

Innovation in Engineering Education: A Proposed ABET Course Outcomes Assessment Portfolio

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Abstract— Among the main eight (8) Accreditation Board for Engineering and Technology (ABET) criteria, namely, Students, Program Educational Objectives, Student Outcomes, Curriculum, Faculty, Facilities, Continuous Improvement, and Institutional Support, that ABET requires engineering programs to address, Student Outcomes process is the most difficult to showcase in the self-study report programs need to present to ABET evaluators. It is interesting to notice that ABET does not require engineering programs to address Course Outcomes directly, although, Course Outcomes is strongly connected to Student Outcomes. Looking carefully at all these eight criteria, we can see that Course Outcomes is sitting at the bottom of the pyramid and is the strong driving force for the continuous improvement of all ABET mentioned criteria. Engineering programs address Student Outcomes in the self-study report through a complex relationship with Course Outcomes. In this paper, we propose a new detailed process for the assessment of the Course Outcomes directly and show how this process can lead smoothly to addressing Student Outcomes (SO's), Program Educational Objectives (PEO's) and the mission of the institution. This will be done through the Course Outcomes Portfolio (COP) process.

Index Terms— ABET, Engineering Curriculum, Assessment, Course Outcomes Portfolio, Course Outcomes, Program Outcomes, Program Educational Objectives, Student Outcomes, Student Learning Outcomes

I. INTRODUCTION

ABET accreditation is very important award that every institution in the USA and abroad would love to seek and obtain. ABET accreditation is a voluntary process. Student outcomes are the a-k list in addition to any specific program criteria. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program [1]. Anyone who dreams to be a professional engineer must graduate from an engineering degree program that is ABET accredited. ABET accreditation is a lengthy process that takes a lot of effort but it is centered on a very critical question that involves the program ability to demonstrate with evidence that program graduates have achieved the program's student learning outcomes set forth by the program. Achieving student outcomes is the most important among the eight criteria set forth by ABET. An institution can build an engineering degree program, can design and put down the needed curriculum, provide all needed labs, recruit students and faculty, and have all the necessary infrastructure in-place, but if they cannot demonstrate to the ABET team through a sound continuous improvement process their ability carry out the assessment process, it will fail.

This process of assessing the student outcomes has been discussed using different approaches. Assessing using contemporary educational psychology has been experienced [2]. Some approaches start from the student outcomes and others start from the bottom at the course outcomes level but use what is known as course experience questionnaire where a survey is completed at the end of the course [3]. Assessment leading to ABET accreditation not only put the institution at an advantage but it is a tool to improve learning [4]. Significant research in improving the assessment of student outcomes was done at Rose-Hulman Institute of Technology where planning, identification and methods of implementation of student learning outcomes took place and an electronic guide for assessment was developed [5,6,7,8]. Research on how to improve and automate this process of electronic has grown significantly [9].

Mapping the course outcomes to the student outcomes is a complex process when you start the assessment at the student outcomes level [10,11]. To improve the process of student assessment the idea of student portfolio has emerged [12,13,14,15]. These types of portfolios where a combination of student work, surveys, sample exams, homework, etc. but did not include a systematic process for student outcomes assessment and used the assessment at the student outcomes level.

In this paper, a new approach to student outcomes assessment will be presented. This approach will establish a strong mapping among course outcome, student outcomes, program educational, and the vision of the institution, and will start the student outcomes assessment at the course outcomes level. In this way, the process will be done in one place; the bottom of the pyramid.

II. THE MAPPING STAGE: ESTABLISHING THE STRONG RELATIONSHIP

We will make a strong connection between the course outcomes and the student outcomes because ABET requires that we establish a process and be able to assess and measure student outcomes. When we start at the top, we begin with the institution mission statement then derive the program educational objectives from the key components in the mission making sure that the mission and the program educational objectives are strongly related. Once the PEO's are established by faculty and constituencies the student outcomes should be derived. Luckily, ABET suggest a set of student outcomes. These are the a-k item in the student outcomes requirement. A sample mapping between the PEO's and the SO's is shown in Table-1.

