On Education Quality Control Issues for Sino-France Hybrid Engineer Diploma

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Abstract—**Quality control in higher education is a complex social key project fostered by the Chinese government. As a sino-foreign cooperation school in engineering, we are focusing more intensively on quality control in higher engineering education. Sino-European School of Technology of Shanghai University (UTSEUS) was established by Shanghai University in cooperation with University of Technology Network (France) in 2006. Dual-campus education program has been introduced to UTSEUS ever since: two years of campus life in China, and the next two years in France. Challenges on the program designs, the teaching modes, the teaching strategies, teaching quality control and teaching collaboration have been updated accordingly concerning the different educational systems we have in China and that in France. With monitoring the dual-campus engineering education, several approaches have been introduced to the quality control of higher engineering education in UTSEUS.**

Keywords- quality control, Sino-European cooperation, dual-campus teaching, teaching assessment system.

I. INTRODUCTION

With our knowledge broadening continuously in the ever-changing 21st century, the problems that we are dealing with have also become ever more complex.

Driven by the economic globalization, the world's need for engineers with an international background is accelerating in the multinational enterprises (MNE). To answer the call of the times, we feel the urge to nurture our engineering majors with a global and innovative mind, which is also the trend of internationalization of higher engineering education in China. In 2006, UTSEUS was officially established by Shanghai University (SHU) with University of Technology Network (UT) of France—University of Technology at Compiegne, at Troyes and at Belfort (UTC, UTT and UTBM). Accordingly, preeminent professors and courses were introduced to UTSEUS from France in order to answer the call of globalization.

It is widely known that engineering education is shifting itself from mere technology education to research education. Teaching method patterns in Shanghai University are in the transition from instructional-based to research-based. Through the study of the model and experience employed by the UT groups, the practice on teaching modes, teaching strategies, teaching quality control and teaching collaboration in dual-campus engineering education system utilized by UTSEUS has been implemented. This paper is to discuss how to manage the quality control in higher engineering education and what UTSEUS has accomplished so far in this field.

II. QUALITY CONTROL IN HIGH INTERNATIONAL ENGINEERING EDUCATION

More and more universities have realized that mastering the techniques is not enough for the engineers of 21st century. It can be a niche for them to comprehend corporate management and the social culture as well.

Our engineering majors should be able to design and practice with a global and innovative mind. International engineering education with a dual-campus system is popular worldwide. Therefore, it is important to find effective approaches to control the educational quality under such system, which is the preoccupation and priority for our international engineering school to design a appropriate program.

Considering the massive and growing market yearning for engineers with an international background, the universities need to adjust their teaching methods. Nevertheless, what key characteristics should such an engineer possess?

In 2001, the United States National Academy of Engineering (NAE) and the United States Natural Science Foundation (NSF) co-sponsored the "2020 Engineer" program. By the end of 2004, the program issued its 1st official report on "2020 Engineer: The vision of engineering development in the new century"; in 2005 summer, they released the 2nd formal report on "Training of Engineers in 2020: engineering education to adapt to the new century" These reports analyze the engineering practice, the technical, social, professional, international backgrounds and etc, which describe in detail the expectations and characteristics of the future engineers.

Engineers in year 2020 should have analyzing capability, practical experiences, creativity, communication skills, business and management expertise, leadership, ethical consciousness, and life-long learning desire. The report describes a qualified engineer for our teachers, employers and students.[1]

With the continuous development of higher engineering education, the traditional mentoring educational model has been replaced and the elite training model has also been diluted. Nowadays, the higher engineering education is available to larger population of students. Meanwhile, the need of the enterprises for elite professionals is on the rise. Considering all the previous aspects, higher engineering education and its reform must be monitored in light of quality control with its evolving management models and tools.

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In the traditional method, quality control is to "discover talents and enable them to maintain excellence".[2] Faced with such massive demand of professional engineers, we feel it our responsibility to cultivate the qualified engineers that will meet the need of the industry and ensure every step in the teaching process with the quality control system. Numerous research projects on Quality Management in Education (QMIE) have been carried out by those prestigious universities renowned in engineering, such as the "CSE model" by UCLA (University of California, Los Angeles). But it is difficult for a school with dual-campus system to control the quality in education via the traditional approaches. It is beneficial for us to learn from the industry in order to update our approaches of quality control. Total Quality Management (TQM) is the most intensive means in quality control. TQM system is based on the information integration technology, takes combination between quality control and quality management as main principle, and fulfills enterprise's long-term operating strategies finally.[3] And thus, it can be an appropriate quality control approach in international engineering education.

