Research on Quality Assurance Strategies within Higher Learning Institutions’ Corresponding Program Accreditation of Engineering Education: From the Perspective of Sino-U.S. Comparison

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Abstract

The paper focuses on the quality assurance practice which promotes continuous quality improvement of engineering and technical talents, makes an in-depth analysis of the mechanisms of quality assurance in engineering education within higher learning institutions in the United States, and analyzes the characteristics of quality assurance mechanisms of engineering education, via reviewing research literature, interpreting the self-assessment reports and interviewing the internal stakeholders. Finally, the paper analyzes the practices and problems of the quality assurance in engineering education in China, discusses the construction of the quality assurance mechanisms of engineering education, and proposes some recommendations for the mechanisms construction of quality assurance in engineering education based on the specific national circumstances. In summary, the theoretical innovation of this paper is to conduct an in-depth research on quality assurance in engineering education from the perspective of higher learning institute, under the realistic background of program accreditation, and to conclude with a discussion of quality assurance approaches and mechanisms in cross-national, comparative perspective, with particular focus on U.S. and Chinese contexts of engineering education.

Keywords: quality assurance, engineering education, program accreditation, continuous quality improvement

1. Introduction

In the new era, the quality assurance system of engineering education in China has been initially established with the joint efforts of engineering education, industry and business communities, and with the strong guidance of the central government. Colleges and universities have begun to explore the approaches of quality assurance in engineering education at the theory and practice levels. Higher education theorists in China are interested in inquiring engineering education accreditation system in the United States, but never completely review the origin and development of the quality assurance in engineering education from the perspective of historical change, never completely make an in-depth analysis of the internal logic and conflicts of the quality assurance in engineering education from the relationship between program accreditation agency and universities, and never systematically explore the philosophy, organizations, policies, systems, procedures and methods of the internal quality assurance from the perspective of the universities. Thus, it needs a comprehensive dialysis of the forms and mechanisms of the internal quality assurance in engineering education within American colleges and universities.
2. Literature Review

2.1. Research Status

Since the establishment of engineering education accreditation system, the research topics generally include accreditation organization, accreditation standards, accreditation procedures, accreditation effectiveness, and comparative study. However, some scholars have also pointed out the shortcomings of the existing researches, for instance, the research content is not systematic, the research method is relatively simple, and the researches lack specific perspective.

2.1.1. Research on Stakeholders of Quality Assurance

With the in-depth development of ABET and its international trend, the practice of quality assurance in engineering education within American colleges and universities has gone through different stages under the guidance of ABET. Engineering education accreditation personnel (ABET managers, staff, accreditors, etc.), engineering education professionals (administrators in engineering departments, engineering faculty, ABET liaison, etc.), engineering students (engineering undergraduates, engineering graduate students, engineering doctoral students, etc.) are important stakeholders. Researches based on the Stakeholder Theory are mainly reflected in the following aspects, research on stakeholders and their role in the accreditation process, research on evaluation culture in the accreditation process, research on stakeholders within the engineering education system.

2.1.2. Research on Policy of Quality Assurance

Quality Assurance in Engineering Education is a systematic project, which requires the engineering departments to develop active and effective policy to advance. In the United States, the vast majority of colleges and universities have formed quality assurance “pyramid” structure including university, college and department, developed mechanisms, systems and political initiatives of promoting the educational quality assurance at the level of college and department. However, the policy-making space of quality assurance in engineering education at the level of college and department is not as big as the level of university. According to existing researches, the political dimension of quality assurance in engineering education has always been neglected. The effective policy-making practice is reflected in the following aspects, formulating the policy of students’ ability development, teacher professional development, promoting Industry Advisory Board participation, promoting administrative involvement.

2.1.3. Research on Philosophy of Quality Assurance

Since the beginning of the 1990s, the concept of “quality” began to appear frequently in the field of engineering education practice, the principles of quality assurance (Total Quality Management, Quality Function Deployment, etc.) also began to be introduced into the field
of engineering education. Related researches began to inspect the concept of quality and quality assurance philosophy of engineering education. Additionally, researches tried to introduce quality assurance philosophy to the research of engineering education. Finally, there are some researches which compared EC2000 and ISO9000.

