Implementing Continual Review of Programme Educational Objectives and Outcomes for OBE Curriculum Based on Stakeholders' Input

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Abstract: - Beginning from 2004, higher learning institutions offering engineering programmes curriculum in Malaysia have evolved into adopting an outcome based education (OBE) based curriculum by the national Engineering Accreditation Council. With this transformation, all engineering programmes must ensure that the programme educational objectives (PEO) and programme outcomes (PO) are continually reviewed and their achievement measured within a certain time frame as part of quality assurance process. Hence, this paper presents a method of implementing a continual review of the objectives and outcomes for OBE based engineering programmes based on stakeholders' survey, where the stakeholders were selected among engineering based companies and organisations resided in Malaysia, particularly from the potential employers of the graduates. In this method, each objective or outcome statement is broken up into attributes that form the full statement and each attribute is to be evaluated based on the five-level Likert scale. The result of the survey based on 131 inputs from the industrial stake holder is presented and is able to highlight statements which need to be reviewed or reformulated.

Key-Words: - Outcome Based Education (OBE); Programme Educational Objective (PEO), Programme Outcome (PO); stakeholder input, employer survey, curriculum review.

1 Introduction

In 2004, engineering programmes in Malaysia have been instructed to adopt OBE based curriculum by the national Engineering Accreditation Council (EAC) led by the Board of Engineers, Malaysia (BEM) as part of the requirement for BEM to be a full member of the Washington Accord (WA). The advantage to be the full member is that the degree produced by the Malaysian higher learning institutions for accredited engineering programmes in Malaysia would be recognised by the fellow WA member, such as United States, United Kingdom, Australia, South Africa etc.

In Malaysia, all engineering programmes are evaluated and accredited by EAC according to the guideline issued [1]. At the same time, all educational programmes offered by public and private higher learning institutions in Malaysia are also governed by the quality assurance policy set by the Malaysian Qualification Agency (MQA) as directed by the Ministry of Higher Education (MOHE), Malaysia [2]. In order to avoid overlaps in accreditation exercises, all professional programmes such as engineering will be

evaluated by only by EAC and the accreditation, if awarded, will be recognised by MQA and the programme is then listed in the Malaysian Qualification Register. However, beginning from 2009, all proposed new programmes including professional programmes are required to fulfil the criteria specified by MQA [3] as directed by MOHE. Hence, for engineering programmes, new programmes will be subject to criteria by both EAC and MQA.

In evaluating PEOs and POs for curriculum review, there are several methods already developed and implemented. For instance, McGourty et al. [4] had performed study of PEO for well known five US universities on the ABET EC2000 criteria. Typically examinations have been used as ideal method for measuring knowledge and technical based outcomes. However, outcomes with generic attribute such as problem based learning and those in affective domain require other specific methods [5]. This situation needs for change and paradigm shift in an engineering faculty in order to successfully evaluate achievement of the curricula [6]. A well developed objectives and outcomes

can then be used to formulate a systematic outcome assessment plan for new or revised curricula [7].

Hence, this paper presents a continual approach to design and review PEO as well as PO statements in order to meet the current needs of targeted stakeholders, where each PEO or PO statement is broken up into several attributes which require evaluation from the stakeholder.

2 Assessment Methodology

2.1 PEO and PO Statements

In this paper, the programmes which have been selected for this study are the engineering programmes offered by the Faculty of Engineering and Built Environment,UKM, where the programmes adopt the same generic PEOs as outlined in the EAC guideline [1].

After considering the vision and mission statements of the university and the faculty, the PEOs were formulated, as follows:

1. A graduate with understanding of the fundamental knowledge prerequisite for the role as an efficient engineer,
2. A graduate with professional attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, clients and the society,
3. A graduate who will uphold the Malay Language as a language of knowledge in the engineering field and at the same time has the ability to communicate in English,
4. A graduate who is able to adapt him/herself to the international/global work environment,
5. A graduate who is able to lead an engineering organisation based on knowledge of important current issues in engineering and experience,
6. A graduate who is able to conduct research in the field of engineering whether at a postgraduate level, or in his/her own organization.