According to the essence of every TQM approach, we can find the corresponding approaches in quality control at different stages of the quantitative management in education, which includes control of pre-teaching design, teaching process control, and teaching quality assessment.

III. CONTROL OF EACH TEACHING PHASE

A. Control of pre-teaching design

During the stage of pre-teaching design, the priority is to design the appropriate teaching program and curriculum planning.

Teaching program is the blueprint in assisting the achievement of the basic goals and specifications of education. The gist is the implementation of program with specifications of monitoring and evaluation in quality of education. Therefore, it is ideal to have a team of experts to monitor the quality of design and practice of the teaching program.

The evaluation of the programs in the University of Massachusetts presents a type of quality control in terms of teaching design. They put forward several points concerning quality control of the programs as follows: (1) How does the professional guide the content of programs; (2) Does teaching scheme meet with contemporary needs; (3) Whether the structure of the programs is logical, sequential, and coherent. How about the field operations, test operations, seminars or other large-scale operations and so forth help students acquire and integrated what they learned? (4) Does programs really enable students properly to prepare further study or employment?[4]

At UTSEUS, four majors are tailored with their own teaching programs respectively. Given the four-year program, it is urgent for us to adjust the program to meet the growing need from the market and retain the quality as well. Having carried out a survey in a large scale with the assistance of the cooperative school in Shanghai University and the prior four-year experience, we feel even more confident in reforming the program of mechanics to start with. Since the undergraduates with engineering backgrounds are popular amongst the enterprises, the teaching program has been reformed or changed according to these needs. With the two-year reform in teaching program of mechanics, our students not only have more access to practical training, but also refresh their understanding with the major.

Curriculum planning is the detailed part of the teaching program, which should be designed by specialists as well.

In the process of designing the teaching program and the curriculum planning, the first step of TQM is fulfilled. The criterion of education quality control is confirmed. Accordingly, the top-down structure for TQM can be devised with the criterion.

B. Control of teaching process

With the dual-campus system, the students in UTSEUS first spend three to four years studying in China, and then, they can choose to study another two years and a half in France in order to attain the engineering diploma or two more years to gain a master degree there instead. Due to the different educational systems between the two countries, divergent teaching processes are therefore lied between the Chinese and French professors. The cooperation courses in UTSEUS will be helpful to students to adapt to the model of engineering education in France. On that account, in UTSEUS, there are approximately 17 courses taught by French and Chinese teachers in the whole learning package .

Considering the two nations' different teaching models, it is important to find more effective approaches to practice quality control in education during the teaching process. By analyzing the four-year practice in UTSEUS, it is clear that the people are the key factors in quality control in such teaching model. As it is emphasized in TQM that everyone in an organization should support and participate in the quality control procedure which is carried out in the organization. The first step of quality control in teaching process is to have all the teachers and students realize the importance of implementing TQM in the teaching process. If each teacher participates in the quality control of the teaching process, it will be a good opportunity to form a standard procedure for cooperation course in dual-campus.

French professors are not able to carry out their long-term teaching plans in UTSEUS because of the short-semester practice in the Shanghai University. As a result, a team of more experienced French professors are formed. The courses taught by them are thus carried out. The question is, how to assure the quality of teaching process with such a team? First of all, we have an experienced French professor to be the head of the teaching team. He will find and organize his teaching team. The object and the quality of the course depend on his design. In order to keep the teaching process effective, the teaching team is composed of several French professors and one to two Chinese professors. It is also the team head's responsibility to keep all the team members communicating effectively and efficiently. According to the different teaching methods and teaching concepts between the Chinese professors and the French professors, the division of teaching part of Chinese and French professors will be well planned approximately one year

prior to the commencement of the course. Although each professor teaches one part of the course during the teaching process, the joint content is designed and monitored by the team head. This structure of teaching team and course design is practicable in the teaching process of the dual-campus, which can also sustain the teaching quality on an average level.

