Reforming the internship of graduating senior students to improve their job readiness - an example from the College of Information Science and Engineering at Ningbo University

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ABSTRACT: Reforms were undertaken to improve innovative and practical abilities of senior students, and their engineering qualities in electronic information courses. This was done while maintaining teaching integrity with respect to the professional knowledge architecture. By combining processes, such as technical courses, short-semester training, on-campus internships for graduating senior students (based on co-operation between companies and the College), off-campus internships and the final year *graduation projects*, it was possible for the students to boost their capability in innovative thinking and application of ideas. The focus was on a comprehensive reform of the graduation internship system to help train the graduating senior students in such a way that their professional abilities and engineering capabilities are improved. Good results have been achieved over several years of such reform.

INTRODUCTION

The key to the sustainable development of the Chinese higher education is to improve the quality of talent cultivation, while the focus for quality improvement lies in the reform of talent training activities. Therefore, colleges and universities must implement the requirements included in the *Outline for Chinese Medium and Long-term Educational Reform and Development Planning (2010-2020)* to construct a talent training system that is adapted to social and economic development. However, in the current education situation, the contradiction between talent training and social demand is marked: on the one hand, society is in urgent need of a wide variety of professional personnel; but on the other hand, the graduates from the colleges and universities cannot meet the job requirements due to their lack of the appropriate professional ability [1].

Basically, the reason lies in the present education mode and the teaching content of undergraduate programmes, which have always valued theoretical knowledge more than professional ability [2]. Most of the colleges and universities base their teaching on the *knowledge-based* course system, which makes the universities attach too much importance to non-technology factors that focus on pure science instead of improving their professional abilities. They pay more attention to students' knowledge hierarchy than they do to improving students' skills, professional abilities and qualities. This has led to a loose connection between talent training and the needs of industry and has thus resulted in a gap between the output of talent training programmes and industry's needs.

In order to solve this problem effectively, the College of Information Science and Engineering has always had the goal of helping students in the electronics and information specialisation to develop application-oriented talent and for them to be characterised by their excellent innovation ability. To do this, the philosophy of converting innovative talent into a series of teaching practice processes has been applied [3]. By improving the engineering qualities of the undergraduate students through reforming training practices, and by guaranteeing teaching integrity of the professional knowledge architecture, it has been possible to improve the students' innovative and practical abilities.

This has been done by combining several practices, including technical courses, short-semester trainings, on-campus internships for graduating senior students in co-operation with companies and graduation projects. Also, by taking on a comprehensive reform of those internship as the integration point to improve graduate students' professional abilities and engineering capabilities, constant improvements have been made to the education mode for the students' growth and progress.

Ability is developed through training not through teaching; therefore, it becomes necessary to set up a reliable process to train students to improve their abilities. The key to improving students' ability is to involve them in a practical or a scientific research project. In this way, the students' engineering skills are improved and their independent thinking and

creative talent will be enhanced as well. The College has been vigorous in its reform of teaching and requires students to undertake research of a practical problem in order to improve the students' innovative and application abilities, as well as their engineering technology literacy. The focus is on the serviceability of the specialisation and on implementing a personnel training plan that connects professional education, engineering skills and qualities [4].

ANALYSIS OF THE COMPOSITION OF ENGINEERING ABILITIES

The core of reform in higher education engineering is to realise the transformation from the traditional knowledge-transference orientation to the ability-training orientation. Ability training is becoming one of the hot topics that has been brought to the attention of the Chinese higher education authorities. The key is to convince colleges and universities to pay special attention to training students in engineering practice and to make them conscious of the need to reform teaching so as to strengthen the students' subjective thinking in practical engineering training. However, it is difficult to implement such a new training philosophy in the current education system, where there is a certain lack of effectiveness in many teaching processes [5].

In recent years, the colleges and universities in China have had their professional teaching centred on teaching traditional professional knowledge and they have focused on the systematic nature and integrity of the discipline to form a knowledge-based teaching mode. The actual teaching outcome under such a teaching mode has been quite different from what had been expected. In terms of this perspective, such a teaching mode attaches too much importance to the knowledge architecture rather than the ability architecture, which has led to a poor combination of theory with practice, and a lack of comprehensive practice and training.