Table -1 Mapping between the PEO's and SO's

PROGRAM EDUCATIONAL OBJECTIVES	STUDENT OUTCOMES										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
(A)	X	X	X	X		X	X				X
(B)	X	X	X		X	X					
(C)			X	X			X				X
(D)						X		X	X	X	

Once the relationship between the PEO's and the SO's is established, we will create also a strong relationship between the SO's and the course outcomes. Table-2 shows this relationship.

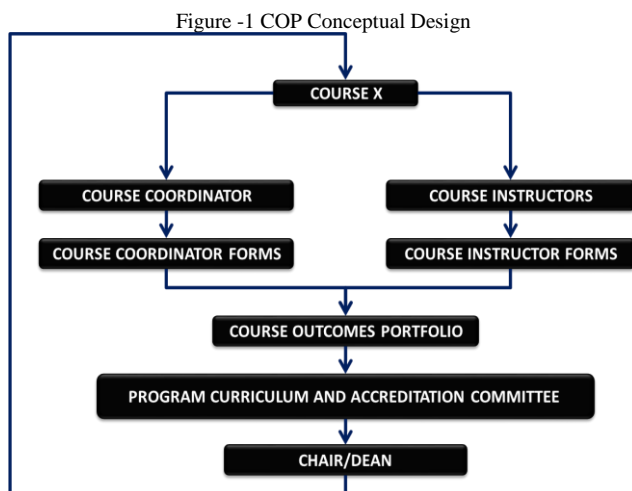
Table -2 Mapping between the CO's and the SO's

COURSE OUTCOMES	(SO) STUDENT OUTCOMES										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
CO1	X	X	X	X		X	X				X
CO2	X	X	X		X	X					
CO3			X	X			X				X
CO4						X		X	X	X	

At this point we are at the course outcomes level and we can focus the assessment on those course outcomes as illustrated in Table-2.

III. THE COURSE PORTFOLIO CONTENT

We are assuming that every course will have a course coordinator and instructors in case multiple sections are offered in a semester. Figure-1 depicts a conceptual design for the course outcomes portfolio (COP).



It is suggested that the course instructor forms section in Figure-1 consists of the following items:

- 1) Teacher Course Self-Evaluation Form Filled

- 2) Faculty Statement on Teaching Philosophy

- 3) Faculty Course Outcomes and Assessment Document Form completed

- 4) Faculty Worksheet for Course Outcomes and Assessment Document Completed

- 5) Sample Proofs of Student Achievement, Like Excellent, Satisfactory and Unsatisfactory Work

We also suggest that the course coordinators section of the portfolio consists of the following items:

- 1) CC portfolio check list completed and filed at the beginning of the portfolio

- 2) ABET Course Syllabus

- 3) Student Course Syllabus

- 4) Coordinator Course Outcomes and Assessment Document Completed

- 5) Coordinator Worksheet for Course Outcomes and Assessment Document Completed

- 6) CO Evaluation Cycle Diagram

- 7) Copies of relevant class notes and handouts

- 8) Copies of all exams and assignments (not the student answer sheets). If a question relates to a particular outcome, indicate that and give the number of possible points on the exam and/or the assignment sheets

- 9) CC duties

- 10) Guide to writing course outcomes

It is a fact that no teacher can teach in the same exact way as another teacher. Some teachers have extensive teaching experience and some do not have at all. However, all instructors of multiple section courses should deliver the same material that at the end support achieving the course outcomes.

The major goal of the Course Coordinator is to make sure that

- i) All course outcomes are covered by the end of the course
- ii) All grades are distributed fairly

The Course Coordinator (CC)

- 1) Will head the course coordination committee (CCC) which will be formed from among instructors who are familiar with teaching the course and the course contents

- 2) Should consult and work as a team with the CCC members. The CCC should always try to come up with decisions that reflect the majority. If the majority cannot be defined, the CC has the final say

