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Practice and Exploration on Bachelor Program Accreditation for Hydraulic Engineering in China During Past Ten Years

Yuanfang Chen, Guibao Li, Hongdao Jiang, Guofang Li and Fei Yuan

ABSTRACT

The development process of engineering program accreditation in China is briefly introduced, then it put more attention to describe the accreditation exploration and practice experiences for hydraulic engineering program in past 10 years, such as the construction of accreditation standard system, how to do the survey at site and selection and training for experts, student outcomes evaluation and the problems to be solved.

1 Introduction

As a type of higher education quality assurance activities, engineering program accreditation was first started in the United States. Accreditation Board for Engineering and Technology (ABET, formerly known as the American Engineers' Council for Professional Development, which was established in 1932) accredited engineering programs in 1936 for the first time, and the accredited engineering programs included the majors in Columbia University, Cornell University and other universities[1]. ABET has now developed into organization of more than 30 professional and technical associations. As an unofficial and non-profit accrediting agency, ABET, at present, mainly carries out the engineering program accreditation in engineering, technology, computer science, and applied sciences.

In order to promote the internationalization of engineering education and the international mutual recognition of registered engineers, six countries including the United States, Australia, Ireland, New Zealand, the United Kingdom, and Canada,

Yuanfang Chen. Hohai University, 1 Xikang Road, Nanjing China. #2, Guibao LI. Chinese Hydraulic Engineering Society, NO 16, 2nd lane, Baiguang Road, Xuanwu district, Beijing. #3, Hongdao Jiang. Hohai University, 1 Xikang Road, Nanjing China. #4, Guofang LI. Hohai University, 1 Xikang Road, Nanjing China. #5, Fei Yuan. Hohai University, 1 Xikang Road, Nanjing China

launched and signed Washington Accord (WA), aiming at achieving mutual recognition of bachelor's degrees between these country members. Thereafter, Hong Kong, Taiwan, South Africa, Japan, Korea, Singapore, Malaysia and other countries and regions have become the members of WA successively.

To improve the quality of higher education and promote the internationalization of higher education are the main goals of higher education reform in China. The scale of undergraduate higher engineering education in China is huge. Over 90% of the colleges and universities have engineering programs, and the number of students majoring in engineering accounts for around 30% of the total number, and 16249 engineering programs occupying more than 30% of the total. In 1992, the former Ministry of Construction began to assess the subject of Construction and Civil Engineering[2]. In 2006, the Ministry of Education organized a pilot project for engineering program accreditation to improve the quality of teaching and joined the Washington Accord. After years of efforts, in June 2013, China became an interim state party of the Washington Accord by an unanimous vote, and then became an official member of the Washington Accord in June 2016. Ten years' hard work has made remarkable achievements. By the end of 2016, more than 780 programs from 14 disciplines have been accredited. At present, engineering program accreditation has entered a new stage. Hydraulic Engineering programs have been accredited since 2007, And Hydrology and Water Resources Engineering programs were accredited from 2007 to 2010.

Then, Hydraulic and Hydropower Engineering programs, Harbor, Waterway, and Coastal Engineering programs and Agricultural Hydraulic Engineering programs were accredited in succession from 2011 to 2013[3]. At present, there are 12 accredited programs in Hydrology and Water Resources Engineering, 14 in Hydraulic and Hydropower Engineering, 6 in Harbor, Waterway, and Coastal Engineering, 6 in Agricultural Hydraulic Engineering. 7 Hydrology and Water Resources Engineering programs in Hohai University, Wuhan University, Changsha University of Science and Technology etc. and 1 Harbor, Waterway, and Coastal Engineering program in Hohai University, were assessed in the second round of accreditation.

Ten years' accreditation has improved the quality of Engineering Education in China, formed valuable experiences and produced a relatively sound accreditation system with international effective equivalence. In order to adapt to the new requirements of the accreditation after joining the Washington Accord and to carry out the hydraulic engineering program accreditation better, the accreditation work during the past 10 years were summarized in this paper, which includes the construction of accreditation standard system, the accreditation of the survey at site and conclusion formation, expert team construction, the evaluation of graduation requirements. Finally the experience, deficiencies, and the countermeasures for future accreditation were discussed.

