

Analysis on the Effect of Sub-Module Practices from a Perspective of “a Plan for Educating and Training Outstanding Engineers”

—In Case of Computer Science Students in Nantong University

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Abstract

In the background of the Ministry of Education to start “a Plan for Educating and Training Outstanding Engineers” (PETOE), Nantong University has implemented the “3 + 1” training mode reform in computer science students; one of the most critical and core is the sub-module practice in the fourth year. The survey about 2015 graduates, teachers and companies who involved in the reform indicates that students’ training quality and employability are positively correlated with the sub-module practice which can enhance students’ professional competence and professionalism. At the same time, we should form practice guidance and management specifications, push teachers to adapt to the reform and strengthen the cultivation of students’ autonomous learning and thinking actively.

Keywords

PETOE, Computer Science Students, Sub-Module, Practices, The Effect

1. Introduction

In June 2010, the ministry of education launched “a Plan for Educating and Training Outstanding Engineers” (PETOE) which put forward the direction of higher engineering education reforms. First, companies deeply involved in the training process. And second, high schools cultivate engineering talents in accordance with the

general standards and the industry standards. The third is to strengthen training students' engineering abilities and innovation abilities. PETOE is intended for the industry, the world and the future, to train a large number of various types of high-quality engineering and technical talents with innovative abilities who can adapt to economic and social development needs. In the same year, Nantong University has initiated feasibility studies about cultivating program reforms in computer science undergraduate students, and has formed a "3 + 1" cultivating mode eventually. After years of exploration and summary, computer science and technology college in Nantong University has preliminarily explored and formed the path of cultivating outstanding engineers. They have formatted the model of modular practice. The exploration had been systematically executed since computer science grade 2011 students (graduated in 2015) came into the school. After four years studying, they have already completed all established undergraduate courses. Through the analysis of these students, it will help us to grasp the effect of the reform, and further promote the reform in the future.

2. Literature Review

European and American countries has been going in the forefront of the world in terms of educating and training outstanding engineers. It has certain impacts in engineers cultivating strategies on other countries of the world including China. Through the thorough research on the three first-class universities in America, professor Shibin wang etc. of Tianjin University considered that pragmatism is becoming the philosophical foundation of American university engineering education reform, that utility is truth, hypothesis is more important than fact, and demand-driven are the three basic principles of American engineering education reform, and the reform modes that mainly including a systematic curriculum, individualized training system and emphasizing the ability training have been built up (Wang et al., 2011). Through the research on the fachhochschulen in Germany that enjoy good reputation of engineer's cradle, professor Jianqiang Liu of Hunan Institute of Engineering considered that German excellence engineers cultivation mode pays attention to students' practices, the cooperation between colleges and companies, teachers' professional practice experiences, the management of the practice process of, etc. (Liu, 2010).

Some scholars have done the researches on the outstanding engineers educating and training. On the cultivation models, the four models-Sandwich model, continuing engineering education model, postdoctoral enterprise workstation model, and Campus Training Mode combining production, study and research-concluded by academician Shilie Weng are typical. In his view, universities should be good at solving the common trend of interests between companies and schools, establish diverse cooperation platform, and adjust subject categories and professional settings according to the needs of social development (Weng, 2007). Professor Jianzhong Cha proposed that the three "learning by doing" is the methodology of teaching, school-enterprise cooperation is the school-running mechanism, and internationalism is the engineering education strategy object facing economic globalization are associated (Cha, 2008). At the micro exploration, Dalian Neusoft University of Information constructed TOPCARES-CDIO (T: Technical knowledge and reasoning, O: Open minded and innovation, P: Personal and professional skills, C: Communication and teamwork, A: Attitude and manner, R: Responsibility, E: Ethical values, S: Social contribution by application practice, C: Conceive, D: Design, I: Implement, O: Operate) mode (Wen, 2010). Shantou University constructed EIP-CDIO (E: Ethics, I: Integrity, P: Professionalism) mode (Gu et al., 2012). Scholar Shouyu Wu has explored in using TRIZ theory (Russian abbreviation of the solving inventive problems theory) and constructivism learning theory to improve students' original innovation, integrated innovation and digestion-reabsorption innovation abilities. It has obtained a more satisfactory education and training result (Wu, 2011). By creating "Nanjing Medical University IT laboratory", professor Qinwen Lv et al. have explored the complex outstanding engineering training method combining medical and engineering. It achieved better results in the employment of graduates of medical colleges (Lv et al., 2013). Through the survey conducted in the electronic and information engineering students of China Civil Aviation University, associate professor Yan Han believe that the CDIO reforms can improve students' initiative to participate actively (Han et al., 2012).