2.1.4. Research on Methods of Quality Assurance

During the mid-1990s, ABET achieved the transformation of paradigm through mechanism innovation, taking the opportunity of which ABET put forward new accreditation criteria (EC2000). EC2000 requires the program define what the graduates should be able to do, and have continuous improvement process based on program outcome. In this context, there appeared a lot of research literatures related to learning outcomes assessment. Other researches focused on the assessment methods of program and course. Course is an important carrier of engineering education, and course quality is the core element of the engineering education quality. Therefore, the course assessment is an important aspect of the quality assurance in engineering education. Related researches concentrated on general course assessment, capstone design course assessment, EPICS project assessment, and also share experiences based on course assessment within institutions practice.

2.2. Research Reflection

The research perspective tends to the nature of “practice” when responding the program accreditation, however, weakens the nature of “theory” when discussing the quality of engineering education. Most researches are conducted to better answer the technical questions, which has the obvious nature of “practice”. The root of the problem is the lack of diversity in research dimensions and perspectives. First of all, most researches focus on the program accreditation system of engineering education in the United States, and the research topics mainly relate to the accreditation philosophy, criterion, procedure, effectiveness, models and methods of quality assurance coping with program accreditation. However, the research perspectives excessively focus on the program dimension, and apparently lack the school-level dimension, college/department-level dimension, course-level dimension, which is difficult to utterly reflect the characteristics and principles of quality assurance practice. Secondly, the lack of historical research perspective leads to a research illusion which is characterized by “technology supremacy” or “experience supremacy”, but also leads to the narrow view of researchers. Although there are many theoretical foundations such as “Stakeholder Theory”, “Total Quality Management Theory”, “Bloom Classification Model” and “Cooper Learning Circulation”, the theoretical interpretation is not complete when are introduced in the research topics. In summary, it is difficult to produce more normative theoretical research results for the lack of standardized research design and research methods.

3. Research Design

3.1. Research Hypothesis
The research mainly includes following hypotheses: First, the quality assurance in engineering education within American colleges and universities is to some extent impacted by specific political and institutional environment. Secondly, colleges and universities in the United States have established organization and management system, and developed corresponding teacher and student policies in order to cope with ABET accreditation requirements. Thirdly, the executive power, academic power and student power have formed collaborative mechanism of power participation in the process of the quality assurance in engineering education. Finally, despite of some differences in educational system, the excellent practice of quality assurance in engineering education within American higher learning institutions is able to provide references for Chinese counterparts.

3.2. Research Purpose

This research will explore the discrepancies and consistencies of quality assurance in engineering education between China and the United States, analyze the progress and issues of quality assurance in engineering education within colleges and universities in China, and put forward strategies of quality assurance in engineering education.

3.3. Research Methods

3.3.1. Literature Analysis

The research intended to comprehensively collect and review the literature materials about the quality assurance in engineering education within higher learning institutions in the United States from the perspectives of Organizational Behavior, Policy Science, Management Science and Pedagogics, analyze and discuss the historical background, implementation and influence of the quality assurance in engineering education. Specifically, the research selected representative colleges and universities in the United States, collected policy text and regulations, summary report, meeting materials, policy text of educational authorities and ABET official documents, summed up and made comparative analysis of the experience of various types of colleges and universities.

3.3.2. Interview

The research used all possible opportunities to experience the practice of higher engineering education in the United States, extensively exchanged with ABET officials and key members of the Committee, Chinese students studying in the United States, Chinese scholars working in the higher learning institutions in the United States, native teachers and students, experts and scholars of engineering education research, managers and engineering teachers and students within colleges and universities in China, members of the China Engineering Education Accreditation Association(CEEAA), explored the uniqueness, complexity and practical effect of the quality assurance in engineering education, so as to have a more comprehensive perceptual understanding of the quality assurance in higher engineering education. In the process of research, interviews were conducted by face-to-face interview,
mail interview and telephone interview. The interview time for each interviewee was approximately one hour. Prior to the interview, the researchers developed scientific interview outline and interview questions through repeated discussions with the instructor, which provided a good expert validity.28

3.3.3. Case Study

The research selects several well-known universities as the object of study, by comparing the reform of different types of colleges and universities in the United States, and reflecting the practice of quality assurance in engineering education. Examples include MIT, Purdue University, Michigan Technological University, University of South Carolina, Southern Polytechnic State University, Georgia Institute of Technology, Washington State University, Worcester Polytechnic Institute, Washington University, Iowa State University, Rose-Hulman Institute of Technology, Alverno College, Olin Institute of Technology, Colorado School of Mines, Virginia Tech University.