Besides PEOs, POs were formulated after considering the EAC guideline [1] as well as adopting some ABET Criteria 3 elements [8], then list of POs for the programmes are:

1. Ability to acquire and apply knowledge of basic science and engineering fundamentals,
2. Ability to communicate effectively, not only with engineers but also with the community at large,
3. Having in-depth technical competence in a specific engineering discipline,
4. Ability to undertake problem identification, formulation and solution,
5. Ability to utilise a systems approach to design and evaluate operational performance,

6. Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member,
7. Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development,
8. Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so,
9. Ability to design and conduct experiments, as well as to analyse and interpret data,
10. Ability to function on multi-disciplinary teams,
11. Having the knowledge of contemporary issues,
12. Ability to use the techniques, skills, and engineering tools necessary for engineering practice.

All PEO and PO statements can be mapped using a relation matrix shown in Fig. 1.

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PO1	✓		✓			
PO2			✓			
PO3	✓	✓				
PO4						✓
PO5				✓		
PO6					✓	
PO7		✓		✓		
PO8				✓		✓
PO9						✓
PO10					✓	
PO11				✓		
PO12	✓					✓

Figure 1   Matrix of PEO-PO

From these PEOs and POs, attributes which make up the statements were identified and compiled in form of survey form which was made accessible though website (www.eng.ukm.my/v2/document/obe_survey_2007.pdf). The form was prepared in two languages, i.e. Malay language and English, and a 5-level Likert scale was used throughout for evaluation. The forms was distributed to selected stakeholders focussing on potential employers of the graduates..

2.2 Profile of Respondents

For the purpose of analysis of the result gathered, respondents were asked of their organisation profiles. This is to enable a more detailed analysis to be done on certain specific categories, if necessary. The sample of the profile used in this questionnaire is depicted in Fig. 2.

Figure 2   Organisation Profile

2.3   Method of Assessment

In order to have a full picture of a respondent's input on certain PEO and PO statement, all attributes in the particular statement are identified and listed in the questionnaire. For example, Figure 4 gives the breakdown of PEO3. This is due to the fact that the mission of the university is to advocate the Malay language while supporting English as the second medium of communication. Apart from that, the media of communication can be oral communication as well as written communication and through graphical media, such as engineering drawings and solid models.
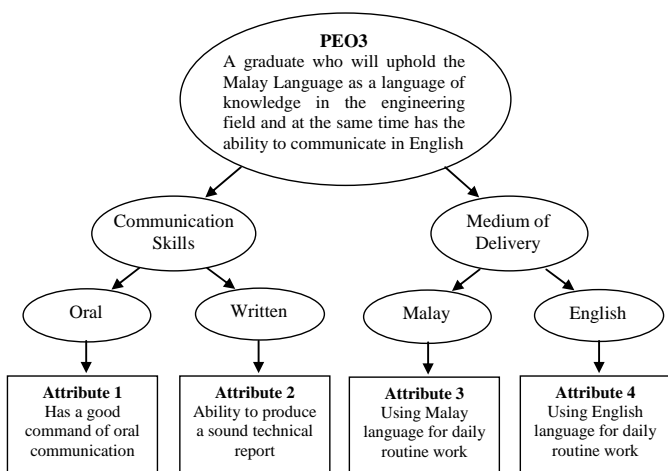

Figure 3   Attributes for PEO3

Here, reformulation of the PEO statement can be done by looking at evaluation obtained by each attribute. For example, if Attribute 3 in Fig. 3 obtain lower value, it can be interpreted that the phrase involving the Malay language need to be reword. However, it cannot to be taken out considering that one of the prime mission of the university is to uphold the Malay language and one of the PEOs should support that mission.

For each attribute, the 5-level Likert scale used to evaluate the importance of the statement is:

0	not relevant	3	neutral
1	not important	4	important
2	less important	5	very important

Similar mechanism can be extended for, reformulations of other PEO and PO statements. The list of the existing PEOs and POs are given in Fig. 4 and Fig. 5, respectively.

2.4   Continual Review of PEOs and POs

Upon completion of reformulation of new or modified set of PEOs and POs, other typical steps in curriculum review can be performed such as establishment of an outcome assessment plan, development of new structure of the curriculum as well as identification of course contents and delivery methods that meet the outcome assessment plan. The continual review process can be performed according to the flowchart given in Fig. 6 which can be part of the bigger continual quality improvement (CQI) cycle of the OBE framework.