These studies that not only have theory and policy researches at the macro level but also have the specific training model and method explores at the micro level have played positive effects in the localization of the outstanding engineers. But it is not specific and clear enough at explores in the most important practice part of the PETOE. Furthermore, it is scarce in the analysis of the practice reform effects. Through the system analysis and inquiry in the practices and effects of the separate-module practice in computer science students of Nantong

University, we can provide richer research data and theory perspectives for further researches and practices.

3. The Specific Method of the Separate-Module Practice

The education reform of PETOE in computer science students of Nantong University mainly contained following aspects: the determination of the whole training program, the allocation of education management staffs, the connection with the enterprises, the practice progress management.

3.1. The Training Program

The program uses the “3 + 1” training mode, that is, completing the teaching plan of theories and practices in the school in former three years, and arranging the students to practice in enterprises in the fourth year. The theory curriculums of three years include general education, academic foundation courses and professional courses. Among them, general education includes 48 credits of compulsory courses and 8 credits of elective courses. Academic foundation courses are all compulsory courses, 48 credits. Professional courses are consisted by compulsory courses and elective courses. The credits of the compulsory courses between 40 and 45 points, differentiated along with professional direction. And elective courses are consisted of module electives and optional electives. Module electives mainly include five modules: software and hardware technology, Java programming, Net programming, network engineering, and computer advanced theory. The setting of optional elective courses is to broaden students’ professional horizons and give students more independent choices.

In the fourth year, the students and the relevant enterprises will make choices with each other. And the students must complete the training programs in the enterprises they have chosen. But the students who choose the computer advanced theory will be allowed to finish the professional training and acquire the credits. In China, a part of undergraduate students want to continue in-depth studies by passing the post-graduate entrance examinations. The students improve their professional theory levels through the computer advanced theory learning, and improve their practice abilities through training in the school.

3.2. The Allocation of Education Management Staffs

The university has set up a teaching team, a teaching assistant team and a management team for the reform. The teaching team is mainly in charge of the theory teaching and practical guidance. The teaching assistant team is mainly in charge of assisting teachers to accomplish their works. The management team is mainly in charge of managing the training progress. The three teams are all equipped of rich experienced staffs as leaders to ensure the orderly forward of the practice and the timely disposal of the unexpected problems.

3.3. The Connection with the Enterprises

Because the reform is at the exploratory stage for the school and enterprises, in order to ensure the practice effects, they must communicate and negotiate with each other and reach a consensus. One hand, the school will screening enterprises to ensure that the enterprises entering two-way choice must meet with practice requirements. On the other hand, through finding the common interests, the enterprises may work in strict accordance with the special contents and requirements of the PETOE.

After the university and the enterprises reached a high degree of consistency, in the sixth semester, the university will arrange the enterprises into the school in batches to make the two-way selections with the students. In the two-way selections, the university will provide the situations of the students’ theory learning and module selections, and the teachers will guide students to select the counterpart enterprises according to their own module selections.

3.4. The Practice Progress Management

In the practice progress, the university regularly organizes the teachers and managements coming into the enterprises to inquire about situations, and accesses according to the requirements of the module practice. Then, the university negotiates with the enterprises, the guidance teachers and the students, and proposes corrective measures. This forms the circulation monitoring management of the practice progress (Figure 1).

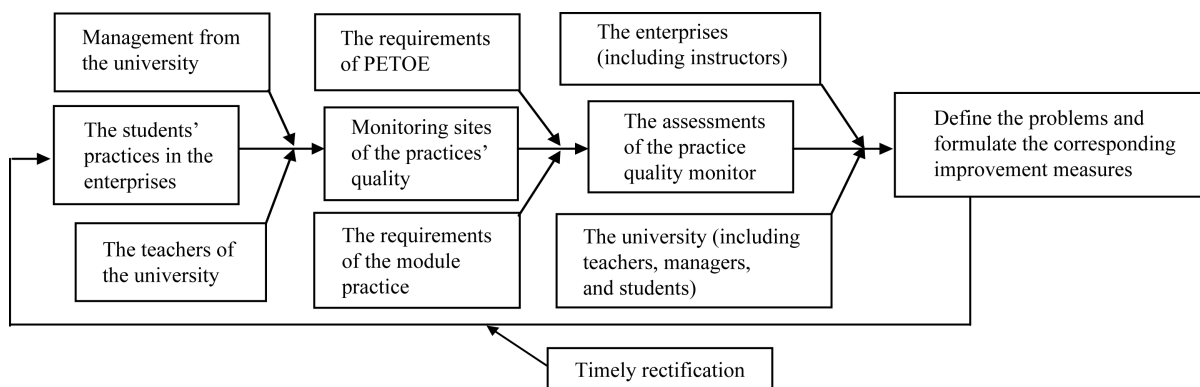


Figure 1. The progress management of the module practice.