2 Summary and Analysis of Construction Process of Hydraulic Engineering Program Accreditation

It is the prerequisite and basis for the engineering program accreditation to develop the professional accreditation standard system with international effective equivalence and strong operability. Accreditation standards are divided into two categories: the common standards, which were formulated by the experts organized by China Engineering Education Accreditation Association (CEEAA) which named National

Committee of experts on Accreditation of Engineering Education before 2012 in a unified way (some experts form accreditation subcommittee participated in consultations, and the revision sought the views and recommendations of the subcommittee), which means all engineering programs must meet the requirements of this standard; and the professional supplementary standards, which were drafted by professional accreditation committees or pilot working groups according to the situation of different majors, and then censored and finalized by China Engineering Education Accreditation Association. The setting of the common standards and supplemental standards has been one of the key points and difficulties in accreditation. The standards have been revised according to the practice in pilot accreditation and recognized by the WA.

The common standards have gone through four stages since 2006: the first stage is from 2006 to 2008, the second stage from 2009 to 2011, the third stage from 2012 to 2014, and the fourth stage from 2015 till now [4]. The common standards of four stages are shown in table 1.

Table 1. Comparison of the Changes in the Framework and Index of the Common Standards of Engineering Education Accreditation in China in Different Stages.

Stages	The first stage 2006--2008	The second stage 2009--2011	The third stage 2012--2014	The forth stage 2015--now
The common standards	(1) Professional goals (specialties setup, graduates' ability)	(1) Professional goals (specialties setup, graduates' ability)	(1) Students (4 requirements)	(1) Students (4 requirements)
	(2) Quality evaluation (internal evaluation, social evaluation)	(2) Curriculum system (course offering, practice links, graduation project (dissertation))	(2) Program educational Objectives (3 requirements)	(2) Program educational Objectives (3 requirements)
	(3) Curriculum system (course offering, practice links, graduation project (dissertation))	(3) Faculty (teachers' structure, teacher development)	(3) Student Outcomes (1+10requirements)	(3) Student Outcomes (1+12 requirements)
	(4) Faculty (teachers' structure, teacher development)	(4) Support conditions (teaching funds, teaching facilities, literature, study, combination of school and enterprise)	(4) Continuous improvement (3 requirements)	(4) Continuous improvement (3 requirements)
	(5)Support conditions (teaching funds, teaching facilities, literature, study, research and production)	(5) Student development (enrollment, employment, student guidance)	(5) Curriculum system (1+4 requirements)	(5) Curriculum system (1+4 requirements)
	(6) Student development (enrollment, employment, student guidance)	(6 Management system (teaching management, Process control and feedback)	(6) Faculty (5 requirements)	(6) Faculty (5 requirements)
	(7) Management system (teaching management, quality control)	(7) Quality evaluation (internal evaluation, social evaluation, continuous improvement)	(7) Support conditions (6 requirements)	(7) Support conditions (6 requirements)
	The standard framework has been very close to WA's framework since 2012, and the graduation requirements have been more similar to WA's after the great adjustment in 2015.			
American EC2000 standard	(1) Students, (2) Program educational Objectives, (3) Student Outcomes, (4) Continuous Improvement, (5) Curriculum, (6) Faculty, (7) Facilities, (8) Institutional Support			

From table 1 it can be seen that there are some social evaluations in the quality evaluation of the common standard in the first and second stage. As a result, the cooperation between schools and the enterprises was strengthened by the accreditation. However, the difference of the structure between the first and second stages is very remarkable, and the main difference is that the quality evaluation was removed from the second index to the seventh index in the second stage and continuous improvement was added in the quality evaluation. However, student outcomes (graduation requirements) aren't listed in these stages, which means the core concept of output oriented accreditation wasn't given enough consideration.

Besides, continuous improvement wasn't included in the first stage and the improvement of the core concept wasn't reflected, indicating the previous accreditation method still affected the standard in the first stage. It was improved in the second stage, but the continuous improvement of the core concept was still not given enough consideration. In a word, the framework of the standards is immature and has gap in comparison with the international one. A major adjustment to the common standards was made in 2012, in the light of the accreditation standards adopted by ABET in 1997 (EC2000 standard). The mean features of the common standards in the third stage are as follow. For all students and enhance the importance of students; More emphasis on qualitative judgments and the role of experts; Combination and classification are more scientific, such as the original professional goals divided into program educational objectives and graduation requirements, the original quality evaluation and management system merged into continuous improvement; More clarity, and the five terms are easier to understand. In the third stage, the main difference of the common standards between China and the United States is that the U.S. divided support conditions into facilities and institutional supports. Therefore, American common standard has 8 indicators while China has 7 indicators. The accreditation standard set in 2012 was only implemented for 2 years. The China Engineering Education Professional Certification Association issued the latest accreditation standard, and this article called it the fourth stage of common standard. The main differences of the common standards between the third and fourth stage are as follows: The requirements in the fourth stage increase from 10 to 12, and the graduation requirements in 9 places increase the requirements for the solution of complex engineering problems. At this stage, the standards need to evaluate the quota and quality of graduation requirements. The implementation of the common standards in the fourth stage makes the engineering program accreditation common standard in our country closer to the requirements of the Washington Accord, which laid a solid foundation for the equivalent of the international substance and constructed a good foundation for our country to become a full member of the Washington Accord in 2016.