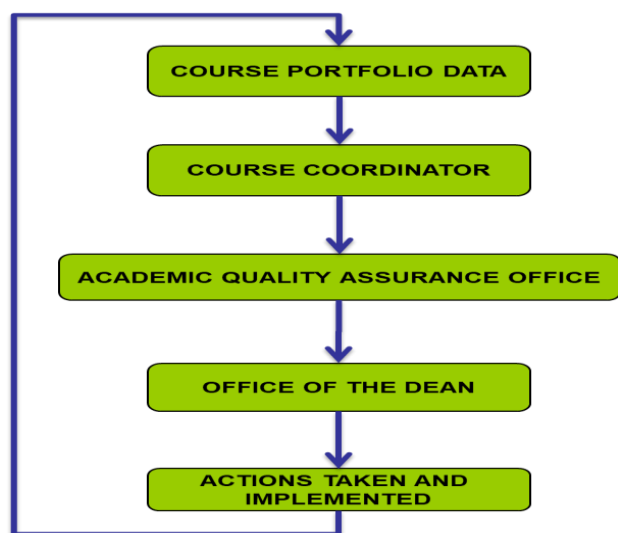
- 3) Is the one who will be responsible for completing all forms in the course portfolio

- 4) Will make sure that the same teaching material is delivered to the students in all course sections in case of multiple section offerings

- 5) Will make sure that the material that support all course outcomes is delivered to the students in all sections
- 6) Will make sure that all tests, quizzes, homework, labs, projects, etc... are similar for all sections
- 7) Will make sure that grading is done fairly for all sections

It is also suggested that the COP be evaluated at the end of the course offering if possible or at least at the end of every academic year. A process is given pictorially in Figure-2.

Figure -2 COP Evaluation Cycle



IV. THE COURSE PORTFOLIO PROCESS

Table-3 consists of several terms that will be used to establish the process of executing this portfolio evaluation.

Table -3 Terms used for the COP Process

Terms	Meaning
CO	<i>Course Outcomes</i>
CC	<i>Course Coordinator</i>
CI	<i>Course Instructors</i>
CCC	<i>Course Coordination Committee</i>
AQAC	<i>Academic Quality Assurance Coordinator</i>
SO	<i>Student Outcomes</i>
COP	<i>Course Outcomes Portfolio</i>

CCC Structure

- 1) The CC is the faculty who is most familiar with teaching of the course and most knowledgeable of its contents. He shall be elected by the CCC.
- 2) Every course that was designed to serve the curriculum should have a CC. The CC will head the CCC that will be formed by the CC and includes the CI.
- 3) The CC should consult with the CCC in any proposed modification to the CO.

- 4) The CO must contribute to the achievement of the particular SO.

CO Target Scale

Table-4 shows a sample target scales for evaluating the course outcomes. This depends on the particular area the course belongs to.

Table -4 CO Target Scale

Area Group	Target Scale (4 Excellent, 3 Good, 2 Average, 1 Unsatisfactory)
University requirements	No scale
Engineering Common Courses	3
English, Science, and Math Courses	3
Program-Specific Courses	3

Portfolio Structure

Towards the end of every semester, every course that was designed to serve the curriculum must have its COP ready. In case of multiple sections for a particular course, the COP will be divided accordingly.

The following folder format is suggested:

I) CI Section with part for each course section that must include

- a) Teacher Course Self-Evaluation Form Filled
- b) In-Class Faculty Evaluation Summary
- c) Student Course Evaluation Summary
- d) Faculty Statement on Teaching Philosophy
- e) Faculty Course Outcomes and Assessment Document Form completed
- f) Faculty Worksheet for Course Outcomes and Assessment Document Completed
- g) Samples Proof of Student Achievement, Like Excellent, Satisfactory and Unsatisfactory Work

II) CC Section that must include

- a) ABET Course Syllabus
- b) Student Course Syllabus
- c) Coordinator Course Outcomes and Assessment Document Completed
- d) Coordinator Worksheet for Course Outcomes and Assessment Document Completed
- e) CO Evaluation Cycle Diagram
- f) Copies of relevant class notes and handouts
- g) Copies of all exams and assignments. If a question relates to a particular outcome, indicate that and give the number of possible points on the exam and/or the assignment sheets.
- h) CC duties
- i) Guide to writing course outcomes
- j) Engineering Programs and Engineering Common Courses (if it is an engineering program)