4. Survey Design and Results

4.1 Survey Design

The samples of this study mainly include the employment data of the computer science graduates nearly three years of Nantong University and the questionnaire surveys to the 2015 graduates, the teachers, and enterprises. The employment data of the computer science graduates was provided by the employment and entrepreneurship center of Nantong University. Through analysis about the data, we can form the overall evaluation of the 2015 graduates' employment situation. Through the questionnaire surveys, we can know the specific evaluations and improvement suggestions of the students, the teachers, and the enterprises to the module practices. Through the quantitative analysis and comparison on the above data, we can form the comprehensive conclusions on the sub-module practice effects of the computer science students of Nantong University.

4.2. Results

4.2.1. Employment Situation of the Nearly 3 Years

The data mainly use the employment rate and the promotion rate (the percentage of the students who past post-graduate examinations accounting for the total graduates) of the computer science graduates and the average employment rate of the Nantong University. In china, the employment rate and the promotion rate are the most important indicators to measure the education qualities. The acquisition times of the data were at the end of June. And it is not only the graduate time, but also the important time nod reflects the first employment situation of the graduates.

4.2.2. The Survey Results of the Graduates

We have carried out the questionnaire survey in the 296 computer science undergraduates of the 2015 session of Nantong University, and collected 266 valid questionnaires. The questionnaires includes four aspects: the evaluations of their own, the teachers and the enterprises, and the total satisfaction of the sub-module practices. The evaluations of the students includes responsibility consciousness, team work, professional theory, practical ability, English proficiency, problem solving, creative design, and the satisfaction of the performance during the practice. The evaluation of the teachers includes teaching ability, teaching method, assessment method, and the total satisfaction. The evaluation of the enterprises includes practice environment, instructor in the enterprise, practice management, and the total satisfaction.

4.2.3. The Survey Results of the Teachers and the Managers

We have carried out the questionnaire survey in the 50 teachers and managers who have taken part in the reform, and collected 50 valid questionnaires.

4.2.4. The Survey Results of the Enterprises

We have carried out the questionnaire surveys in the 80 staffs working in the human resources department and the business department, and collected 69 valid questionnaires.

5. Analysis of the Survey Results

5.1. The Relationship between the Module Practice and the Students Training Quality

From **Table 1**, in the past 2 years, the first employment rate of the computer science graduate is almost the same as the average rate of the university. In 2015, the first employment rate of the computer science students is obviously higher than the average rate. Comparing the 3 years data of the computer science graduates, it is 27% higher in 2015 than the average level of the past 2 years. Considering the reflection of the good employment environment in 2015, it can still hold nearly 10% higher than the past 2 years. So, this indicates that the employment situation of the computer science graduates has improved significantly in 2015. The promotion rate of 2015 is 4% higher than the past 2 years. From the dynamic trend of the 3 years, the rise of the promotion rate in 2015 is more significant. Then, it declares that the quality of the computer science graduates in 2015 is better than past years and is better than the average level of the university. While the whole environment of the school has little change, courses and credits are generally comparable to the past, and the large change is the practice model, this fully proves that sub-module practice is positively related to the cultivation quality of the computer science students. It also proves the above conclusion that, from the **Table 2**, the vast majority of the graduates, teachers, and enterprises are satisfied with the sub-module practice.

5.2. The Main Influence of the Sub-Module Practice to the Students' Quality

From **Table 3**, the students' evaluation of their own sort descending: practice ability, problem solving, professional theory, responsibility consciousness, team work, creative design, and English proficiency. From **Table 4**, the teachers' evaluation of the student sort descending: practice ability, responsibility consciousness, problem solving, team work, professional theory, creative design, and English proficiency. From **Table 5**, the enterprises' evaluation of the students sort descending: practice ability, responsibility consciousness, professional theory, problem solving, team work, English proficiency, and creative design. That more than half consider there is a significant improved includes practice ability, problem solving, professional theory, responsibility consciousness, and team work. It shows that the sub-module practice can improve the abilities mentioned above. That practice ability is all ranked in the first fully proves that the positive influence of the sub-module practice to the students' practice ability is the most significant. More than 70% considers that the abilities of problem solving and professional theory are improved significantly. It shows that the sub-module practice is positively related to the above two abilities. But we also find more than 70% consider that the abilities of English proficiency and creative design is not improved or improved not obviously. The reasons may be that the students have less chance to use English. And because it is difficult to close to the core technology and the practice time is limited, the students have no enough chance to improve and show their creative design ability.