3   Results and Analyses

All the PEO and PO statements together with their attributes are compiled into a 4-page questionnaire and has been sent to respondent from various field of engineering which have possibility to employ the graduates. The questionnaire were distributed with 2006-2007, both by hand, mail as well as via on-line. Fig. 7 illustrates the organisation profiles according to sector, class and industries.

Figure 4   List of PEOs for the Questionnaire

Programme Outcomes	Statement Importance
PO 1 Ability to acquire and apply knowledge of basic science and engineering fundamentals	
1. Ability to acquire knowledge of basic sciences and engineering fundamentals	⓪ ① ② ③ ④ ⑤
2. Ability to apply basic sciences and engineering fundamentals	⓪ ① ② ③ ④ ⑤
PO 2 Ability to communicate effectively, not only with engineers but also with the community at large	
1. Ability to communicate well with fellow engineers	⓪ ① ② ③ ④ ⑤
2. Ability to communicate effectively within the community at large	⓪ ① ② ③ ④ ⑤
PO 3 Having in-depth technical competence in a specific engineering discipline	
1. Possess in-depth technical skills	⓪ ① ② ③ ④ ⑤
2. Possess broad technical skills	⓪ ① ② ③ ④ ⑤
3. Ability to apply technical skills effectively	⓪ ① ② ③ ④ ⑤
4. Keep abreast with current technical skills	⓪ ① ② ③ ④ ⑤
PO 4 Ability to undertake problem identification, formulation and solution	
1. Ability to identify problem	⓪ ① ② ③ ④ ⑤
2. Ability to formulate and analyse problem	⓪ ① ② ③ ④ ⑤
3. Ability to obtain appropriate solution	⓪ ① ② ③ ④ ⑤
4. Ability to implement the solution to the problem	⓪ ① ② ③ ④ ⑤
5. Ability to monitor the degree of success of the implemented solution	⓪ ① ② ③ ④ ⑤
PO 5 Ability to utilise a systems approach to design and evaluate operational performance	
1. Ability to use a systems approach to design	⓪ ① ② ③ ④ ⑤
2. Ability to use a systems approach to evaluate operational performance	⓪ ① ② ③ ④ ⑤
PO 6 Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member	
1. Ability to function effectively as an individual	⓪ ① ② ③ ④ ⑤
2. Ability to function effectively as a member in a working group	⓪ ① ② ③ ④ ⑤
3. Ability to function as a leader/manager in a working group	⓪ ① ② ③ ④ ⑤
PO 7 Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development	
1. Behave professionally	⓪ ① ② ③ ④ ⑤
2. Practice good ethics	⓪ ① ② ③ ④ ⑤
3. Appreciate social, cultural and humanity responsibilities	⓪ ① ② ③ ④ ⑤
4. Appreciate global and environmental responsibilities, as well as the need for sustainable development	⓪ ① ② ③ ④ ⑤
PO 8 Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so	
1. Recognise the needs of self-improvement	⓪ ① ② ③ ④ ⑤
2. Recognise the needs to lifelong learning	⓪ ① ② ③ ④ ⑤
3. Ability to extract information from various sources	⓪ ① ② ③ ④ ⑤
4. Possess capability to undertake self-study	⓪ ① ② ③ ④ ⑤
PO 9 Ability to design and conduct experiments, as well as to analyse and interpret data	
1. Ability to conduct experiment	⓪ ① ② ③ ④ ⑤
2. Ability to design experiment	⓪ ① ② ③ ④ ⑤
3. Ability to analyse experimental data	⓪ ① ② ③ ④ ⑤
4. Ability to interpret experimental data	⓪ ① ② ③ ④ ⑤
PO 10 Ability to function on multi-disciplinary teams	
1. Ability to cooperate effectively in the team	⓪ ① ② ③ ④ ⑤
2. Ability to communicate effectively	⓪ ① ② ③ ④ ⑤
3. Ability to accept other view and criticism	⓪ ① ② ③ ④ ⑤
4. Possess high level of discipline and self-motivation	⓪ ① ② ③ ④ ⑤
PO 11 Having the knowledge of contemporary issues	
1. Sensitive to current technological development	⓪ ① ② ③ ④ ⑤
2. Sensitive to current issues locally and abroad	⓪ ① ② ③ ④ ⑤
3. Knowledge of mega projects and their effects to the community and the nation	⓪ ① ② ③ ④ ⑤
PO 12 Ability to use the techniques, skills, and engineering tools necessary for engineering practice	
1. Ability to utilise information and communication technology (ICT)	⓪ ① ② ③ ④ ⑤
2. Ability to apply the required techniques and skills	⓪ ① ② ③ ④ ⑤
3. Ability to use specific engineering tools	⓪ ① ② ③ ④ ⑤

