A Quick Overview of Accreditation of Engineering Programs in United States

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Abstract.
Accreditation is assurance that a college or university program meets the quality standards established by the profession for which it prepares its students. For example, an accredited engineering program must meet the quality standards set by the engineering profession. Accreditation gives colleges and universities a structured mechanism to assess, evaluate, and improve the quality of their programs. In the United States, accreditation is a non-governmental, peer-review process that assures the quality of the postsecondary education students receive. Educational institutions or programs volunteer to undergo this review periodically to determine if certain criteria are being met. Engineering accreditation in United States is handled by ABET Inc. In this paper we will present a quick overview of assessment and the engineering accreditation in United States carried out by ABET. A general overview of the benefits of the accreditation will also be included. Finally, some recommendations in regard to starting such a process in Iran will be presented.

Keywords: Assessment, Learning Assessment, Engineering Education, ABET

Introduction

It is generally accepted that assessment is at the heart of the learning process [1-4]. The purpose of assessment is to systematically improve the quality of student learning through improved programs, curricula, and teaching. Assessment as long term strategy is intended to provide a measure that would enable planners and decision makers to modify the processes in order to enable a high-performance student learning system through the continuous measurement of processes and outcomes, and using the results to further refine performance. Systematic assessment of student learning is the first step in an ascending stairway of structured self-examination that enables individual faculty members, programs, and institutions to build a learning organization.

One can also state that assessment is at the heart of accreditation. The history of engineering accreditation in United States can be traced back to early 1900's. The idea behind accreditation was to assess the quality of engineering education from different universities [5]. What is now known as engineering accreditation began in 1932 with the formation of the Engineers' Council for Professional Development (ECPD) with headquarters in New York. The original principles for accreditation were adopted in 1933. They consisted of nine major points and contained little that would tell an institution what to do to prepare for an accreditation visit, other than to answer a questionnaire and provide a copy of the school's catalog to the visiting panel. This procedure left a great deal of discretion to the panel members, who judged the information provided and decided whether to accredit. There was virtually no specification of minimum standards, except that all accredited programs had to lead to

a degree. The first engineering programs were accredited in 1936. In 1946, ECPD extended accreditation to technology programs. In 1980, ECPD changed its name to the Accreditation Board for Engineering and Technology (ABET) [6]. In 1984, ABET began to accredit engineering-related programs.

This paper is organized in the following way: first we present a brief introduction about assessment and engineering assessment, next we present a brief introduction about ABET and engineering accreditation in United States and other countries that have adapted similar approaches, finally we provide some recommendations about accreditation that can be implemented in Iran.

A Brief overview of Engineering Assessment

The intention behind assessment is to improve student learning and although many experts have provided definition of assessment [7-8], but The challenge is in deciding what constitutes learning and how best to measure it. In defining assessment experts agree that it is an "ongoing process," which involves making our expectations explicit to the public, setting appropriate criteria and high standards for learning quality; systematically gathering analyzing and interpreting evidence to determine how well performance matches those expectations and standards; and using resulting information to document, explain, and improve performance. When embedded effectively within large institutional systems, assessment can help us to focus our collective attention, examine our assumptions, and create a shared academic culture dedicated to assuring and improving the quality of higher education [9]. From this definition it can be deducted that the assessment is both a process and a product. It is a process for evaluation and it provides a product that faculty can use to provide evidence of what and how well students are learning. The following figures [10] show the assessment process in three cycles: (i) The program educational objectives cycle, (ii) the program outcome cycle and (iii) the course outcome cycle.