Then how to improve the quality of such course? We need the help from our students and advanced information techniques. Considering the characteristics of teaching in dual-campus, we designed a platform called "open-course-ware" to assist the teaching team to improve teaching quality. On such platform, students can present his problem and put forward his suggestion to the teaching team. It will help the head teacher of the team adjust the course to benefit the students in time. Then there will be good effect at the end of the teaching process. Of course, the effect of the course will be measured by a evaluation survey. The traditional evaluation on teachers is replaced with the evaluation on courses. The results of course evaluation are the reference to the academy and the teachers.

There are still a lot of courses only taught by our Chinese teachers in UTSEUS. These courses are within the framework of teaching managements in Shanghai University. Experienced professors in Shanghai University will evaluate the teaching process of specified course occasionally and submit their opinion by reports. The same evaluation standards are applied to the courses taught by Chinese teachers.

Therefore the teaching process quality control in dual-campus should focus on the approaches of motivating both teachers and students. The teachers should design an efficient method to organize the course. And it is important for them to teach with an open manner and positive attitude.

C. Evaluation of teaching quality

We can evaluate the quality of teaching by two methods: evaluation of students and evaluation of curricula.

a) Evaluation of Students

The evaluation of students can also reflect the quality of our education. Our purpose is to develop high quality engineering, so our evaluation of students must be suitable to this purpose. By traditional method, we evaluate students by their absolute score in the examination. It may reflect how many contents students have mastered and how well they master the knowledge. But its reflect-function depends on that the exam is normative, rational and has reasonable difficulty. Moreover, the absolute score can not reflect the student's location in the course. Students may focuses on refining results excessively. This is not the characteristics of a high quality engineer.

In UTSEUS, we have introduced European Credit Transfer System (ECTS), which is a relative score evaluation system, to reform the traditional evaluation. Through using ECTS, we can efficiently overcome the disadvantages brought by the absolute score system. It will help us to encourage students to compete healthily, promote them to improve their studies continuously and let them develop their self-learning ability.

Based on using both absolute score and ECTS, we adopt an all-round evaluation model to evaluate the students' academic situation. In reference to the absolute score and ECTS of students, we establish a mode of communication called "assessment conference". In this conference, we analyze students' learning comprehensively, assess their academic achievement and pay more attention to their development in the future. And the most important focus we consider is the trends of students' learning.

With four-year practicing, 63% of our first students have finished their 3-year studies in UTSEUS and gone to France for their studies for Engineering Diploma.

b) Evaluation of Curricula

Evaluation of teaching at universities is traditionally realized in terms of student ratings. Curriculum evaluation is rarely done in a systematic manner. More often, the emphasis is placed on a particular aspect, which is only of little help in terms of modifying education. Christine Spiel introduces five phase of evaluation to be considered and contrasting results to others. The first and the concentrated phase is the baseline evaluation. Especially, while a course is under reformation, the evaluations of it should primarily focus on new curricula by contrasting it to traditional ones. [5]

UTSEUS has learned the experience and method from UT groups, and established our own method evaluation of curricula. With traditional evaluation, students will give a course or a teacher a grade to evaluate its teaching quality. Considering our own characteristics, we have a teaching group working on the course, it's not reasonable to value one teachers on one course. So we concentrated on the course itself. We have the students to fill a form, which is about the course, including teaching method, teaching content, and the detailed feeling about the course by students, etc. With the result of this form, we can learn the general information about the quality of this course. By collecting the information and suggestion given by students, we can analyze the reformation of the course and suggest the teaching group to adjust the teaching method. By means of evaluation, several courses have improved its teaching effect obviously, and our cooperating colleagues will be much more glad to teach and do reform in UTSEUS.

IV. ADVANCED INFORMATION TECHNIQUES

A. System Architecture

An online education assessment system is under development. The system was initially designed as PHP + MySQL architecture, but due to the database of UTSEUS is not a completely independent system, which relies on the raw score provided by Registry office and basic personal information provided by student's affair office of Shanghai University. In order to share the public information platforms of the campus and reduce the maintenance cost of infrastructure of data and database server, the database was migrated to the Microsoft SQL Server solution.

