Satisfying ABET Accreditation: Program Assessment

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Abstract

The Accreditation Board for Engineering and Technology (ABET) has revised the accreditation criteria that is designed to assure that graduates of accredited programs are prepared to enter the practice of engineering and satisfy industrial requirements. The general criteria also specifies that engineering programs must demonstrate that their graduates possess or satisfy eleven (11) educational outcomes generally known as "a" through "k".

This investigation suggests that graduating seniors in Civil (Construction) engineering believe their educational experience has given them a strong background in two of the outcomes required by ABET. These include: (1) an ability to apply knowledge of mathematics, science, and engineering; and (2) an ability to identify, formulate, and solve engineering problems. In contrast, three outcomes received slightly lower ratings from alumni practitioners and employers. These include, a knowledge of contemporary issues; the broad education necessary to understand the impact of engineering solutions in a global/societal context; and an ability to communicate effectively. Overall, the data may suggest that not all ABET educational attributes are considered by graduating seniors in Civil (Construction) engineering, employers, and industrial practitioners, to have the same level of significance and perhaps should not be stressed to the same degree in an engineering program. In this regard it was found that the scores from a benchmarking study tend to be lower than those of students and practitioners educated at Lamar University. Nevertheless for comparative purposes, the findings of the investigation could be utilized by other institutions and departments that may wish to study and/or assess their curriculum and satisfy ABET criteria.

I. Introduction

Over the years there have been recommendations from employers and various technical/professional societies to revise the engineering curriculum to ensure that students are prepared for the increasing complexity and international aspects of engineering work[3, 4, 11, 14]. Engineering educators have also been involved with these efforts[5, 7, 8, 9]. Nevertheless, there appears to be a general belief that the engineering profession must change so that in the future it will be highly recognized and respected at national and international levels[1, 2, 13]

This paper presents the results of an investigation of the perceptions of three groups: graduating seniors, employers and alumni practitioners. The data for the study was obtained, in part, from a survey instrument that was distributed to graduating seniors requesting them to rate their educational experience at Lamar University. In addition, a similar questionnaire was completed by firms who employ graduates, and alumni practitioners. Employers were requested to indicate the background of their employees who graduated from Lamar University. Alumni practitioners were asked to indicate the level at which their civil engineers coursework related to the 11 attributes or outcomes, prepared them for a professional career.

In order to obtain a data base for comparison products, information from EBI Engineering Education e news was utilized[6]. Here, results based on approximately 7,000 responses from graduating seniors at 58 engineering schools are available. The information includes a tabulation of the highest and lowest score for various engineering majors. These include: Aerospace, Bioengineering, Chemical, Civil/Construction, Computer/Computer Science, Electrical/Electronic, Engineering Management, Industrial, Materials, and Mechanical/Mechanics Engineering.

II. *Engineering Criteria*

ABET, the recognized accreditor for college and university programs in engineering, technology, computing, and applied science, is a federation of 31 professional and technical societies representing these fields. It is also involved in international activities, including the Washington Accord, and offers educational credentials evaluation services to those educated abroad. In addition ABET is recognized by the Council on Higher Education Accreditation[12].

It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the criteria. In particular the quality and performance of the students and graduates are important considerations in the evaluation of an engineering program. Specifically, the institution must evaluate, advise, and monitor students to determine its success in meeting engineering program objectives[3]. To enhance these concepts, the ABET *Engineering Criteria* requires that engineering programs must demonstrate that their graduates possess the following:

(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 multidisciplinary 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/societal context
(i) A recognition of the need for, and an ability to, engage in lifelong learning
(j) A knowledge of contemporary issues

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

In addition, each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured[3].

III. Perceptions of Required Educational Outcomes

As a segment of the continuing review and evaluation of the curriculum, a survey instrument was distributed to alumni practitioners, employers, and graduating seniors of the Civil Engineering Department of Lamar University. The tabulated results of which form the database for the investigation. The questionnaire listed eleven educational outcomes and requested that respondents indicate at which level—strongly agree, agree, disagree or agree or disagree—each outcome has been incorporated into the curriculum. The educational outcomes chosen were those that engineering programs must require of their students before they are allowed to graduate. They were included in the program outcomes and assessment section of the ABET *Engineering Criteria 2000* and are listed in the previous section as "a" through "k".

In particular, Table 1 lists data from the various constituencies of the civil engineering program. As shown, the composite scores of graduating students indicate that two outcomes are covered at the highest level (4.6), including:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to identify, formulate, and solve engineering problems

In addition, alumni practitioners perceive that the program has given them an above average background in these areas. These results indicate strong support for the application of the technical aspects of engineering. This may be considered to be the traditional role of civil/construction engineers.

