AC 2011-15: ENGINEERING TECHNOLOGY COURSE ASSESSMENTS FOR ABET CRITERION 3: STUDENTS OUTCOMES

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Engineering Technology Course Assessments for
ABET Criterion 3: Student Outcomes

Abstract

Too much assessment may become too tedious for the instructors but yet may not be enough to satisfy the ABET (Accreditation Board for Engineering and Technology) evaluators. This paper deals with making assessment process less involved and yet improving the quality of assessment of student outcomes. The key elements for neat presentation of assessment documents are i) selecting appropriate courses of a program to assess student performances and ii) presentation of the documents in a way that the evaluators feel comfortable and seamless in assessing the outcomes. To document student performance assessments, each course may be mapped (designated) to measure only a few specific outcomes. Each instructor of a course is then entrusted to measure the mapped outcomes. However, the major hurdle may be in the design of appropriate assessment rubrics and developing assignments to reflect the specific outcome measures. Assessment itself is considered as an extra burden on the shoulders of instructors. As a result, the instructors may find less time and energy in improving the quality of teaching. In addition, a fatigue condition may prevail resulting in obscure documentation which may cause dissatisfaction to the evaluators. For easy and successful accreditation, the assessment process may be designed with two objectives in mind, such that i) it does not exhaust the instructors, and ii) the evaluators find the assessment process transparent and seamless. This paper focuses on ABET expectation on assessment and produces some examples to make assessment less involved and create an environment of pleasant experience for the evaluators in granting accreditation for a maximum number of years.

Introduction

The process and requirements for ABET[1] accreditation acts as a driving force for continuous improvement of a program. Besides teaching and grading, the faculty members are required to maintain adequate documentations on the method of teaching, performance results and the continuous improvement mechanism. To measure the success level of graduates in the industry, the opinion surveys of the alumni and employers are also analyzed and documented. These generate a mammoth of additional tasks for the instructors, often creating a fatigue condition for them. As a result, when assessment becomes a burden, it is likely to result in obscure documentation which, in turn, may cause frustration and dissatisfaction to the evaluation team jeopardizing the accreditation.

Gloria Rogers[2] observed some programs as creating laborious assessment machines that yielded little in terms of meaningful results but a lot in terms of faculty irritations. The objective of assessment, therefore, should be directed to minimize the burden on the faculty but still to

collect, analyze and maintain adequate amount of information to support the strength of a program.

Criterion 3 – Student Outcomes

Currently the exact name of Criterion 3 is "Program Outcomes." The proposed name change is "Student[3] Outcomes." ABET defines[4] Program (Student) Outcomes as follows:
"Each program must demonstrate that graduates have:

> a. an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines
> b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology
> c. an ability to conduct, analyze and interpret experiments, and apply experimental results to improve processes
> d. an ability to apply creativity in the design of systems, components, or processes appropriate to program educational objectives
> e. an ability to function effectively on teams
> f. an ability to identify, analyze and solve technical problems
> g. an ability to communicate effectively
> h. a recognition of the need for, and an ability to engage in lifelong learning
> i. an ability to understand professional, ethical and social responsibilities
> j. a respect for diversity and a knowledge of contemporary professional, societal and global issues
> k. a commitment to quality, timeliness, and continuous improvement"

ABET Expectation on Student Outcomes

The so-called "a-k outcomes" as mentioned in the above section relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program. This translates that the students are supposed to attain the above qualifications at the time of their graduation. This statement has clear scope of reducing faculty burden by emphasizing assessment on some key courses rather than spending energy and time on many preparatory courses, like, AC, DC, Logic Circuits, and Computer Applications on MS Office, etc., offered particularly at the freshman and sophomore levels. In fact, these fundamental courses at the preparatory level do not have adequate scope to measure the student outcomes.

Mapping a-k Outcomes to Courses

Figure 1 is an example of mapping a-k outcomes to courses for some arbitrary degree plan. As explained in the last sentence of the previous section, the a-k outcomes are mapped only to the 3000 and 4000 level courses but not to the 1000 and 2000 courses (shaded). An outcome may not be required to map to a specific number of courses. For example, outcome 'f' is mapped to five

courses while some outcomes are mapped to as low as two courses only. This is highlighted at the bottom of the Figure 1.