4. Research Findings

4.1. Strategies and Characteristics of Quality Assurance in Engineering Education

4.1.1. Specific Political and Institutional Environment

Quality assurance in engineering education within colleges and universities has political and institutional environment. The accreditation system of engineering education which has both advantages and deficiencies puts forward far-reaching implications for quality assurance in engineering education and engineering education reform. Quality assurance in engineering education within colleges and universities is the response to the economic and social demands. Thus, the participation in program accreditation is kind of “bottom-up”, “self-regulation” quality assurance behavior. With the maturing of accreditation system of engineering education, the practice of quality assurance in engineering education has been conducted deeply, gone through the emergence, formation and growth of quality assurance awareness, and formed the continuous quality improvement mechanism. The other motivation of quality assurance in engineering education is the Scientific Education and Management Movement which promotes colleges and universities involve in theoretical research on quality assurance in engineering education, and actively carry out the practice and exploration of quality assurance in engineering education.

4.1.2. Transition from “Conservative Response” to “Active Participation”

The mid-1990s witnessed the ABET innovation which achieved the transformation of accreditation paradigm. It provided an opportunity for ABET to put forward the new accreditation criteria-EC2000, which brought a profound impact on engineering education within colleges and universities. In order to cope with the transformation paradigm of program accreditation, colleges and universities carried out various engineering education
reform which included the exploration of a variety of learning outcomes assessment methods, the engagement of a wide range of intellectual resources, the internalization of the philosophy of continuous quality improvement, the integration of evaluation management mechanism, the in-depth reform of curriculum and teaching.

4.1.3. Deep Understanding of the Philosophy of “Continuous Quality Improvement”, Exploration of Rigorous Procedure and Techniques

Essentially, program accreditation requires the future accredited program to establish an effective mechanism for continuous improvement. Under the background of EC2000 reform, many colleges and universities integrated the philosophy of continuous improvement into program quality assurance in accordance with their own characteristics of program development, and put up with several proven continuous improvement models. Each program is required to prove that their graduates have 11 competencies stipulated by EC2000 criteria 3; form program assessment scheme, record assessment result, and prove that these results will be applied to further develop and enhance program education; prove that the qualitative results of these assessment schemes can demonstrate the school’s task and teaching objective. Each program is required to constantly conduct self-evaluation of teaching objective and process via appropriate and normative assessment tools which need to be refined and improved. Quality assurance in engineering education not only requires teachers to put more effort in teaching, but also master the specialized knowledge and skills needed for continuous improvement. Engineering teachers use diversified assessment methods of program including conventional assessment methods of learning outcomes, develop new assessment methods, and positively reflect the reliability and validity of various assessment methods.

4.1.4. Establishment of Corresponding Management Mechanism

Quality assurance in engineering education is a comprehensive, systematic project, including a series of institutions, policies, resources and support. First, colleges and universities have developed mature and sound quality assurance organization at the school level, and actively established quality assurance organization at the college/department level. In order to meet the accreditation requirements, engineering departments of colleges and universities gradually integrated EC2000 accreditation criteria and philosophy into the quality assurance system, and established assessment management system at the college/department level by integrating evaluation and management mechanisms. Secondly, colleges and universities developed teacher incentives to lead teachers to participate in quality assurance; developed teacher development policy which carried out new recruited teachers’ training, and led the new recruited teachers’ growth; established specialized organizations which promoted the professional development of teachers; developed students’ development policy; established internal educational evaluation system including school-level evaluation system, department-level evaluation system, program-level evaluation system, course-level evaluation system, which provided a good guarantee for internal quality assurance in engineering education.
4.1.5. Formation of Synergetic Power Participation Mechanism

Continuous improvement of undergraduate engineering education requires systemic reform which continuously integrates the school and various departments and requires that three strands of power-students power, academic power and administrative power-must appropriately involve this systemic reform process, in order to achieve continuous improvement of program. Stakeholders of engineering education not only include teachers, students and parents, but also include state legislators, alumni, practitioners and industry representatives who hire graduates. The powers have different attitudes and behaviors of participating in quality assurance.

4.2. Status and Issues of Quality Assurance in Engineering Education within Colleges and Universities in China

Quality assurance in engineering education is a systematic project which surrounded by specific political environment. At present, colleges and universities in China are actively exploring the practice of quality assurance in engineering education. As an important means of quality assurance and an important mechanism of the international mutual recognition of academic degree, the establishment and implementation of engineering education accreditation system has potential impact on higher engineering education in China. This section tries to analyze the issues of quality assurance in engineering education within colleges and universities in China, based on relevant research literature, self-study reports and accreditation reports submitted during 2006-2013.