Figure 5   List of POs for the Questionnaire

From Fig. 7, it can be seen that 80% of the respondents are from the private sectors, while the highest percentage of industry is manufacturing based industry (including petrochemicals), i.e. 35%. In terms of class of industries, which are based on definition by the Ministry of International Trade and Industries, Malaysia, nearly 50% of respondents comes from medium-sized industries.
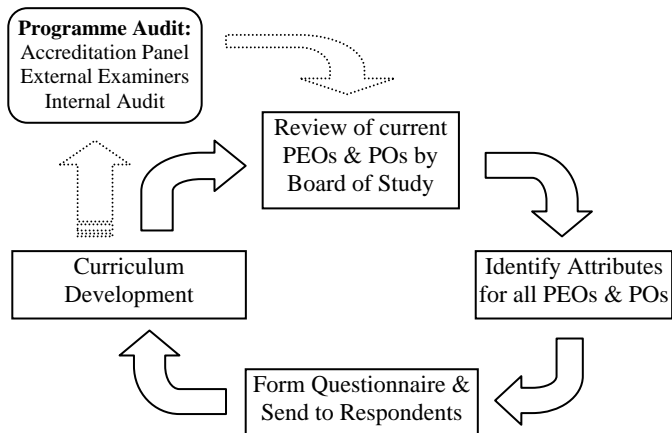
Figure 6   Flowchart for Continual Review or PEOs and POs

(a) Based on Sectors

(b) Based on Class of Industries

(c) Based on Type of Industries
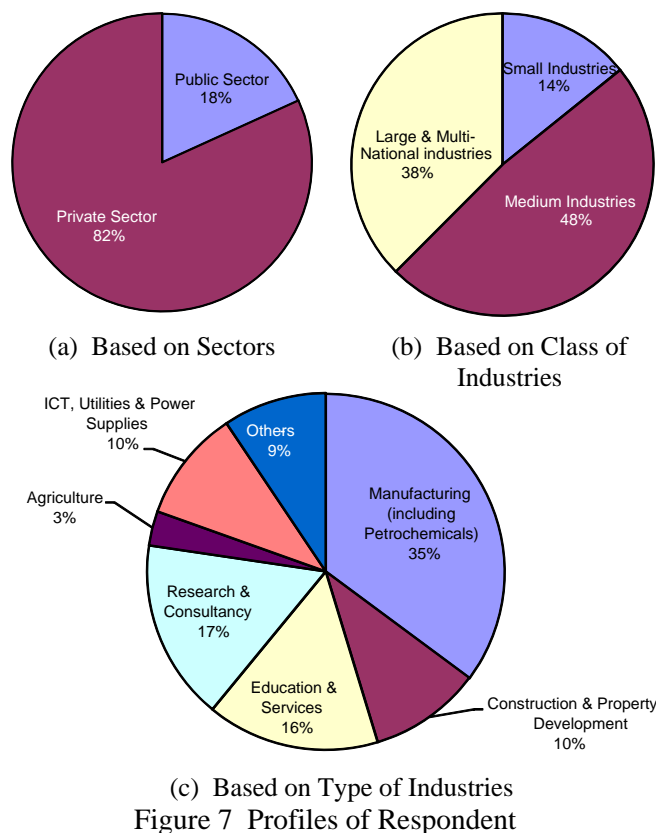
Figure 7 Profiles of Respondent

The results are based on 131 survey forms received during 2006-2007 and are summarised in Table 1 and Table 2 for the PEOs and POs, respectively, for the evaluations of statement importance by the selected stakeholder. However, to avoid a long list of attributes for POs, the statement of attributes associated with the mean and standard deviation values listed in Table 2 can be referred to Fig. 5. These evaluations are represented by their mean values as well as the standard deviations to show the spread of the data for each attributes. Then the means of the PEOs are calculated by averaging the means for all attributes belonging to the PEO.