As far as the whole country is concerned, the supplementary standards of accreditation have also experienced four changes and can be divided into four stages. It is shown in the Table 2 that the comparison of the changes in the framework and content of the supplementary standards in different stages.

Table 2. Comparison of the Frameworks of the Supplementary Standards of Engineering Education Accreditation in China in Different Stages.

stage	The first stage 2006--2007	The second stage 2008	The third stage 2009--2011	The forth stage 2012--now
Standard content	(1) Training targets and requirements	(1)Course offering	(1) Training targets and requirements	(1) Course system
	(2)Course	(2) practice links	(2) Course offering	(2) Teaching staff
	(3) Teaching staff		(3) Teaching staff	(3) Support conditions
	(4) Support conditions		(4) Professional conditions	

From Table 2, it can be seen that the supplementary standard in 2008 is the simplest one and just includes the content of the course system which is the result of two years' pilot practice in early 2008. Some experts thought that the supplementary standards were excessive and some were duplicated with the common standard, and then they simplified the supplementary standard. However, they felt that the supplementary standards in 2008 couldn't reflect the differences between different professional requirements after one year's practice. Therefore, the framework of the supplementary standards in 2009 was basically restored to the same as the first stage, but the course was changed into the course offering and the support conditions were changed into professional conditions. On the basis of the third stage, the training targets and requirements were deleted, and the course was changed into course system, combined with the professional conditions changed into support conditions. In the supplementary standards in 2012, the course system contains course offering, practice links, graduation project (dissertation), teaching staff including professional background and engineering background, support conditions including professional information, experimental conditions and practice base. At present, comparing to the United States, the supplementary standard in China adds an item about support conditions.

In the process of setting the supplementary standard, how to deal with the relationship between the common requirements and the individuality characteristic of the same specialty is one of the problems that need to be solved. The course systems of Hydraulic and Hydropower Engineering, Harbor, Waterway, and Coastal Engineering and Agricultural Hydraulic Engineering in hydraulic specialties are similar, while the course system of Hydrology and Water Resources Engineering differs from them. Therefore, the requirements of Hydraulic and Hydropower Engineering, Harbor, Waterway, and Coastal Engineering and Agricultural Hydraulic Engineering are introduced together, and the requirements of Hydrology and Water Resources Engineering are introduced separately in this article. In order to meet the needs of social and economic development, different professional points should have their own characteristics according to different specialties. For example, the course offering of Hydrology specialty is divided into four types of courses instead of listing all the courses that need to be offered in each school; On the premise of the credit requirement for each course, the supplementary standards put forward the compulsory courses and the optional compulsory courses for the basic professional courses and professional courses according to the features of each school. This can not only meet the requirements of learning basic professional knowledge for each student, but also make different programs choose different courses in their own characteristics to allow their students to meet the basic requirements of accreditation and keep the professional characteristics of each school.

After the publishment of the fourth stage of common accreditation standard, China Engineering Education Accreditation Association requires the accreditation

subcommittee to amend and improve the supplementary standard under the latest common standard, including how to solve the complex engineering problems in the course system, such as graduation project, comprehensive practice and experiment. It is obviously that different specialties should solve the complex engineering problems in different ways, and hydraulic engineering specialties have already started this work.

According to the above analysis, it can be seen that the formulation of supplementary standards needs to be constantly improved and continues to revise on the basis of understanding the training targets and graduation requirements and widely collecting suggestions from universities and experts.

3 How to effectively carry out on-site evaluation and the formation of certification conclusions.

The first step in carrying out accreditation is that the colleges and universities who have the programs should submit accreditation applications to the China Engineering Education Accreditation Association (Including the submission of program educational objectives and graduation requirements, the original training plan, and the evaluation of the actual example for a certain graduation request). If the application passed, the programs will assess by themselves, and write self-assessment reports according to the requirements of the accreditation standards. After the self-assessment report has been reviewed, China Engineering Education Association will arrange experts to conduct on-site inspections. On-site inspection is a very important link in accreditation work, because the efficiency of the accreditation is directly affected by the quality of this work.

According to the practice in the past 10 years, the main practice and experience of hydraulic engineering program accreditation are as following:

(1) Deeply understand the core concept of accreditation. Teaching evaluation should focus on educational output instead of input. The target is to cultivate students' ability. Accreditation should be geared to all students. Conclusion should not be affected by the landmark achievements in education. Accreditation is to reach the standard, not to select elites.