5.3. The Problems in the Sub-Module Practice

From **Table 6** and **Table 7**, the vast majority of the students and teachers are satisfied with the teachers' teaching ability, which indicates that the teaching staffs equipped are all recognized by the students and teachers. But more than 70% students consider that the teachers' teaching method and assessment method are ordinary or bad. It shows that the students have more expectation for the teaching method and assessment method. On the other hand, much more teachers are satisfied with their teaching methods and assessment methods. It shows that the teachers' teaching ideas need to be further improved accommodate the reform.

From **Table 8**, **Table 9** and **Table 10**, there is high satisfaction in the practice environment. But, in the two aspects of the instructor and progress management, that the teachers and students satisfaction is low deviates

Table 1. Employment statistics of the nearly 3 years' graduates.

Year	2013 (%)	2014 (%)	2015 (%)
The promotion rate of the computer science graduates	11.19	12.30	15.88
The employment rate of the computer science graduates	67.12	68.24	93.92
The average employment rate of the Nantong University	60.59	58.39	75.10

Table 2. The total satisfaction of the graduates, teachers, and enterprises (%).

	Students	Teachers	Enterprises
Good	88.35	92.00	85.51
Ordinary	6.02	6.00	10.14
Bad	5.64	2.00	4.35

Table 3. Students' evaluation of their own.

	Responsibility consciousness	Team work	Professional theory	Practice ability	English proficiency	Problem solving	Creative design	Total satisfaction
Obvious promotion	73.68	62.78	74.44	96.24	38.72	84.96	39.47	73.31
General promotion	21.05	25.56	17.29	3.76	37.22	8.27	28.20	21.43
No promotion	5.26	11.65	8.27	0.00	24.06	6.77	32.33	5.26

Table 4. Teachers' evaluation of the students (%).

	Responsibility consciousness	Team work	Professional theory	Practice ability	English proficiency	Problem solving	Creative design	Total satisfaction
Obvious promotion	64.00	56.00	50.00	72.00	26.00	56.00	32.00	70.00
General promotion	20.00	26.00	28.00	16.00	28.00	24.00	28.00	22.00
No promotion	16.00	18.00	22.00	12.00	26.00	20.00	40.00	8.00

Table 5. The enterprises' evaluation of the students (%).

	Responsibility consciousness	Team work	Professional theory	Practice ability	English proficiency	Problem solving	Creative design	Total satisfaction
Obvious promotion	82.61	60.87	81.16	89.86	43.48	68.12	37.68	66.67
General promotion	14.49	23.19	10.14	8.70	17.39	13.04	17.39	31.88
No promotion	2.90	15.94	8.70	1.45	39.13	18.84	44.93	1.45

Table 6. Students' evaluation of the teachers (%).

	Teaching ability	Teaching method	Assessment method	Total satisfaction
Good	89.10	27.07	25.56	81.20
Ordinary	7.14	51.50	38.72	9.77
Bad	3.76	21.43	35.71	9.02

Table 7. Teachers' evaluation of their own (%).

	Teaching ability	Teaching method	Assessment method	Total satisfaction
Good	88.00	88.00	76.00	88.00
Ordinary	12.00	10.00	18.00	12.00
Bad	0.00	2.00	6.00	0.00

Table 8. Students’ evaluation of the enterprises (%).

	Practice environment	Instructors in enterprises	Practice management	Total satisfaction
Good	80.42	50.79	56.61	76.72
Ordinary	11.64	30.69	26.98	8.99
Bad	7.94	18.52	16.40	14.29

Note: The data is mainly from the students practicing in the enterprises.

Table 9. Teachers’ evaluation of the enterprises (%).

	Practice environment	Instructors in enterprises	Practice management	Total satisfaction
Good	80.00	42.00	40.00	52.00
Ordinary	12.00	30.00	42.00	22.00
Bad	8.00	28.00	18.00	26.00

Table 10. The enterprises’ evaluation of their own (%).

	Practice environment	Instructors in enterprises	Practice management	Total satisfaction
Good	81.16	73.91	68.12	79.71
Ordinary	10.14	20.29	26.09	13.04
Bad	8.70	5.80	5.80	7.25

from the enterprises’ self-evaluation. It shows that the enterprises should strengthen the guidance to the students and be strict to the management of the practice progress.

6. Conclusions and Suggestions

From the above data and analysis, we can make the following conclusions: first, the sub-module practice achieved an ideal reform expectation, the second is that the sub-module practice is positively related with the cultivation quality and employment ability of the students, and the third is that the sub-module practice has a positive effect to the students’ professionalism. And the suggestions are that the students should strengthen the training of the autonomous learning and thinking, the guidance and management standard of the enterprises for the sub-module practice should be formed as soon as possible, and the teachers should think outside the inherent teaching habits, understand and implement new teaching ideas.

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