participants were designated Meritorious Winner in the year of 2014, as well as receiving an Honourable Mention in 2015; in the CUMCM (China Undergraduate Mathematical Contest in Modelling), hosted by the China Society for Industrial and Applied Mathematics, the participants won second prize in 2014.

As can be seen from the above results, the effect of the reform of IT-S at the Guangdong Polytechnic Normal University, has been good. Compared with previous traditional training, the quality of students has risen year-by-year and the success rate in competitions has improved.

CONCLUSIONS

Experience shows that modern engineering education should attach great importance to quality training in order to cope with technological developments. Considering existing problems in IT-S training, this work explored and implemented an interdisciplinary IT-S training system integrating knowledge instruction and practical ability with an emphasis on quality. The new system provides systematic training, integrates resources in the university, and enhances connections between universities, and between universities and enterprises. It is a flexible, open system with abundant options and opportunities. With this multidimensional co-cultivation training mode, co-operation between universities, and between universities and enterprises, is enhanced. Hence, engineering education has been improved, with a focus on interdisciplinary training to meet national and social demand.

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