



# Innovation in Engineering Education: A Proposed ABET Student Learning Outcomes Assessment Portfolio

Taan ElAli

*College of Aeronautics, Engineering Program, Embry Riddle Aeronautical University-Worldwide, Daytona Beach, USA*

**\*Corresponding Author:** *Taan ElAli, College of Aeronautics, Engineering Program, Embry Riddle Aeronautical University-Worldwide, Daytona Beach, USA*

**Abstract:** *There are four sections in the ABET Self-Study document that are at the heart of the Self-Study report. These are the curriculum, student outcomes, program educational objectives, and continuous improvement. Engineering programs are to demonstrate that the student outcomes are achieved using a well-documented, assessed and evaluated process. In this paper, a strong relationship among all those criteria will be established. We will propose a new detailed process for the assessment and evaluation of the Student Outcomes criteria.*

**Keywords:** *ABET, Engineering Curriculum, Assessment, Course Outcomes Portfolio, Course Outcomes, Program Outcomes, Program Educational Objectives, Student Outcomes, Student Learning Outcomes.*

## 1. INTRODUCTION

ABET commission has just approved the new 1-7 student learning outcomes to replace the a-k outcomes and programs seeking accreditation for the academic cycle of 2019-2020 will have to shift to this reality. Student outcomes are now the 1-7 list in addition to any specific program criteria. Student outcomes describe what students are expected to know and can do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program [1]. Achieving student outcomes is the most important among the seven 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 to carry out the assessment process, the institution program will fail.

Assessment of student outcomes has been discussed using different approaches. Assessing using contemporary educational psychology has been experienced [2]. In many cases researchers 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]. Obtaining ABET accreditation not only put the institution at an advantage but it is a tool to improve learning [4]. Increased research for improving the assessment of student outcomes was carried out at Rose-Hulman Institute of Technology. This is where an electronic guide for assessment was developed [5,6,7,8] through planning, identification and methods of implementation of student learning outcomes. Course outcomes mapping to the student outcomes is a complicated process [10,11, 17, 18, 19, 20]. The idea of student portfolio has emerged [12,13,14,15, 16] to improve the process of student assessment. Such portfolio examples did not include a systematic process to improve the process of student assessment. A new approach to student outcomes assessment will be presented in this paper.

## 2. THE MAPPING STAGE

A strong connection between the student outcomes and the program educational objectives should be made. Once the institution mission statement has been formulated then the 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. ABET suggest a set of student outcomes. These are the 1-7 items in the student outcomes requirement.

A sample mapping between the PEO’s and the SO’s is shown in Table-1.

**Table1.** Mapping between the PEO’s and SO’s

Program Educational Objectives	Student Outcomes						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(a)	x	x	x	x		x	x
(b)	x	x	x		x	x	
(c)			x	x			x
(d)						x	