Course Number and Title	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CPET1011 Intro to Eng., CS, & Tech.											
CPET1013 Computer Applications I											
CPET1021 Intro to CPET Program Lab											
CPET1023 Computer Applications II											
CPET2111 Digital Logic Circuits Lab											
CPET2113 Digital Logic Circuits											
TECH1103 Computer Aided Drafting											
CPET3161 CPU Arch Hardware Lab			c								k
CPET3163 CPU Arch Hardware	a										
CPET3231 Micro. Assem Lang Lab					e	f					
CPET3233 Micro. Assem Lang				d		f					
CPET4061 Data Comm Method Lab			c				g				
CPET4063 Data Comm Method	a	b									
CPET4082 Senior Project I								h		j	k
CPET4092 Senior Project II				d			g		i		
CPET4111 Software App. Micro Lab					e	f					
CPET4113 Software App. Micro				d		f					
CPET4151 Micro. Comp Peri Hard Lab			c		e						
CPET4153 Micro. Comp Peri Hardware	a	b									
CPET4361 Computer Networks Lab			c				g				
CPET4363 Computer Networks	a	b									
TECH3203 Eng/Technical Comm								h	i	j	
MCET3103 Math Apps for Tech		b				f					
Number of Courses per Outcome	4	4	4	3	3	5	3	2	2	2	2

Figure 1. The a-k outcomes are mapped to individual courses

An instructor is required to prepare assignments directed to measure the designated outcome(s) for the course. At the end of a semester, the same instructor is required to prepare a course binder which may be designated as "Assessment Course Binder." The major component of this binder is the "Outcome Analysis". This analysis may include data from previous semesters as well. Thus this reflects the trend of student performances over a period of time. This analysis may be considered as a valuable document for the continuous improvement process as well.

Rubrics for Assessing Outcomes

As mentioned above, the courses designated to measure outcome(s) should have specially designed assignments for assessment. To have uniformity across the courses to measure one

single outcome, there should be one cover page with specific rubric. This means that there should be exactly eleven different rubrics to assess all eleven (a-k) outcomes. For example, to assess outcome 'a', all the four courses (as mentioned in Figure 1) should use the same rubric for all types of assignments while a different rubric should be used for three courses to measure outcome 'g' and so on. Using specific rubrics has two advantages, such as, i) rubric acts as a guide in preparing assignments, and ii) assessment by evaluator becomes seamless. Figure 2 shows one example rubric to assess outcome 'c'.

Institution Name:
Department Name:
Semester:

Course Name:
Type of Assignment:
Date Assigned:

Topics Covered

Justification of the Assignment

> This assignment is given to test the students' ability to conduct, analyze and interpret experiments and apply experimental results to improve process (**Outcome c**)

Last Name _____ First Name _____

Assessment Topics	Points	Student Score
Explain the use of instruments and experiment setup		
Explain the method of conducting experiments		
Analyze and interpret the experimental data into results		
Draw conclusion including any application of this experiment		
Total	100	

Figure 2. Example rubric to assess outcome 'c'

The rubric in Figure 2 has four sub-areas to assess. Depending on the course and type of assignment, an instructor has freedom to select any or all of the sub-areas to assess and distribute the points as well.

Sample Outcome Analysis

At the end of a semester, an instructor prepares his/her Assessment Course Binder. The quantitative and qualitative information is placed in the Outcome Analysis page as shown in Figure 3.

Figure 3 shows the student performances in outcomes 'd' and 'f' which are, for example, 76.4 and 76.8 respectively. As mentioned at the top right corner in the Figure, it may be the department's decision to make faculty work hard to have 75% as the minimum average (target) performance in all courses and that 70% of the students are above the target in each course. Thus the outcomes for this course barely fulfill the target. In addition, this Figure gives some comparative analysis of performance over some semesters. The inserted bar graphs make this result very clear and straight forward. This Figure also contains some descriptive activities towards the effort of continuous improvement. The instructor states, i) Semester Plan for Continuous Improvement, ii) Problems Identified that might affect performance, iii) Suggestions made to the next instructor, and iv) Performance trend over three semesters. The next time instructor picks up this page at the beginning of the semester and prepares his/her teaching plan for further improvement.