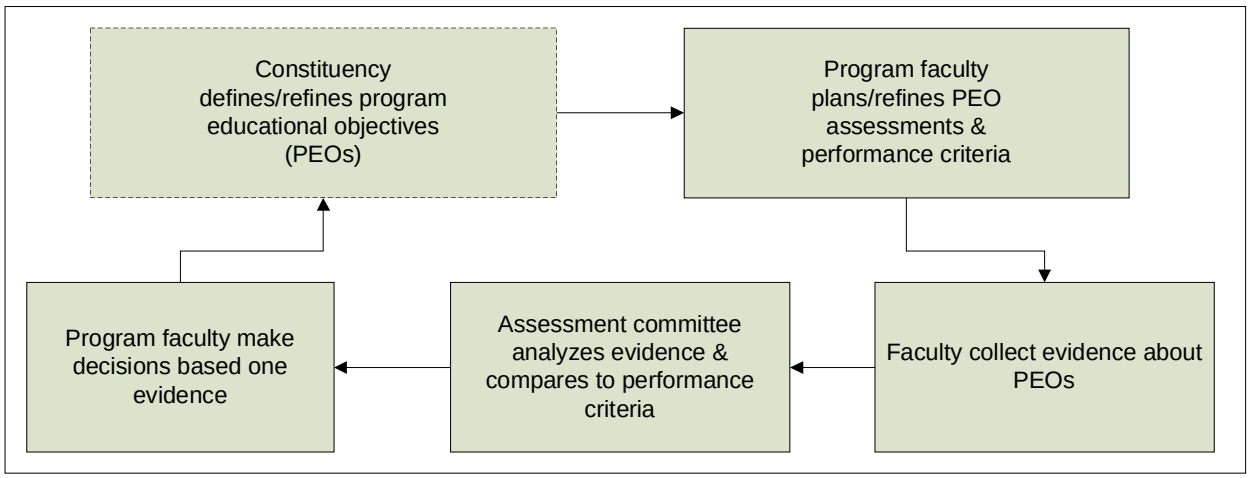

Figure 1. Assessment of PEOs

Figure 1. outlines the assessment cycle for program educational objectives (PEOs) as defined by ABET criteria 2 (ABET's criteria are listed in the next section). These reflect "broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve" [11].

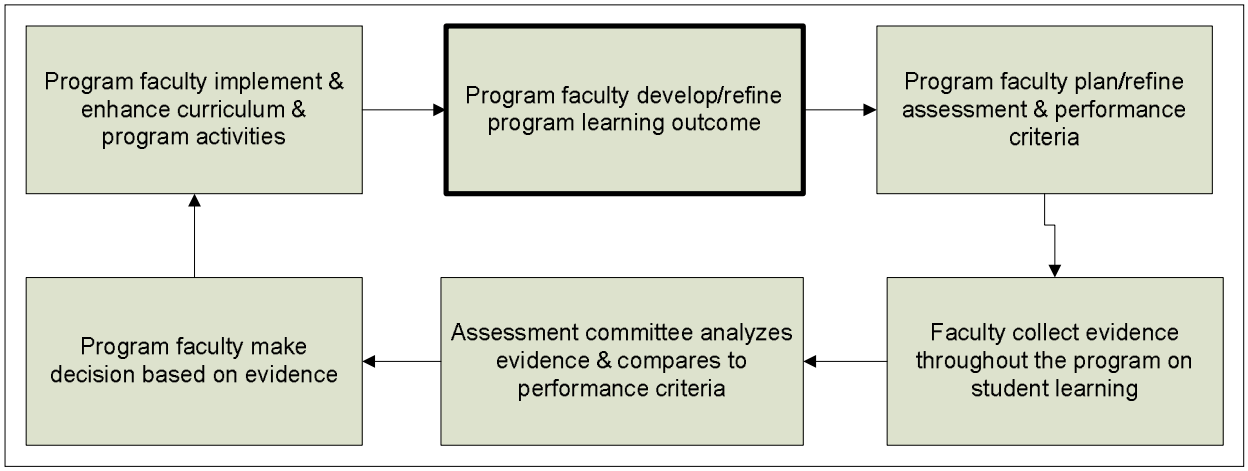

Figure 2. Assessment of Program Outcomes

Figure 2. shows the assessment cycle for program learning outcome. ABET outcome 3, defines the program outcome as "statements that describe what students are expected to know and be able to do by the time of graduation. They relate to the skills, knowledge and behaviors that students acquire in their matriculation through the program" [11]