The three attributes or outcomes listed below and shown in Table 2 are also rated with relatively high scores, (4.4-4.6) by graduating seniors at Lamar University

- An ability to design and conduct experiments, as well as to analyze and interpret data
- An understanding of professional and ethical responsibility
- An ability to function on multidisciplinary design teams

These findings suggest that in addition to the traditional technical aspects of civil (construction) engineering, students and alumni practitioners believe they have received a good background in the following: an understanding of professional and ethical responsibility, and an ability to function on multidisciplinary design teams.

Table 1. Comparison of ABET Outcomes with Student Scores = 4.6			
Level of Educational Outcomes, as a Composite Score			
Educational Outcome (1)	Graduating Seniors (2)	Alumni Practitioners (3)	Employers (4)
An ability to apply knowledge of mathematics, science, and engineering	4.6	4.5	4.2
An ability to identify, formulate and solve engineering problems	4.6	4.4	4.3
Composite score based upon 5.0=strongly agree; 4.0=agree; 3.0=neither agree nor disagree; 2=disagree; 1.0=strongly disagree			

Table 2. Comparison of ABET Outcomes with Student Composite Scores			
Level of Educational Outcomes, as a Composite Score			
Educational Outcome (1)	Graduating Seniors (2)	Alumni Practitioners (3)	Employers (4)
An ability to design and conduct experiments, as well as to analyze and interpret data	4.5	4.3	4.2
An understanding of professional and ethical responsibility	4.6	4.3	4.4
An ability to function on multidisciplinary teams	4.4	4.1	4.4
Composite score based upon 5.0=strongly agree; 4.0=agree; 3.0=neither agree nor disagree; 2=disagree; 1.0=strongly disagree			

IV. Practitioner Perceptions and Recommendations

In the previous section, various attributes were listed that, according to the respondents to the survey, are presented at a high level. Nevertheless, as shown in Table 3, three outcomes—an ability to design a system, component, or process to meet desired needs; an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice; and a

knowledge of contemporary issues—are rated by practitioners in the agree range (4.1). This suggests that practicing civil engineers believe that they have received an average background in these areas from their educational experience. Nevertheless, graduating seniors at Lamar University have indicated relatively strong support for these attributes.

Table 4 illustrates that there may be large differences in composite scores. For example, graduating seniors at Lamar University indicate that they strongly recognize the need for an ability to engage in lifelong learning as well as an ability to communicate effectively. In contrast practitioners do not believe they received the same background in these areas when they were in school. However, the perceptions of practitioners most likely reflect, in part, the actual job experiences of the practicing engineers responding to the questionnaire. In this regard, a number of practitioners have written comments involving specific attributes, including[10]:

- The broad education necessary to understand the impact of engineering solutions in a global and societal context is developed after graduation not in school.
- Lifelong learning in the form of documented continuing education classes or experiences will most likely be required by the various state registration boards in 10-15 years.
- The ability to design a system, component, or process to meet desired needs should be developed in a work environment, and not in a classroom
- An understanding of professional and ethical responsibility is difficult to accomplish in an academic setting
- Knowledge and use of modern methods is dependent on the specific interest of an individual not necessarily that of a program in a university

Table 3. Comparison of ABET Outcomes with Practitioner Scores = 4.1

Level of Educational Outcomes, as a Composite Score			
Educational Outcome (1)	Graduating Seniors (2)	Alumni Practitioners (3)	Employers (4)
An ability to design a system, component, or process to meet desired needs	4.4	4.1	4.2
A knowledge of contemporary issues	4.4	4.1	4.2
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	4.4	4.1	4.2
Composite score based upon 5.0=strongly agree; 4.0=agree; 3.0=neither agree nor disagree; 2=disagree; 1.0=strongly disagree			

Table 4. Comparison of ABET Outcomes with Relatively Large Differences in Composite Scores			
Level of Educational Outcomes, as a Composite Score			
Educational Outcome (1)	Graduating Seniors (2)	Alumni Practitioners (3)	Employers (4)
An ability to communicate effectively	4.7	4.1	4.1
A recognition of the need for and an ability to engage in lifelong learning	4.7	4.2	4.2
The broad education necessary to understand the impact of engineering solutions in a global/societal context	4.4	3.9	3.8
Composite score based upon 5.0=strongly agree; 4.0=agree; 3.0=neither agree nor disagree; 2=disagree; 1.0=strongly disagree			

It is noteworthy that according to the above listing some practitioners believe that industry is in a better position than an educational institution to teach certain concepts in engineering.