4.2.1. Difficulty of Carrying out the Philosophy of Continuous Quality Improvement

In recent years, colleges and universities in China have made efforts on the quality assurance in engineering education. The engineering education accreditation relies on the formation of mechanism with virtuous circle, which makes the teaching activities can continuously obtain from the feedback of the quality monitoring, and maintain the teaching quality in a continuous improvement process rather than repeat formalized document collection. In the process of implementing international program accreditation with substantial equivalence, how to promote each school to gradually establish an effective self-improvement mechanism via program accreditation is still an issue worthy exploring. Continuous quality improvement is not only an important accreditation criterion of domestic and international engineering education but also an important aspect of quality assurance in program education. However, the efforts of universities and programs in continuous improvement are insufficient. Continuous quality improvement will still be the bottleneck of quality assurance in engineering education.

4.2.2. Lack of Effective Assessment Mechanism

Over the years, quality assurance in higher education in China has excessively relied on “government-led” policy, while ignoring the construction of internal quality assurance system
and mechanism. The continuous improvement of educational quality requires the joint efforts of all students and staff rather than solely rely on external quality assurance mechanism such as accreditation. Colleges and universities have initially established monitoring mechanism of teaching quality, track and feedback mechanism of graduate, and external assessment mechanism, however, the implementation effect is questionable. For monitoring mechanism of teaching quality, the daily working mechanism is not clear, the effort is not enough; for track and feedback mechanism of graduates, the mechanism lacks normalization and standardization, the gathering and organizing methods of information need to be further improved; for external assessment mechanism, the assessment mechanism between schools and businesses, industry is not effective, the effect of external assessment for continuous improvement is not obvious, the extent of industry enterprises to participate in quality assurance in engineering education is not high.

4.2.3. Lack of Effective Management System of Quality Assurance

Practice shows that the establishment of multiple organization and management system is effective for improvement of teaching quality. With the continuous advance of engineering education accreditation, colleges and universities have made some progress in the construction of organization and management system of engineering education quality, while have much room for improvement in terms of effectiveness. According to the 2013 analysis report of engineering education accreditation, the organization and management system is insufficient within majority of colleges and universities.

4.2.4. Lack of Balanced Power Participation

Due to program accreditation of engineering education started relatively late in China, most people are not very familiar with it. With the in-depth development of undergraduate teaching evaluation led by the Ministry of Education, colleges and universities have begun to attach importance to the teaching quality, and actively explore the construction of quality assurance system. However, many administrators and teachers regard program accreditation as teaching evaluation, which generate a lot of misunderstandings. Essentially, program accreditation differs from undergraduate teaching evaluation, as shown in Table 1. From the perspective of program accreditation, all work of program and school should be “student-centered”. Students are direct stakeholders of engineering education and responsible for actively involving the teaching process of engineering education and evaluating the effectiveness of engineering education. However, students’ voice is absence in quality assurance in engineering education, and the “student-centered” philosophy advocated by quality assurance in engineering education is difficult to implement in practice.

4.3. Sino-U.S. Comparative Analysis of Quality Assurance in Engineering Education

Different political environment, economic system, cultural tradition and educational system determine that there are discrepancies between China and the United States in quality assurance in engineering education. Therefore, the consistency and discrepancies between
two countries in quality assurance in engineering education should be keenly inspected.