Meanwhile, this emphasis is more on knowledge and technology rather than on non-technology factors. For example, it overlooks engineering business and communication, which will certainly lead to lower levels of engineering ability. In addition, some problems remain in undergraduate education. For example, the boundary between *professional education* is too distinct and the *sheep herding style* teaching and practice have hindered significantly the training of students' engineering abilities from making progress.

When it is illustrated from a different perspective, engineering innovation ability is defined with different focuses. Actually, engineering innovation ability is the ability of engineering personnel to apply the relevant engineering technologies in order to perform social reform under a certain engineering background. It consists mainly of the following: engineering design ability, engineering application ability, engineering operation ability, engineering business capability and engineering communication skills as shown in Figure 1.

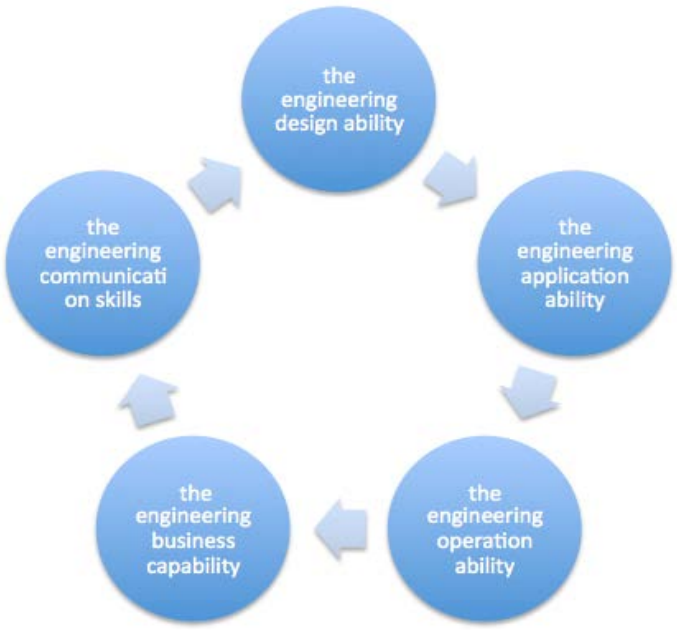

Figure1: The composition of engineering abilities.

Nowadays, industry and enterprises are in urgent need of high-quality personnel, who are characterised by excellent engineering quality, superior practical ability and the capacity to adapt to the job in a short time. They demand high standards of engineering design ability, application ability, engineering business capability and communication skills. Unfortunately, graduates from Chinese colleges and universities currently do not possess the relevant abilities and capabilities, which has led to a gap between them and reality. In view of this, the colleges and universities must update their training philosophy and combine training processes effectively to make constant attempts to introduce new methods to train the students to have excellent engineering abilities.

COMPREHENSIVE REFORM OF GRADUATING SENIOR STUDENTS' INTERNSHIPS

In many other countries, training students to improve their engineering ability has played a major role in the whole process of education. During their attempts to cultivate talent, many universities have implemented the connotation of Dewey's theory, *learning by doing* and carried out an engineering educational philosophy based on conceive, design, implement and operate (CDIO) theory to focus practically on the enhancement of the students' engineering ability. American colleges and universities have set up a comprehensive course for the senior students, known as the *Capstone Course*. This is particularly for those students that are about to graduate from the universities. It is a course for the students to integrate, develop, criticise and apply knowledge, skills and attitude, etc, learned during their study in the disciplinary area. A capstone course is characterised by their having students develop their comprehensive quality and helping them transfer from university to the job market. This methodology has been widely applied in American higher vocational and technical education.

However, national conditions in China differ from those in America, which determine that the practices in other countries cannot be copied. However, practical engineering education promotes the improvement of the student's ability anywhere. In addition, social and economic development calls for the creation of high-quality human resources. Therefore, the common features in the mentioned modes have provided enlightenment and an excellent reference point for the improvement of engineering ability-based education in Chinese colleges and universities. This is especially relevant to improving high-quality engineering talent, including excellent engineers. Through an analysis of Chinese educational practices, it is possible to find that as long as some of the main questions regarding the training of students to improve their engineering ability. If the dilemmas in current Chinese engineering education are resolved, talent cultivation in the colleges and universities can be improved and integrated with industry demands.