V. Benchmarking and Student Data

Tables 1-4 include information involving students enrolled at Lamar University, in addition to practitioners who have graduated from the Civil (Construction) engineering program at the institution. It reflects, in part, the education and exposure to the profession that the students have received while studying for their degree at the institution. In addition, data from firms who employee civil engineering graduates is presented. Here, the findings suggest that employers perceive that the background of employees, especially recent graduates, is lower than that which the individuals themselves believe it is.

In general, the scores from the benchmarking data tend to be lower than those from Lamar University. Specifically, as illustrated in Table 5, the students at Lamar University rate ABET outcomes “a” through “k” with a higher score compared to those students included in the EBI benchmarking data. In particular, the following outcomes shown in Table 5 are among those with the largest difference in composite scores.

- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global/societal context.
- A knowledge of contemporary issues

- An ability to use the techniques skills, and modern engineering tools necessary for engineering practice

Table 5. Comparison of ABET Outcomes with Benchmarking Data

Level of Educational Outcomes, as a Composite Score		
Educational Outcome (1)	Graduating Seniors (2)	Benchmarking Data (3)
An ability to apply knowledge of mathematics, science, and engineering	4.6	Unavailable
An ability to design and conduct experiments, as well as to analyze and interpret data	4.5	4.0 – 3.6
An ability to design a system, component, or process to meet desired needs	4.4	4.1 – 3.6
An ability to function on multidisciplinary teams	4.4	4.1 – 3.4
An ability to identify, formulate and solve engineering problems	4.6	4.1 – 3.8
An understanding of professional and ethical responsibility	4.6	3.8 – 3.2
An ability to communicate effectively	4.7	4.0 – 3.3
The broad education necessary to understand the impact of engineering solutions in a global/societal context	4.4	3.8 – 3.1
A recognition of the need for an ability to engage in lifelong learning	4.7	4.7 – 3.7
A knowledge of contemporary issues	4.4	3.5 – 2.7
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	4.4	3.7 – 3.4
Composite score based upon 5.0=strongly agree; 4.0=agree; 3.0=neither agree nor disagree; 2=disagree; 1.0=strongly disagree		

Reviewing the data it appears that graduating seniors in Civil (Construction) engineering at Lamar University perceive they have obtained a much stronger background in professional issues compared to the students involved in the benchmarking study. It is hoped that this additional background information will assist the Lamar students in their career as future engineering practitioners.

VI. Summary and Conclusions

Engineering program assessment for an academic institution is periodically conducted by an ABET team during a scheduled accreditation visit. In particular, ABET *Engineering Criteria* is designed to assure that graduates of accredited programs are prepared to enter the practice of engineering. Specifically, it is required that engineering programs must demonstrate that their graduates have satisfied 11 educational attributes or outcomes commonly known as "a" through "k".

As part of a continuing review and evaluation of its curriculum, the Civil Engineering Department at Lamar University distributed a survey instrument to three groups: graduating seniors, employers and alumni practitioners. The questionnaire listed the aforementioned 11 educational outcomes and asked respondents to indicate the level at which they are or should be included in the engineering curriculum. The findings indicate that the respondents associated with Lamar University believe that the civil engineering department has given them an above average background in two of the 11 attributes. They include: an ability to apply knowledge of mathematics, science, and engineering; and an ability to identify, formulate, and solve engineering problems. These results suggest strong support for the traditional technical aspect of engineering. In contrast, three attributes received slightly lower ratings. They include: the broad education necessary to understand the impact of engineering solutions in a global and societal context; a knowledge of contemporary issues; and an ability to design a system, component, or process to meet desired needs. This may suggest that not all ABET educational attributes are considered by respondents from Lamar University to have the same level of significance, and should, perhaps, not be stressed to the same degree in an engineering curriculum. In this regard the scores from the EBI benchmarking study to tend to be consistently lower than those from Lamar University. In particular four outcomes in the ethics/communications area show relatively large differences compared to those from Lamar graduates.

Overall, the findings indicate that, for some outcomes, employers tend to believe that the background of employees with a Lamar University CE degree is less than the level the employees, themselves perceive it actual is. This may reflect a natural case of disagreement between employers and employees. However, the data and comments also suggest that practitioners do not believe that the attributes, in general, reflect all the skills and knowledge required for some, especially entry level, engineering positions. Nevertheless, the information indicates that the graduating seniors believe their coursework has given them a strong background in the 11 educational outcomes required by ABET. For comparative purposes, the findings of this investigation could be utilized by other institutions and departments that may wish to study their curriculum and/or develop a system of evaluation to measure the achievement of ABET objectives.

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