From Table 1, it can be clearly seen that from the perspective of the overall stakeholders, the third attribute of PEO3 needs revision since its evaluation is below 4.0, even though it cannot be removed entirely due to the reason mentioned in Sect. 2.3. Furthermore, when looking at the mean value of a particular attribute, one should also see the spread of the data represented by the standard deviation. For the third attribute of PEO3, it demonstrate a high value for standard deviation which implies that there are also some percentage of respondent favoured the attribute while the majority felt that it needed revision. Another item which may require revision is the third attribute of PEO6 since the term "innovative research" may lead to many interpretations. On the other hand, PEO1 and PEO 2 receive the positive remarks from the stakeholders and may be kept in their current form.

Table 1   Means and Standard Deviations
for Stakeholders' Evaluation on PEOs

Programme Educational Objectives	Statement Importance*
PEO1 A graduate with understanding of the fundamental knowledge prerequisite for the role as an efficient engineer	4.54
1. Possess competency in fundamental engineering knowledge	4.57 (0.60)
2. Ability to apply fundamental knowledge in the engineering profession	4.51 (0.58)
PEO2 A graduate with professional attitude and ethics necessary in fulfilling his/her responsibilities towards the Creator, clients and the society	4.42
1. Ethical and professional	4.57 (0.58)
2. Capable of fulfilling the clients' needs	4.44 (0.65)
3. Understand his/her responsibilities to the society	4.28 (0.76)
4. Understand his/her responsibilities to the Creator	4.40 (0.83)
PEO 3 A graduate who will uphold the Malay Language as a language of knowledge in the engineering field and at the same time has the ability to communicate in English	4.24
1. Has a good command of oral communication	4.44 (0.72)
2. Ability to produce a sound technical report	4.40 (0.69)
3. Using Malay language for daily routine work	3.80 (1.01)
4. Using English language for daily routine work	4.30 (0.72)
PEO4 A graduate who is able to adapt him/herself to the international/global work environment	4.28
1. Understand the working culture of different races and nations	4.14 (0.78)
2. Ability to adapt himself/herself to multiple working conditions	4.41 (0.63)
PEO5 A graduate who is able to lead an engineering organisation based on experience and knowledge of important current issues in engineering	4.41
1. Apply knowledge in leading and managing an organisation	4.31 (0.68)
2. Apply experience in leading and managing an organisation	4.37 (0.66)
3. Ability to make rational and effective decisions	4.56 (0.60)
PEO6 A graduate who is able to conduct research in the field of engineering whether at a postgraduate level, or in his/her own organisation	4.22
1. Ability to seek research information from multiple sources	4.27 (0.73)
2. Ability to conduct research using current methods and techniques	4.23 (0.79)
3. Ability to perform innovative research	4.16 (0.80)

* Values in the bracket are standard deviations

In terms of POs, from Table 2, there are also attributes which clearly needs revision in the stakeholder's perspectives as their mean values are below 4.0, namely PO9(ii), PO11(ii) and PO11(iii). The result for the second attribute of PO9 may indicate that the stakeholder do not really favour the graduate to acquire the skill of designing an experiment or the term "design experiment" needs to be rephrased or elaborated further. Similarly, for the second and third attributes of PO11, the low mean values address the need to revise both attributes as well as the overall statement for PO11. Although the average mean values of all POs are above 4.0, POs with lower values such as PO5, PO9 and PO11 are recommended to be revised. On the other hand, the standard deviations for all POs are below 1.0 which signal common agreement of the statements by the stakeholder. Furthermore, some POs receive positive remarks, namely PO7 and PO10.