**Table 1. Difference between program accreditation of engineering education and undergraduate teaching evaluation**

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COMPARISON DIMENSION</th>
<th>PROGRAM ACCREDITATION</th>
<th>UNDERGRADUATE TEACHING EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Requires</td>
<td>Voluntary Application</td>
<td>Mandatory</td>
</tr>
<tr>
<td>2</td>
<td>Objective</td>
<td>Conformity</td>
<td>Excellence</td>
</tr>
<tr>
<td>3</td>
<td>Scope</td>
<td>Program</td>
<td>School</td>
</tr>
<tr>
<td>4</td>
<td>Discipline</td>
<td>Engineering Only</td>
<td>All</td>
</tr>
<tr>
<td>5</td>
<td>Authority</td>
<td>Non-Government</td>
<td>Government</td>
</tr>
<tr>
<td>6</td>
<td>Standards</td>
<td>International Substantial Equivalence</td>
<td>National</td>
</tr>
<tr>
<td>7</td>
<td>Purpose</td>
<td>Talents Cultivation of Mutual Recognition</td>
<td>Teaching Quality Assurance</td>
</tr>
<tr>
<td>8</td>
<td>Internationalization Level</td>
<td>International</td>
<td>National</td>
</tr>
<tr>
<td>9</td>
<td>Members</td>
<td>Colleges and Universities, Industries, Companies, Etc.</td>
<td>Colleges and Universities</td>
</tr>
<tr>
<td>10</td>
<td>Examination Level</td>
<td>Comprehensive Systematical</td>
<td>Selected</td>
</tr>
<tr>
<td>11</td>
<td>Engineering Requirements</td>
<td>Attention to Practice</td>
<td>No Special Requirements</td>
</tr>
<tr>
<td>12</td>
<td>Validation Period</td>
<td>3 to 6 Years</td>
<td>From Time to Time</td>
</tr>
<tr>
<td>13</td>
<td>Cost</td>
<td>Accredited Program</td>
<td>MOE</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

### 4.3.1. Discrepancies of Quality Assurance Environment

**Cultural Tradition**

Cultural traditions which influence quality assurance in engineering education in the United States include academic freedom, institutional autonomy, individualism, equality and democracy, pragmatism. While the cultural traditions which influence quality assurance in engineering education in China include the “great unification” culture which causes convergence of educational idea and model, similarities of talents cultivation model, turpitude of school characteristics, and “bureaucracy and ideology” culture which causes the decay of academic autonomy, weakness of self-management, convergence of higher education accreditation system.

**Institutional Environment**

Quality assurance in engineering education in the United States has a special historical background, is closely related to engineering education reform transformation of engineering
education paradigm, development of engineering knowledge. Over past 80 years’
development, engineering education accreditation in the United States has formed a complete
set of effective system. In contrast, theoretical research and accreditation practice in China
are still at the exploratory stage, and there are differences with the United States in the
accreditation criteria, subject and procedure as engineering education accreditation started
lately.

*Traditional Education*

In the United States, the formation and development of accreditation criteria are deeply
affected by the academic autonomy and academic independence. Independent educational
system allows customize the types of courses so that colleges and universities can devote
more energy to focus on the students’ need. It is in this environment that program
accreditation criteria develop indicators which pay more attention to student personalized
development.35 The autonomy tradition of higher education plays an important role in colleges
and universities, which makes quality assurance in higher education relies more on
non-governmental organizations. In China, the Ministry of Education unifies higher
education management in the country. The vast majority of colleges and universities are
public universities which are directly under the jurisdiction of administrative departments at
all levels, which requires the organization with official nature to conduct program
accreditation.35

### 4.3.2. Consistency of Quality Assurance Environment

As for quality assurance in engineering education, two countries have common demands in
the construction of continuous improvement mechanism under the “Washington Accord”
qualification framework.

*Scientific Assessment Principles, Procedures and Methods*

Although there are discrepancies between the two countries in terms of accreditation criteria,
procedure and subject etc., colleges and universities have the obligations to conduct
self-assessment, and should establish an effective internal self-assessment mechanism which
is inseparable from the assessment philosophy, principles, procedures and methods. Therefore,
the pursuit of reasonable assessment philosophy, legitimate assessment principle, integrated
assessment procedure and effective assessment method is the common aspiration of the two
countries in terms of quality assurance in engineering education.

*Systemic Reform*

This systematical reform is a procedure of periodically, systematically assessing and revising
the outcome criteria in order to influence the expected change of educational outcomes,36 with
the adjustment of internal organization structure and policies. It requires understanding series
of external and internal factors, and understanding teaching and learning, in order to conduct
reforms of engineering faculties and programs in accordance with accreditation criteria. Thus, quality assurance in engineering education needs appropriate adjustment and innovation in terms of organizational structure, policy design and institutional arrangements.

**Mutual Influence, Cooperation and Harmonization of Main Stakeholders**

The complete participation of students, teachers, administrators, employers, industries and government can promote quality assurance in engineering education. Thus, quality assurance in engineering education requires an extensive participation of internal and external stakeholders. Administrative power, academic power and student power should understand their own responsibilities and rights, and jointly promote the continuous quality improvement of engineering education.

**5. Recommendations**

Colleges and universities in China should gradually explore quality assurance pathways; establish scientific quality assurance mechanisms, in order to response to program accreditation.