(2) Scientifically establish a team of accreditation experts and strengthen training. Accreditation experts should have a reasonable structure. They should not only come from universities, industry or enterprise, but also need to accept accreditation training, and understand the concept of accreditation. They should be familiar with the latest standards, procedures and requirements. On-site inspection expert team leader should have a better understanding and mastery of standards, and participate in many times on-site inspection. In addition to actively organize experts to participate in the training organized by the association for the organization, Hydraulic engineering program accreditation committee should also organize special training for key and difficult problems in accreditation, and carried out case discussions with the conclusion review meeting, which effectively improved the level of certification work.

(3) Arrange site visits reasonably. Organize the preparatory meeting after arrived. Accreditation experts should carefully review the self-assessment report and put forward some key points. Draw a preliminary examination calendar before arrive at the school. On the eve of the examination, the preparatory meeting will be held to discuss the key points of the examination, as well as the detailed agenda of the group and the

individual. The accredited school should have a student roster, a course schedule, a list of teachers and recommendations, a list of graduates, employers and other people, and a workplace in where facilitates expert access to materials and archives. In interviews or seminars of various types of personnel, some public courses and basic courses taught by teachers from other departments should be included. After the first two days of the examination activities, the expert group meeting should be held to communicate the situation and discuss the issues in a timely manner so as to facilitate the inspection of progress and consensus.

(4) Expert feedback should pay attention to practical results, and clearly point out the shortcomings and improvement directions in school running. The content of feedback mainly includes the basic situation of the school, which is obtained by the expert group, the evaluation opinions of the self-assessment report, completeness of 39 general standards involved, the points of concern, the situation, the existing problems and suggestions for improvement. The inspection team leader presides over the feedback, and will mainly introduce the feedback content. The other experts make a supplementary speech on a question in accordance with their own examination situation.

(5) The draft of report should be completed after site inspection and the evaluation and analysis should be ready. The standard of achievement evaluation and the proof of insufficient problems should be adequate, targeted, realistic description of the problems found. Do not set high hats, directly describe the problem. The leader may refer to the relevant requirements and preliminary opinion from experts. In the evening of the second day, assessment team should discuss and prepare the draft report. In the morning of the third day before the feedback, group members should get together to discuss the formation of group consensus on the feedback, and make an appropriate division of labor. As the experts are often very busy, it will be better to complete the on-site investigation report during the inspection period. This is a very good experience in hydraulic engineering program accreditation after 10 years' pilot certification. Combined with other categories of specialty accreditation, they recognized highly of us. Through intensive discussion, we can more accurately judge the situation and problems of different index points, brainstorm, spark ideas and promote exchanges.

The formation of a program accreditation conclusion shall be discussed and confirmed by all members of the Certification Committee (enlarged). This will help to play the role of collective wisdom, discuss more deeply, and make the conclusion more reasonable and credible. The meeting should first listen to the on-site inspection team leader on the examination of the presentation, focusing on the problems identified. Then, the participants present their views at different levels and should pay attention to the consistency of the conclusions. The most important thing is the consistency of the nature of the proposed or found problem and the accreditation conclusion, and note to compare with the existing professional accreditation conclusions. Under the same standard, different expert groups due to master different scales and lead to obvious inconsistencies should not happen.

4 The main methods and effect of strengthening the construction of certification expert team

A team of accreditation experts who have strong sense of responsibility and familiarity with accreditation requirements is important to the accreditation. In the past

10 years, China Engineering Education Accreditation Association (CEEAA) has attached great importance to strengthening the construction of accreditation expert teams. At present, a team of more than 80 experts from Hydraulic Engineering, Hydropower Engineering, Waterway Engineering and Agriculture Engineering in different industries and universities has been formed.

The main experience of hydraulic program accreditation committee in strengthening the construction of accreditation expert teams includes:（1）Good plan. There are an annual plan for the construction of expert teams and a 5 years plan for the hydraulic accreditation. It is forward-looking and beneficial to fulfill the requirement for the experts. （2）Overall coordination. Take action and attract attention of relevant departments, associations such as the Ministry of water resources, personnel division, China Water Conservancy Society, China Hydropower Engineering Society, China water Construction Industry Association. Then they will recommend excellent experts from different industries. Their recommendations play an important role in the accreditation work.（3）Actively participation. The relevant personnel were participated in the training of the experts organized by the Ministry of education and the training schools every year. Sending experts to participate in counseling program accreditation, write self-assessment reports, centralized answer questions.（4）Discussion. China Engineering Education Accreditation Association (CEEAA) has organized several professional experts and schools for research and training. For example, the national accredited school and all the accreditation experts were organized to discuss and exchange experience in Nanjing in 2012. We also organized special training after accreditation standard revised and invited the national well-known accreditation experts and leaders to advise.（5）Exchanges with the outside world. Experts were organized to go to Australia and Hong Kong to inspect and observe local accreditation work. Experts also went to Japan for professional engineer qualification and professional accreditation training. At the same time, foreign experts (such as Singapore professor Chen Xunji) were invited to participate in on-site inspection.（6）Seeking potential candidates. In each on-site examination, experts are selected to participate in the accreditation process, so as to train qualified experts as soon as possible. Selecting and training experts in a variety of measures made accreditation in 4 majors of hydraulic engineering programs carried out smoothly.