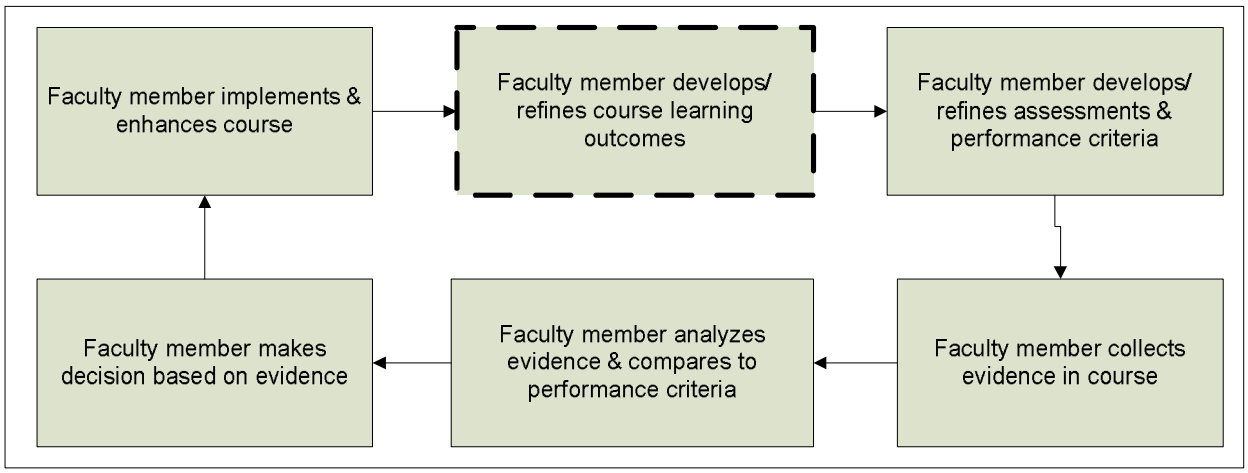

Figure 3. Assessment of Course Outcomes

Figure 3. outlines the assessment cycle for a course that occurs within one semester. Not all courses need to be evaluated at this level, but for those that do, this cycle can be very useful. The faculty member(s) who teaches the course defines the learning outcomes, some of which map to the program learning outcomes. To improve the course the faculty develops assessment for the outcomes.

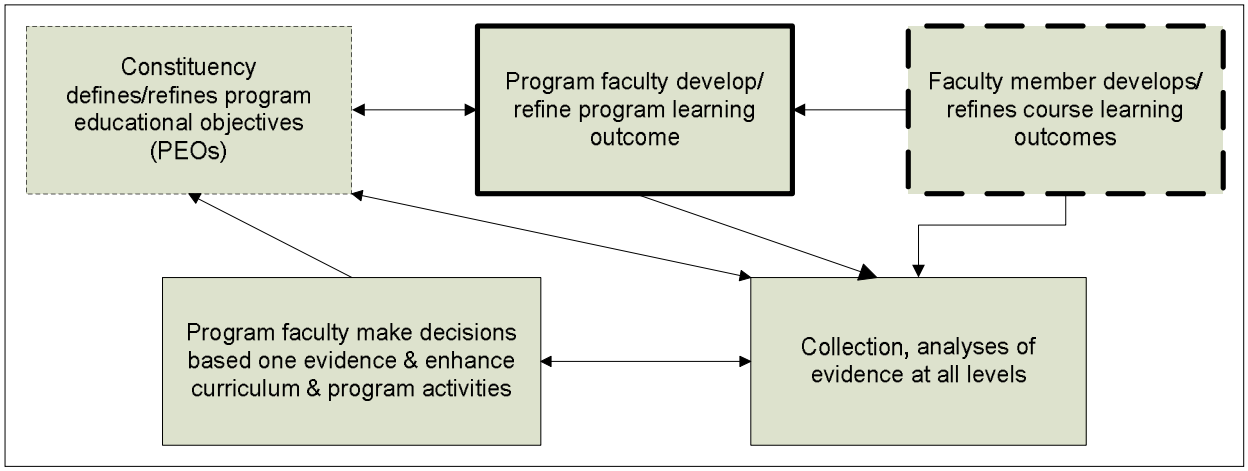

Figure 4. Interrelationships of Assessment Cycles

Figure 4. shows the interrelationships of the previous three processes. This figure is a macro view of the important connections of these processes.

ABET has defined both program educational objectives and a set of 11 outcomes (covered in the next section) that students in every engineering program must meet (i.e. ABETs criteria 3 a-k).To further define what we want our students to know, the program educational objectives and program learning outcomes must be directly linked to the curriculum and to course outcomes and objectives. Each course in the program will typically have three to five course learning outcomes/objectives related to one or more of the program outcomes.