2. OUTCCOME ANALYSIS
(Closing the Loop for Continuous Improvement)

Report Prepared by:

Report Date:

<u>Targets set by the Department:</u>
- Class Outcome Average (Target): 75%
- Students above the Target = 70%

| Semesters	Number of Students	Outcome 'd' an ability to apply creativity in the design of systems, components or processes appropriate to program objectives		Outcome 'f' An ability to identify, analyze and solve technical problems	
		Class Average	Students above Target Average, %	Class Average	Students above Target Average, %
Fall 2009	13	76.4	47.4	76.8	31.6
Fall 2008	9	74.5	55.6	75.5	33.3
Fall 2007	20	Not measured	Not measured	68.0	40.0
Semester Plan for Continuous Improvement		Technique of breaking down problem into smaller ones was explained and asked to produce problem design using flowchart		Elegant programming technique with procedures and macros was demonstrated. Emphasized on solving problem based on flowchart (design)	
Problems Identified that might affect performance		Breaking a problem into appropriate pieces was not understood well.		Weakness in solving problems became apparent due to the weakness of breaking of problem into smaller pieces.	
Suggestions made to the next instructor		Some exercises on method of breaking problems into pieces may be useful for students to build confidence.		Incremental solution based on broken pieces of a problem may be a good strategy to improve student performances.	
Performance trend over three semesters (see the figures)		Performance in Fall 2009 is better than the previous year. This outcome was not measured in Fall 2007.		A trend of performance improvement noticed over three years.	
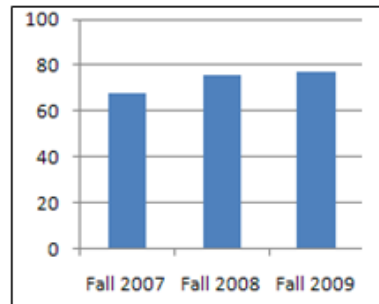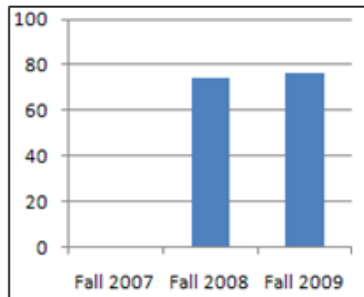
Figure 3. The Outcome Analysis page in the Assessment Binder for a course

The Outcome Analysis shown in the above Figure contributes to the right hand loop of the continuous improvement process as shown in Figure 4.
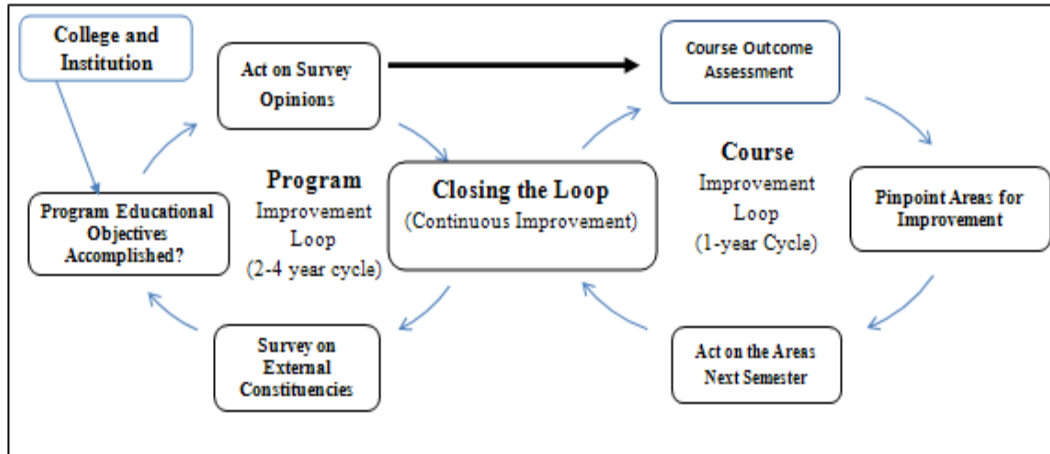
Figure 4. Method of continuous improvement[5]

Conclusion

The ABET evaluators often experience enormous amount of data but without meaningful assessment and analysis. This generates frustration in the assessment process often jeopardizing the accreditation of programs. Since ABET specifies that the so-called "a-k outcomes" relate to the skills, knowledge, and behaviors that students acquire in their matriculation, it is more appropriate to concentrate assessment on junior and senior level courses only rather than on Freshman and Sophomore level courses. This drastically reduces the burden of the instructors which, in turn, gives them adequate time and energy to meaningful outcome assessments.

Rubrics are useful tools to measure outcomes in a standardized manner which make instructors' lives easy and the evaluators' job transparent as well. The outcome analysis page is the major focus of an Assessment Binder. The evaluators are likely to get the real picture of outcomes by glancing over this page alone. It indicates the major efforts to continuous improvement of student learning and the trend of student performances in a particular outcome. The Outcome Analysis pages for all courses may be pooled into a separate binder for evaluators to find all data in a single place.

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