There are views and stored procedures running on the SQL server for complex computing tasks, reducing the data exchange between database and application server to improve network performance and reducing the complexity of

application development, applications and end users to focus on aesthetic interaction and a clear presentation of data.

A flash library named as “The Open Flash Chart” is being delivered by LGPL. It can be a graphical front-end display of statistical data. The database statistical data is read by PHP and the OFC class library transfer output data into a JSON (JavaScript Object Notation) format, sent to the open-flash-chart.swf object, it can draw a lot of kinds of charts on-line output.

A Moodle site is set to provide e-learning services in UTSEUS. The Moodle system is an open source software based on PHP. The low layer libraries of Moodle are well developed, it includes classes and functions covered database abstract and User managements. The base codes can be reused in new software development. The applications integrated in moodle seamlessly with the benefits of mature user authorities and privileges mechanisms. By modify some core codes of Moodle we made it fit the education activities of UTSEUS well.

B. Applications Oriented to Quality Control

Figure1 is a transcript of a student in UTSEUS, a self-developed program convert a Shanghai University Score System to the ECTS and GPA system. On this page, a GPA performance chart is given to show the trend of a specified student, progress or retrogress.

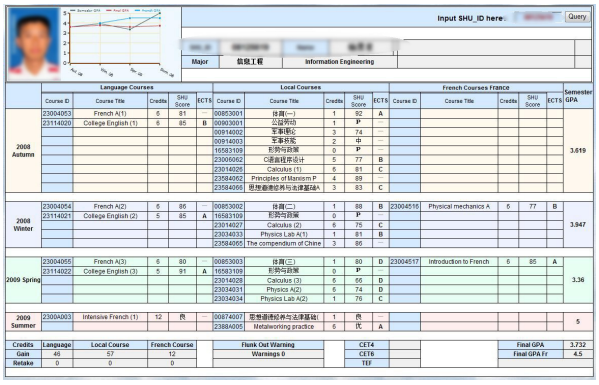

Figure.1 Transcripts

Figure2 is Zoom of GPA performance chart. The green dot-line is semester GPA, the red dot-line is final GPA and the blue dot-line is French course GPA.

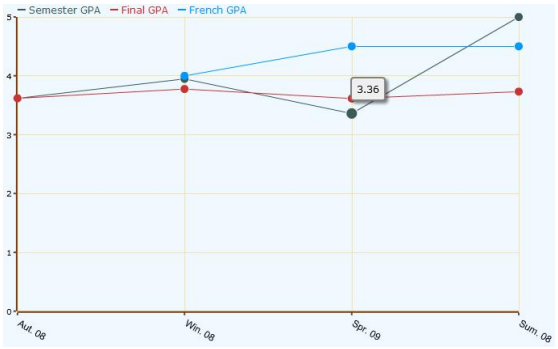

Figure.2 Zoom of GPA performance charts

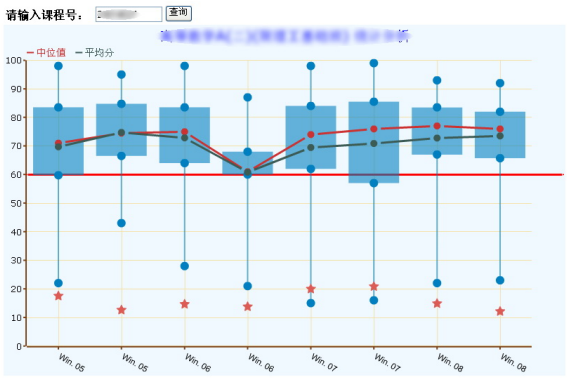

Figure.3 Box Plot for course quality analysis

Box plot, also known as box-line diagrams, is a box and two line segments graphics indicated by five eigenvectors which include maximum, minimum, median and two quartiles. "Single course quality analysis map", highest point of each box is a specific the highest score of the exam when a semester is over, the next point is the student who in the top quarter, the third point is the score in the top three quarters, the lowest point is the lowest score(except 0)of the test (lots of reasons not directly associated with learning level cause 0 point such as absence of test, cheating, so 0 point is not included in statistics), the red dot is the median value that means the score of half ranked score of the exam. The box is the distribution of the middle half ranked score. Box plot graph characterizes the distribution of results, in general, a large dispersion implying a no good quality of education. Formula for the overall standard deviation formula is as follows