III) AQAC Section

a) AQAC Course Outcomes and Assessment Document Completed

Forms and Responsibilities

a) *ABET Course Syllabus*

The syllabus should be submitted by the CC to the AQAC at the beginning of the semester

b) *Student Course Syllabus*

The syllabus should be submitted by the CC to the AQAC at the beginning of the semester

c) *Faculty Statement on Teaching Philosophy*

Should be completed at the beginning of the semester and handed in to CC

d) Faculty Course Outcomes and Assessment Document

Should be completed by the CI and given to CC towards the end of the semester

e) ***Coordinator Course Outcomes and Assessment Document***

Should be completed by CC towards the end of the semester

f) AQAC Course Outcomes and Assessment Document

Should be completed by AQAC towards the end of the semester

g) *Teacher Course Self-Evaluation Form*

Should be completed before the end of the semester by the CI and given to the CC.

h) *In-Class Faculty Evaluation Form*

This process should be initiated and finished before the end of the first month of the semester. A committee for the purpose of administering the In-Class Faculty Evaluation Form should be established. The name of the committee can be Faculty Assessment and Continuous Improvement Committee (FACIC). The committee shall constitute senior faculty members from the college of engineering. The committee will work with the CC to arrange for at least three visits to the particular faculty member. The committee will fill in the summary sheet and submit it to the CC to be filed in the specific section in the COP. The original evaluation forms should be submitted to the AQAC office for filing.

h) Student Course Evaluation Form

The AQAC will assign a student volunteer from the same class or a staff member to administer the evaluation. The form should be completed before the end of the semester by the students. The student volunteer or the staff member should then give the completed forms to the AQAC office where a summary is produced. The AQAC office will submit the summary, that should be filed in the appropriate section, to the appropriate CC.

The Steps

The steps below should be completed every semester until the CCC is satisfied with the overall structure of the COP and the target scale is achieved or exceeded.

1) The course coordinator will collect the following from all CI teaching the course:

a) Teacher Course Self-Evaluation Form

b) Faculty Statement on Teaching Philosophy

c) Faculty Course Outcomes and Assessment Document Form

d) Faculty Worksheet for Course Outcomes and Assessment Document

e) Samples Proof of Student Achievement, Like Excellent, Satisfactory and Unsatisfactory Student Work

2) The COP submitted to the AOAC by the CC

3) The COP will be evaluated by the AQAC

4) The AQAC will make recommendations of proposed changes to the Dean

5) The Dean decides on proposed changes

6) Proposed changes implemented

An important document that the instructor will work with is the Faculty Worksheet for Course Outcomes and Assessment Document. This document (as a sample) is shown in Table-5. This is an excel sheet that can be programed and used for any course.

Figure -3 Faculty Worksheet for Course Outcomes and Assessment Document

Instructor's Name				Semester				Year			
Course Name				Number				Section			
Course Assessment Results: EGAU = Excellent Good Average Unsatisfactory E=4 (E≥90) G=3 (75≤G<90) A=2 (60≤A<75) U=1 (U<60)											
E= 4 G= 3 A= 2 U= 1											
Number of students				15							
Number Assessment Methods				5							

T1				T2				P1				H3				Outcome A			
Outcome A				Outcome B				Outcome C				Outcome D				Average			
E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U
																2	6	4	3
Ave:		0		Ave:		0		Ave:		0		Ave:		0		Ave:		0.7333	

EGAU	=	(4)Excellent	(3)Good	(2)Average	(1)Unsatisfactory
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V. CONCLUSION

The need to have a process of assessing the student outcomes is of most importance in the ABET self-study document. There are many methods as seen in the references provided but none did have a detailed process that works at the bottom level of the course outcomes. Working at the course outcomes level makes it easy on the instructors teaching the courses once they identify the course outcome that relates to the student outcome. The forms provided to the instructor and the coordinator will make it simple for them to complete this assessment during the weeks of the semester and starting from the first week. What is more significant is that this process can be automated and updated regularly.

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