The outcome based assessment is a dynamic process. It starts with designing outcomes that would reflect student learning, next comes documentations of the achievements (for ABET a-k processes), and finally establishing a link to PEOs in meaningful way. Overtime PEOs change and/or as it becomes clearer which outcomes best reflect knowledge about student learning, the way outcomes are assessed may need to be modified. Finally, we would like to point that in regard to assessment methodology the level of analysis must be identified as assessment for an individual student, a course, a program, or an institution require different approaches.

ABET

Historical background

Engineering accreditation began in 1932 with the formation of the Engineers' Council for Professional Development (ECPD) with headquarters in New York. Seven engineering societies founded the organization and contributed to its original direction and focus: The American Society of Civil Engineers (ASCE), the American Institute of Mining and Metallurgical Engineers (now the American Institute of Mining, Metallurgical, and Petroleum Engineers), the American Society of Mechanical Engineers (ASME), the American Institute of Electrical Engineers (now IEEE), the Society for the Promotion of Engineering Education (now the American Society for Engineering Education), the American Institute of Chemical Engineers (AIChE), and the National Council of State Boards of Engineering Examiners (now NCEES).

Within its first year of existence, ECPD had begun developing itself as an accreditation agency; in 1936, ECPD evaluated its first engineering degree programs. In 1946, ECPD extended accreditation to technology programs. In 1980, ECPD changed its name to the ABET. In 1984, ABET began to

accredit engineering-related programs. In 1994, the headquarters of ABET were moved from New York to Baltimore. ABET's international activities initially launched in 1979 when ECPD signed its first mutual recognition agreement with the Canadian Engineering Accreditation Board. By 1989, ABET was a consultant to both fledgling and established international accreditation boards, a "substantial equivalence" evaluator of international programs, and a founding member of the multinational Washington Accord. Currently, ABET accredits some 2,700 programs at more than 550 colleges and universities in United States. Each year, over 1,500 volunteers from its now 29 member societies actively contribute to ABET's in applied science, computing, engineering, and technology education, serving as program evaluators, committee and council members, commissioners, and Board representatives.

Current Structure

ABET is a federation of 29 professional and technical societies. Individual members of these societies - practicing professionals from industry and academe - form the body of ABET through its program evaluators (PEVs), Board of Directors, and four accreditation commissions, the Applied Science Accreditation Commission (ASAC), Computing Accreditation Commission (CAC), Engineering Accreditation Commission (EAC), and Technology Accreditation Commission (TAC).

The ABET Accreditation

ABET accreditation is assurance that a college or university program meets the quality standards established by the profession for which it prepares its students. For example, an accredited engineering program must meet the quality standards set by the engineering profession. An accredited computer science program must meet the quality standards set by the computing profession. It is important to recognize that accreditation is not a ranking system. It is simply assurance that a program or institution meets established quality standards.

The ABET Accreditation Process

Accreditation is a voluntary process on the part of an institution. The first step is that an institution requests an evaluation of its program(s). (Only programs that have produced at least one graduate are eligible for accreditation.) Each program then conducts an internal evaluation and completes a self-study questionnaire. The self-study documents whether students, curriculum, faculty, administration, facilities, and institutional support meet the established criteria. While the program conducts its self-examination, the appropriate ABET commission (Applied Science, Computing, Engineering, or Technology Commission) forms an evaluation team to visit the campus. A team chair and one or more program evaluators make up the evaluation team. Team members are volunteers from academe, government, and industry, as well as private practice. During the on-campus visit, the evaluation team reviews course materials, student projects, and sample assignments and interviews students, faculty, and administrators. The team investigates whether the criteria are met and tackles any questions raised by the self-study. Following its campus visit, the team provides the school with a written report of the evaluation. This allows the program to correct any misrepresentations or errors of fact, as well as address any shortcomings in a timely manner. At the annual meeting of all ABET commission members, the final evaluation report is presented by the evaluation team, along with its recommended accreditation action. Based on the findings of the report, the commission members vote on the action and the school is notified of the decision. The information that the school receives identifies strengths, concerns, weaknesses, deficiencies, and recommendations for improvements. Accreditation is granted for a maximum of six years. To renew accreditation, the institution must request another evaluation.

EC2000: Outcomes Assessment and Continuous Improvement

In 1997, following nearly a decade of development, ABET adopted Engineering Criteria 2000 (EC2000. The focus of EC2000 was on what is learned rather than what is taught. At its core was the call for a continuous improvement process informed by the specific mission and goals of individual institutions and programs. Lacking the inflexibility of earlier accreditation criteria, EC2000 meant that ABET could enable program innovation rather than stifling it, as well as encourage new assessment processes and subsequent program improvement.