$$\sigma=\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}$$

The standard deviation can be more precise to describe a number of discrete levels of data, and its unit is the same as the input data; The asterisks in lower part of the chart is the standard deviation of the exam results. Visual comparison in a box plot diagram, with a large polymerization there’s a small standard deviation, and on the contrary with a small polymerization there’s a large standard deviation. The second box-plot reflects the desired result of a exam (Calculus of winter semester in 2005) with high average and low dispersion; the sixth box-plot (exam result of Calculus in winter semester, 2005) indicates poor quality of teaching with even the box of middle ranks crossing the pass line and the difference of the highest score to the lowest is large and the overall dispersion is large. When the mouse moves onto each box, the teacher’s name and related information will be shown in a float label.

Figure 4 is a final GPA of all grades in subparagraph (>= 3 and< 2.5) percentage of charts, dashed line for the French course GPA. Figure.5 is a specific semester GPA for all grades compared, each column is a grade. The information system gives these charts automatically. Statistics and data mining is an emerging field, new methods and new techniques emerging, In future research, more statistics and analysis of score will be integrated into the system.

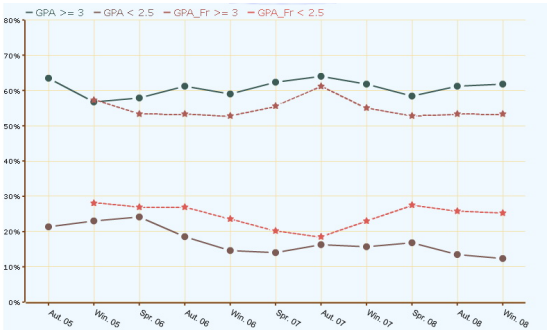

Figure.4 A specific grade divided by the cumulative semester GPA Analysis

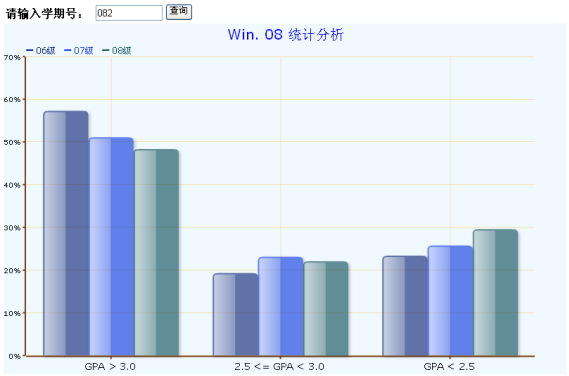

Figure.5 A specific sub-semester GPA for all grades compared

To analyze the relationship of studying in China and in France, Pearson correlation coefficient is introduced. For the score data are continuous and approximately normally distributed, fit the condition of Pearson coefficient. The result is the Pearson coefficient is around 0.4~0.5. The significance is 0.01 that means the result is acceptable.

V. CONCLUSION

The quality of engineering education is the most important support for an engineering school. As a sino-european engineering school, we have the duty to do well in quality control of our engineering education. Since there are so many aspects in the quality control of education, the first thing we try to do is to design a schedule and blueprint to guide our efforts in this job. As is said above, we have some successful experience in evaluation of students and curricula. It's time to synthesize the evaluation method to integrate into a general system. It's a long-term work to design a perfect culture program. But we have to determine our standard about the evaluation of the program, and then we can do a good job in designing and reforming the culture program. On above topic, we do the quality control on the whole procedure of teaching and have got successful experience in evaluation stage. In the future, the teaching process quality control may be the second emphasis to improve. While we have the clear and determined goals (programs) of education, we should do the quality control in teaching process (including teaching method, teaching standard, etc.), and when the course finished we can use the evaluation of students and curricula as a feedback system to our quality control system.

Statistics and data mining is an emerging field, with new methods and new techniques emerging. In our future research, more statistics and analysis of score will be integrated into the system.

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