**5.1. Thorough absorption of “continuous quality improvement”**

In the United States, applying program accreditation is a voluntary activity. During the accreditation process, ABET fully respects the autonomy of program development. Although applying for accreditation to some extent relates to the resource allocation system, the professionalism and authoritative of ABET accreditation, more importantly, can obtain national, social and public recognition, and win competition for college and program. Thus, in the United States, applying program accreditation is established on the basis of autonomy, self-management and self-improvement of colleges and universities. Accreditation is the responsibility of accreditation agency, yet appeals for cooperation between accreditation agency and universities. Colleges and universities should insist on their program characteristics, and achieve diversity of program development via combining the economic and social development.

The application of “continuous quality improvement” in higher education is not an innovation, while has played or are playing a subtle role on the continuous improvement for accreditation agency, colleges and universities or program quality. The engineering education accreditation practice within higher learning institutions have to some extent proved the significance of this philosophy. Due to this cultural philosophy, engineering education accreditation in the United States can carry out the reform of ABET, foster the formation of self-assessment culture within higher learning institutions, establish the global authority and continuous influence, and guide the direction of global engineering education reform. ABET is dedicated to assist higher learning institutions to form the philosophy of “continuous quality improvement” which is not only permeated in the recruit, selection, training and performance evaluation of volunteers, but also reflected in the constantly updated database of experts and the
establishment of teacher professional development mechanism.

Currently, one bottleneck of engineering education program accreditation in China is the achievement of the philosophy of “continuous quality improvement”. Colleges and universities should take effective measures to establish teaching quality standards, clarify the quality demand of all teaching stages, promote professional development and reform of talent cultivation model, so that the quality of engineering education talent cultivation reaches substantial equivalence of international requirements; promptly integrate human resources elements such as engineering practice ability, innovation ability, management ability, international communication ability which are concerned by and will affect industries and enterprises’ future development into all stages of engineering talent cultivation, form internal and external quality assurance system, continuously improve the quality of engineering talent cultivation; further improve the standardized management, gradually explore the establishment of the internal teaching quality evaluation system, gradually establish educational assessment system of all programs, improve the program quality assurance system according to its own characteristics; establish and improve graduates tracking and feedback mechanism and user evaluation mechanism, comprehensively understand the customer satisfaction and the ability demand for graduates, continuously improve talent cultivation quality, continuously improve customer satisfaction, better provide talent support for the development of industries and enterprises according to the social evaluation information and user demand.

5.2. Comprehensive Establishment of Technology Mechanism

5.2.1. Deepening of “outcome-oriented” philosophy, promotion of engineering education reform

In the early accreditation activities, ABET more emphasized on investment in educational process, therefore, accreditation criteria also focus too much on input and process, which led to a convergence of engineering education model. Currently, the program accreditation of engineering education in China is vigorously undergoing, has explicit demand for outcome of engineering program, and for providing evidence of outcome. Many colleges and universities are unable to adapt to this transition, which is reflected in the lack of assessment approaches of learning outcomes, and the modularization of self-study report. Therefore, China Engineering Education Accreditation Association (CEEA) should play a leading role as an accreditation agency, regularly carry out professional training, promote and popularize the typical experience. Colleges and universities should take the initiative and actively learn from the excellent experiences of learning outcomes assessment from American counterparts.

First, colleges and universities should definite the objectives and specifications of engineering talents cultivation; construct diversified engineering curriculum system; set up integrated practice teaching system; comprehensively use capstone design courses, project/problem based learning, cooperative learning, group learning, active learning, to cultivate students' comprehensive abilities; expand professional development channels of
engineering faculty, and comprehensively enhance the professional level of engineering education and teaching ability of engineering practice.

Secondly, colleges and universities should develop discipline/program objectives, outcome objectives and course objectives in accordance with criteria formulated by program accreditation agency, further implement instructional design and assessment, in order to maintain teaching efficiency of program and ensure that students have these capabilities when they graduate.