TOP-LEVEL DESIGN

For many years, the College of Information at Ningbo University has taken full advantage of its limited teaching resources to find an effective way to optimise the various training processes, in order to meet the demands of industry. This has included designing practices in the talent training system to form a progressive and comprehensive reform plan of the graduation year internship by undertaking some of the comprehensive training modes that are critical at the undergraduate level.

USING SHORT COURSES TO IMPROVE PRELIMINARY TRAINING OF APPLICATION ABILITY

The College has applied a teaching mode that combines the general skill training (practice of network system integration), aimed at improving the application ability of students in the College's electronics disciplines. This has been done via a short course of three weeks' duration.

In this short course the students must complete one or two comprehensive practice projects of medium difficulty. The tutor assigns a topic for each student, guides them through it, and answers their questions and evaluates their results. Through such a programme, the students gain a better understanding of the actual application context and professional knowledge, which includes programming skills, circuit design and the application of network technology, so as to help them move beyond the low-level learning environment, which is built around theoretical study and experimental validation. In this way, students improve their abilities to analyse and solve practical problems.

REFORMING THE GRADUATION PROJECT TO IMPROVE THE APPLICATION OF PROFESSIONAL KNOWLEDGE

The *graduation project* has been an important component of the comprehensive practical teaching received by students when they are studying at the University. It is a comprehensive training module during which students apply the basic theories, professional knowledge and basic skills that have been learned and, then, design (or research) practical problems for the purpose of teaching students to have independent operational capability, the ability to analyse and solve the problems, innovation ability and scientific spirit.

The College is active in creating conditions for students to commence the graduation project six months in advance that lasts the whole senior year. In order to maintain strict control over the quality of the graduation project, a quality-control process has been established. It includes the second capstone presentation and the second duplicate checking, etc. With the exploration of school-enterprise cooperation, an open process-management mode and quality-control mechanism for the graduation project and graduation paper, has been set up so that the student's graduation project, their graduation internship, the trial employment and the pre-job training can be combined together. Also, the *enterprise-school dual-tutor management system* has been put in place for those students that enter the companies early.

The process mode, system approach and the principle of continuous improvement have been developed based on the total quality management concept. A well-established quality guarantee mechanism for the undergraduate graduation project and graduation paper has been set up. Various systems and standards that take full advantage of information

technology have been perfected. These will strengthen the quality guarantee mechanism for the undergraduate graduation project and graduation paper to be a network-based and platform-based software system. When timely management systems and standards were established, a management platform for the undergraduate graduation project and graduation paper was also set up. This has been widely applied in several colleges and universities within Zhejiang Province.

PRACTICAL CAMPUS TRAINING TO AUGMENT ENGINEERING ABILITY

By referring to the American capstone course, it has been possible to provide the students with a comprehensive engineering teaching process, which is integrated with training in engineering design, engineering application, engineering operation, engineering business and engineering communication skills [6]. The main purpose comprises three aspects: first, it supports the student's in-depth study; second, it is an effective evaluation tool for the undergraduates' study; and third, it can help the students to transfer from university to the job market [7].

Based on the real demands of industry and on the basis of guaranteeing the teaching integrity of the professional knowledge architecture, the teaching process for the graduation internship of the undergraduates in information and technology will be redesigned. Through enterprise-school cooperation, a comprehensive project-driven practice has been carried out. It takes the virtual enterprise as the core and has a comprehensive real project as the carrier. The students need to complete the whole engineering life cycle, which includes demand investigation, analysis and design, document compilation, project bidding, organisation and implementation, as well as acceptance and delivery, so they will be provided with a comprehensive engineering teaching process that is integrated with the overall training. In this way, it will facilitate the students to improve not only their engineering innovation ability and teamwork spirit, but also their social adaptation ability and the ability of professional competition.