The two major changes brought on by EC 2000 were embedded in Criteria 2 and 3 of the eight ABET criteria [11]. Criterion 2 states that engineering degree programs must define a set of educational objectives, promote those objectives to external interests, and have in place a mechanism to evaluate the success of their objectives. Educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve several years after the undergraduate degree. Criterion 3 states that engineering degree programs must define a set of program outcomes, promote those outcomes to all constituents, and have in place a mechanism to continuously assess the achievement of these outcomes. Program Outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These outcomes relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.

1. Students
2. Program Educational Objectives
3. Program Outcomes
4. Continuous Improvement
5. Curriculum
6. Faculty
7. Facilities
8. Support
9. Program Criteria

Table 1. ABET's General Criteria for Baccalaureate level

Program Outcomes

ABET has published a list of eleven outcomes that they offer for general use by engineering programs. The eleven ABET outcomes, commonly referred to simply as (a) through (k), are listed in Table 2. The original intent was for this ABET list to serve as an example, from which each engineering program would fashion their own set of outcomes. In some cases, this did happen; but in other cases, programs just stayed with (a) through (k).

(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component, or process to meet desired needs
(d) An ability to function on multi-disciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context

(i) A recognition of the need for, and an ability to engage in life-long learning
(j) A knowledge of contemporary issues
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Table 2 ABET Outcomes (a through k)

Preparing for ABET accreditation: From an institution stand point

To comply with the ABET engineering criteria, a program must first formulate program educational objectives (broad goals) that address institutional and program mission statements and are responsive to the expressed interests of various groups of program stakeholders. The program must then formulate a set of program outcomes (knowledge, skills, and attitudes the program graduates should have) that directly address the educational objectives and encompass certain specified outcomes (Outcomes 3a–3k, shown in Table 2). In some required courses in the program curriculum, outcome-related course learning objectives (statements of things students who complete the course should be able to do—explain, calculate, derive, design,…) must be written. The program educational objectives and outcomes must be set forth in a self-study report, which must also include statements of where the outcomes are addressed in the program curriculum, how their level of attainment is to be assessed, and how the assessment results will be used to improve the program. Beginning with the second accreditation visit, the program will also presumably have to demonstrate that it has implemented the improvement plan formulated in the prior visit.

Concluding Remarks: Why Start an ABET Type Accreditation in Iran?

From the previous sections it is obvious that the accreditation process requires a substantial investment in terms of money and time by institutions and faculty. There may be some that would question this suggestion and state that there is nothing wrong with the current system and may even say if it is not broken don't fix it. To answer these critiques one has to show the benefits of such an approach. Apart from the fact that there are clear religious evidences in support of assessment and evaluation in the general sense, it is well accepted that establishing and maintaining a quality program requires some sort of assessment and evaluation, and for academic programs learning based assessment has been proven the best tool and approach. It is true putting together the required infrastructure will be expensive and time consuming, but it is money and times well spent. Due to the importance of the engineering education in the future of the country this effort will be well justified. It should be mentioned that this process has been implemented in United States for several years and there are vast amount of available literatures, about the whole process, which can be used as a good source and a starting point. It is also worth mentioning that ABET accreditation process is being recognized and adopted by other countries such as Canada, Mexico, several Latin American countries, India, and even UAE [12-15]. Another related issue that should be examined is the direct relationship between a quality undergraduate education and a graduate education; one cannot have a strong graduate program without good students that are product of a fine undergraduate program. Moreover, it is unfortunate that the quality of institutions in Iran is being mostly judged by the level of students that are being admitted to the programs and their ability to learn abstract concepts on their own, without much examination of the role of the faculty and the programs. Even the best students, when coming abroad for graduate studies, although possess a good knowledge of their field but most of them lack the anticipated level of creativity and design skills that one expects from their level of intelligence. Finally, in the coming years the creativity requisite for engineering will change only in

the sense that the problems to be solved may require synthesis of a broader range of in-depth and interdisciplinary knowledge and a greater focus on systemic constructs and outcomes. This cannot be achieved without a dynamic assessment program. Creating a non-governmental accreditation system would benefit the Iranian educational system and the Iranian nation.

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