5. Making quantitative and qualitative evaluation of student outcomes (graduation requirements)

Before 2012, student outcomes were not included in accreditation standard system (the common standards), so there is no question about evaluating outcomes. In 2012, the student outcomes were presented as the second indicators in the standard system, from this time, output oriented theory (American scholars Spady1981) began to be implemented in the accreditation. However, the evaluation was only including qualitative analysis and evaluation rather than quantitative evaluation. In order to become a formal member from the temporary contracting part, China Engineering Education Accreditation Association (CEEAA) required all programs to pilot one quantitative evaluation of student outcomes from ten graduation requirements, so that an initial conclusion about whether it achieved the requirements can be presented.

In 2015, after the fourth stage common standards, the standards should integrate qualitative evaluation with quantitative by taking into account non-technical factors of graduation requirements, although CEEAA required all programs meet entire 12 requirements with quantitative evaluation.

According to the practice and exploration on bachelor program accreditation for hydraulic engineering, to complete student outcomes evaluation, following measures should be taken:

(1) To formulate work regulations, colleges could issue a document in the form of introduction, including the time and period, personnel composition and division of labor, the quantitative and qualitative evaluation methods, evaluation results and record requirements, etc.;

(2) In accordance with the requirements of the documents, colleges should organize the discussion about the decomposition of index points and the corresponding teaching activities by college leaders, professionals, teachers, and industry experts engaged in. At present, there is an obviously unreasonable phenomenon as only young teachers lack experiences in evaluation without professional responsible person that lead to a lack of discussion;

(3) All relevant courses must be assessed before the evaluation of student outcomes, or if the premise is unreasonable, it will be difficult to achieve the goal. Judging from current practice, there is still a big gap between specialized courses in curriculum evaluation and continuous improvement;

(4) Student outcomes need not only quantitative evaluation, but also qualitative evaluation, because assessing ways of non-technical ability graduates are not by the examination, but through the design of questionnaire. How to investigate needs further exploration and improvement;

(5) There should be a correct understanding on the evaluation of student outcomes, which means the evaluated numerical value is not too much serious, such as a preset value (0.7) which is up to the requirements cannot be the only key of evaluation. The value can analyze the short board and support programs with continuous improvement, so as to improve the quality of talent training and achieve the original intention of certification work. In addition, before graduation requirements are evaluated, it is necessary to analyze whether the graduation requirements of the programs can support the training goals and include 12 requirements in the general standards. According to the characteristics of hydraulic engineering program, graduation requirements should include not only the proposed general standard with environmental factors restriction, but also the ecological factors, and it will be more accordant with practical circumstances.

6 Conclusions

Through the practice of hydraulic engineering program accreditation pilot in last ten years, we find it is necessary and meaningful to conduct engineering program accreditation. On the one hand, it can help to promote international recognition of education and internationalization of talents cultivation. On the other hand, it can promote the development of professional points and enhance talents cultivating quality, which means it can greatly promote the contact between hydraulic higher education and enterprises and make graduates adapt to the society earlier.

The hydraulic engineering program accreditation has been successfully carried out in past ten years, including a complete accreditation standard system with international effective equivalence, expert teams from different specialties, and extensive experience in accreditation. However, with the accession to the Washington Accord, the accreditation will need to expand the scale and improve requirements. Therefore, in addition to routine accreditation, we should also increase the manpower, material and financial resources and strengthen research of the practice, such as how to improve the accreditation standard system especially the hydraulic engineering program accreditation supplementary standards, construction of hydraulic engineering teaching materials to be adapted for new requirements, the complex engineering problems involved in different hydraulic engineering programs to be reflected, the different hydraulic specialties in the same university or the same specialty from different programs to be accredited at the same time, the consistency of authentication conclusion to be realized better, the non-technical factors in graduation requirement to be conducted and highly regarded and so on.

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