Thirdly, colleges and universities should focus on the curriculum system reform, innovate the system and mechanism of engineering talent cultivation, effectively solve the problems such as the talent cultivation objectives, the weakness of curriculum system supporting for graduation requirements, and promote the implementation of abilities cultivation.37

5.2.2. Shape of Evidence Culture and Quality Culture

Colleges and universities in China should take the opportunity of engineering program accreditation, genuinely shape and strengthen the evidence-based culture, and in turn popularize and promote the culture throughout the school.38 In the context of vigorously promoting and implementing the “China Educating and Training Plan of Excellent Engineer” (CETPOE), it is necessary to focus on the quality culture which penetrates the practice of engineering education within higher learning institutions, making “the pursuit of excellence” become habit and convention of university, and finally evolving into a culture.32

5.3. Scientific Construction of Management Mechanism

5.3.1. Development of Quality Assurance Policy

Colleges and universities should conduct a comprehensive reform of teachers, enhance the attractiveness of engineering education, improve cultivation model of engineering faculty, broaden the recruitment channels of engineering faculty, promote engineering faculty involve in engineering practice, enhance evaluation mechanism of engineering faculty, promote engineering faculty to understand and involve in the reform.39 On the basis of these initiatives, colleges and universities should focus the policy target on the educational assessment training of engineering faculty, as formulating relevant policies according to educational outcome assessment and carrying out series of activities have important practical role.

On the one hand, colleges and universities should extensively and deeply disseminate advanced philosophy, reform objectives, operating procedures, evaluation system of engineering education, mobilize the initiative of engineering faculty to participate in engineering education reform. On the other hand, colleges and universities should develop a comprehensive policy of faculty development, strengthen the training of educational assessment method for engineering faculty, and strengthen their attention on engineering education accreditation. At present, CEEAA has established policy of comprehensive faculty
development, educational assessment and training system, regularly conducted training of engineering education program accreditation. Colleges and universities should provide appropriate funding and incentives to encourage engineering faculty to participate in training which enable engineering faculty comprehensively and timely learn the advanced philosophy and practices of program assessment.

5.3.2. Improvement of System Basis, Establishment of Integrated Assessment System

Colleges and universities should establish quality assurance mechanisms at the school, college and department level, build an integrated assessment system of educational quality, regularly carry out normalized assessment of educational quality, timely identify problems and take corrective actions. A set of complete and standardized assessment system is an important approach of improving the teaching quality of higher learning institutions, promoting educational reform and assuring the quality of talents cultivation. Integrated assessment system includes integrated assessment of course teaching, integrated assessment of students’ ability, integrated assessment of engineering practice, integrated assessment of faculty’s capacity, and so on.

5.4. Gradual Improvement of Power Mechanism

5.4.1. Deepening of “student-centered” philosophy, promotion of “science-based” teaching model reform

College and universities should deeply study the development tendency of engineering science and technology, understand the actual needs of industrial development, combine with their own characteristics, and develop the talent cultivation objectives of engineering education program which are scientific and rational, clear and precise, and in line with industrial development needs; establish cultivation objective system, assessment system and continuous quality improvement system which involve industries and enterprises to deeply participate in, take effective measures to implement the cultivation objectives into all aspects of talents cultivation of engineering education; shifted from “teacher-based” teaching paradigm to “student-based” teaching paradigm, regularly conduct student satisfaction surveys to understand students’ learning experience, learning gains and career development needs, and design teaching system, allocate teaching resources, adjust curriculum system, improve teaching methods, perfect teaching environment, improve learning follow-up assessment, based on student learning needs and capacity requirements, really making student benefit and satisfy.

5.4.2. Cultivation of Evaluation Culture, Formation of Joint Force

Colleges and universities should reconstruct the responsibilities of all stakeholders to shape an evaluation culture which is based on multiple subjects and collaborative participation. Leaders and managers at all levels, the majority of teachers and students should work together to dedicate to the quality assurance in engineering education. Leaders and managers
at all levels should pay more attention to program accreditation, fully mobilize the enthusiasm of relevant departments, and form teamwork spirit of mutual cooperation. Managers should amend the objectives and program of talent cultivation, form continuous improvement mechanism, on the basis of extensive investigation, in order to promote the continuous improvement of talent cultivation quality. Engineering faculties should reasonably position the program objectives of talent cultivation, and prepare for implementing program accreditation by self-study. Teachers should actively participate in self-study and rectification to achieve development and construction of program. Students should clarify the talent cultivation objectives, understand the role of each course to achieve program objectives, and more actively and purposefully study.

Acknowledgments

This work was made possible by the grant from the Project Funded by China Postdoctoral Science Foundation. We acknowledge the thoughtful feedback we received from our anonymous reviewers, whose insights helped improve the quality of the final version of this paper. In addition, we would like to express our genuine thanks to CEEAA for providing self-study reports and accreditation reports.

References