Table 2   Means and Standard Deviations
for Stakeholders' Evaluation on POs

Code	Statement Importance*	Code	Statement Importance*
PO1	4.38	PO7	4.44
(i)	4.34 (0.67)	(i)	4.52 (0.59)
(ii)	4.42 (0.67)	(ii)	4.56 (0.56)
PO2	4.33	(iii)	4.31 (0.71)
(i)	4.37 (0.61)	(iv)	4.38 (0.65)
(ii)	4.29 (0.75)	PO8	4.38
PO3	4.27	(i)	4.48 (0.55)
(i)	4.23 (0.70)	(ii)	4.39 (0.67)
(ii)	4.18 (0.74)	(iii)	4.38 (0.65)
(iii)	4.39 (0.70)	(iv)	4.26 (0.72)
(iv)	4.27 (0.71)	PO9	4.07
PO4	4.41	(i)	4.06 (0.80)
(i)	4.47 (0.64)	(ii)	3.92 (0.81)
(ii)	4.40 (0.62)	(iii)	4.10 (0.73)
(iii)	4.42 (0.71)	(iv)	4.19 (0.73)
(iv)	4.43 (0.72)	PO10	4.48
(v)	4.30 (0.73)	(i)	4.50 (0.59)
PO5	4.14	(ii)	4.48 (0.64)
(i)	4.14 (0.73)	(iii)	4.38 (0.63)
(ii)	4.13 (0.76)	(iv)	4.54 (0.56)
PO6	4.35	PO11	4.02
(i)	4.25 (0.68)	(i)	4.18 (0.67)
(ii)	4.47 (0.57)	(ii)	3.98 (0.72)
(iii)	4.33 (0.76)	(iii)	3.90 (0.78)
		PO12	4.25
* Values in the bracket are standard deviations		(i)	4.30 (0.67)
		(ii)	4.30 (0.62)
		(iii)	4.15 (0.66)

From the analysis, it can be that by breaking down each statement to its attributes, we can filter which attributes receive a positive remark and can be kept and which are not and need revision. Then, the result of the analysis should this reported to the faculty authority in order to call for revision and review on certain aspect of the programme outcomes which can provide guidance for the next curriculum review. Therefore, this process can be part of overall CQI cycle of the curriculum development.

4 Conclusion

In this paper, an attribute based evaluation method is proposed to perform continual improvement of PEO and PO statements based on stakeholders' input. As a conclusion, by using this method, problematic attributes which can lead to unfavoured statement can be revised and reformulation in order to ensure that the programme meets the expectation from the stakeholder as well as keep intact with the vision and mission statements of the faculty and the university. The case study demonstrated in this paper clearly shows how problematic attributes can be identified and revised in order to perform continual review on the PEO and PO as part of the CQI process under the OBE framework.

References:

[1] Engineering Accreditation Council (EAC), *Engineering Programme Accreditation Manual*, Board of Engineers Malaysia (BEM), 2007.

[2] Malaysian Qualification Agency (MQA), *Code of Practice for Institutional Audit*, MQA, 2008.

[3] Malaysian Qualification Agency (MQA), *Code of Practice for Programme Accreditation*, MQA, 2008.

[4] McGourty, J., Shuman, L., Besterfield-Sacre, M., Atman, C., Miller, R., Olds, B.M., Rogers, G., & Wolfe, H., Preparing for ABET EC 2000: Research-Based Assessment Methods and Processes, *International Journal of Engineering Education*, Vol. 18, No. 2, 2002, pp. 157-167.

[5] Shuman, L., Besterfield-Sacre & McGourty, J., The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed?, *Journal of Engineering Education*, Vol. 94, No. 1, 2005, pp. 41-55.

[6] Olds, B.M., Moskal B.M. & Miller, R.L., Assessment in Engineering Education: Evolution, Approaches and Future Collaborations, *Journal of Engineering Education*, Vol. 94, No. 1, 2005, pp. 13-25.

[7] Amini, F & Rahman, S, A Systematic and Structure Outcome Assessment Plan for a New Engineering Program, *International Journal of Engineering Education*, Vol. 24, No. 1, 2008, pp. 185-198.

[8] Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs*, Accreditation Board for Science and Technology (ABET), 2008.