Taking the opportunity to construct a training base for fostering the professional application-oriented talents for the Ningbo IT industry, the College has embarked on a reform of the graduation internship as the integration point to boost undergraduates' professional ability. From 2011, well-known domestic and foreign companies have been used to innovate the campus graduation internship and training based on the virtual enterprise. In this way, the student's professional abilities including their career planning, professional skills and qualities, etc., will be enhanced synchronously, as is the student's teamwork awareness and the teamwork spirit, which will be improved as well.

Figure2: The project bidding process.

TAKING INDUSTRY COGNITION AND PROFESSIONAL ORIENTATION AS THE GOAL TO ORGANISE PRACTICE IN THE ENTERPRISES

If the student has not planned the post and the job content of their internship, it is likely that the student's graduation internship will become an aimless graduation trip. The aim is to let the students prepare for the internship position, therefore, by choosing enterprises that share the College's views regarding education and employment. Some students are guided through corporate internship. Several off-campus practice bases have been established, including Zhenhai Refining and Chemical Company (ZRCC), Hangzhou Lierda and Ningbo Leke Ke.

In order to develop a new mechanism for the colleges and universities to unite with industry to train students, it is necessary to follow the principles of industry guidance, school-enterprise cooperation and classified implementation. Therefore, the enterprise is no longer merely an employer; it becomes a central training unit. The enterprises will define their requirements and will participate in working out the teaching plan and the talent training programme. They will go through the training process with the universities to achieve a win-win result involving the enterprise, university and student during the student's off-campus internship.

Improving each student's engineering capacity and capacity for innovation are the main reasons for reforming training methodologies. A four week virtual-enterprise based campus graduation internship and training as the connection and preparation for the students to begin their off-campus practice was included. After the campus graduation internship and training has been completed, arrangements must be made for some of the students to take part in practical off-campus

enterprise training in the following two to three months. The students can have their graduation project finished in the practice base and combine the job application by internship with their graduation project. This helps students to have an appreciation of industry and develop their personal career planning and the professional orientation [8].

Outstanding students who are capable of designing, developing and have studied well can be permitted to work in the enterprises for two-three days a week. They work with the R&D personnel in the companies and do the R&D work for the project or just participate in the project. Academic competitions are also arranged, which include electronic design and service outsourcing. These activities help convince engineers from the enterprises to cooperate with the College and provide guidance to the students [9].

CONCLUSIONS

In recent years, comprehensive reform of the graduation internship has promoted the training of the students in terms of the integration of their knowledge hierarchy, skill system, professional abilities and qualities, attempting to have an educational reform on the engineering ability to transform the existing mode. It has started from the perspective of helping with the students' general development and the enhancement of their professional skills. By introducing industry and enterprise resources, it has been possible to explore a new mode that is both effective and systematic, which has solved the conflicts between student knowledge and industry demands, and made a contribution to the constant improvement of the student's employment competitiveness and expanded their future professional development space. The student's employment quality has been improved, which has contributed to a significant strengthening of the student's competitiveness, as demonstrated in Table 1.

Table 1：Employment statistics of the communication engineering specialty.

Types of employment unit	Students/Percentage in 2010	Students/Percentage in 2011	Students/Percentage in 2012
Attending postgraduate entrance examinations or going abroad	20 (28.2%)	9 (15%)	20 (24.7%)
Telecom operators	3 (4.2%)	3 (5.0%)	5 (6.2%)
High-end enterprises (high-end IT and foreign-funded enterprises)	11 (15.5%)	19 (31.7%)	26 (32.1%)

ACKNOWLEDGEMENTS

This article was partially supported by 2012 Zhejiang Province Education Science Planning Studies (SCG104), 2012 Zhejiang Province Education Technology Research Project (ZX2012000075), 2013 Ningbo University Research Project (JYXMxyb201330), Ningbo Key Construction Service-oriented Professionals (Sfwxzdzy200903), Ningbo Key Professional Electronic Information Science and Technology Construction Project (A00076094702), Zhejiang Advantage Professional Electronic Information Science and Technology Construction Project, 2011 Ningbo Education and Science Planning Studies (YGH005), 2012 Ningbo Education and Science Planning Studies (YGH014), Ningbo Application of IT Industry Talent Training Base (Jd070504).

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