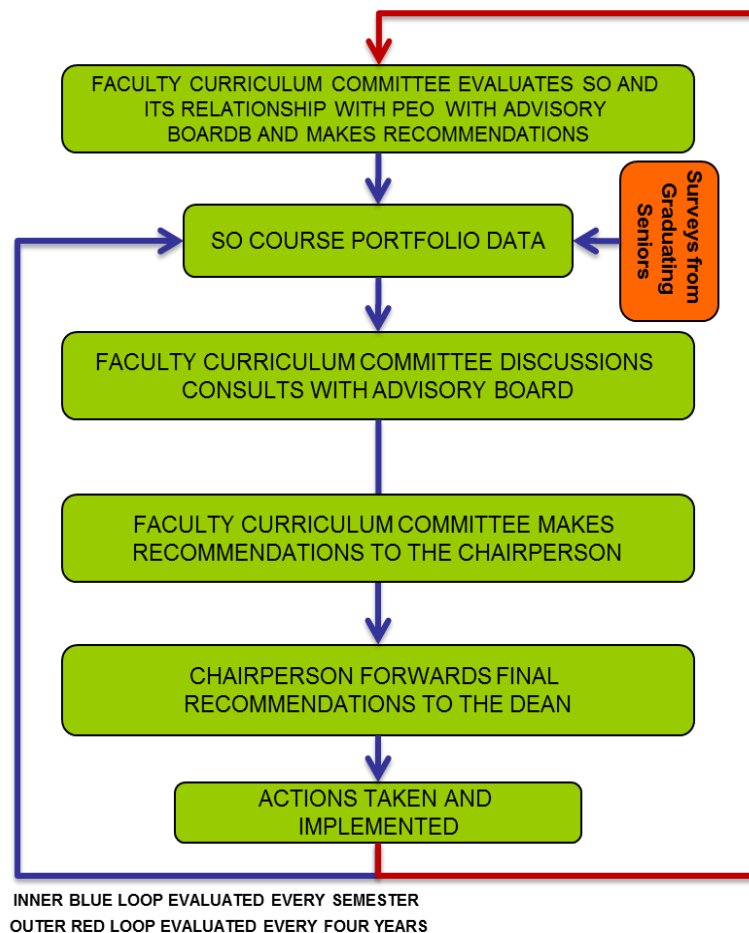
Once the relationship between the PEO’s and the SO’s is established, we will create also a strong relationship between the SO’s and the course outcomes. Table-2 shows this relationship.

**Table2.** Mapping between the CO’s and the SO’s

Course outcomes	Student Outcomes						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	x	x		x		x	x
(2)	x		x		x	x	
(3)				x			x
(4)			x			x	

**3. THE STUDENT OUTCOMES PORTFOLIO CONTENT AND THE STEPS**

Figure-1 depicts a conceptual design for the student outcomes portfolio (SOP).



**Fig1.** SOP Conceptual Design

Let us adopt the following terms to be used in this process:

EP	Engineering Program
CO	Course Outcome
FCC	Faculty Curriculum Committee
SO	Student Outcomes
SOP	Student Outcomes Portfolio
SOPC	Student Outcomes Portfolio Coordinator
PEO	Program Educational Objectives
AB	Advisory Board
CC	Course Coordinators

SO's are those outcomes that are derived from the PEO by faculty and AB. SO are statements that describe what students are expected to know and can do by the time of graduation. These relate to the skills, knowledge, and behaviors that student acquire in their matriculation through the program.

Let us also make sure that

- Every program outcome has a section in the SOP.
- The SOPC should be from among the EP faculty who are more experienced in the area of ABET accreditation.
- The CO must contribute to the achievement of the EP SO. The CO must be approved by the EP faculty body.
- The EP must invite ABET for program evaluation after
  - the first group of EE students has graduated
  - the students have been placed at work or at graduate schools as the EP mission indicates
  - the EP has tracked its graduates to see if the PEO have been achieved.
- The EP will start evaluating the SO at least 3 semesters before the graduation of the first group of students.

The FCC must decide on what EP courses must be evaluated to test for the achievement of the entire SO. It is desired and advisable that the courses that have strong relationship with the SO be selected.

The EP (as of today per ABET suggestions) has 7 SO. Every single student outcome must be evaluated. For example, let us consider the first EP student outcome:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

The CC must search for course outcomes that map strongly in achieving this student outcome, in specific courses from among the courses that were selected as explained above.

The CC then will produce something like:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

With course outcomes

- Analyze circuits using nodal analysis (CO A) in EE 241 Electric Circuits I)
- Analyze and design operational amplifier circuits (CO A in EE 242 Electric circuits II)
- Understand the way MOSFETS work and use then in circuit applications (CO C in EE 243 Electronics

Then the Faculty Student Outcomes and Assessment Document will be used to carry out the assessment towards the end of the semester.

Towards the end of every semester, the Faculty Student Outcomes and Assessment Document must be prepared and filed in the SOP with

- ABET Course Syllabus
- Student Course Syllabus
- Mapping of EP Outcomes to ABET Outcomes Sheet
- SO Evaluation Diagram
- SO and PEO Relationship Sheet
- Student Course Evaluation Form
- Teacher Course Self-Evaluation Form
- Graduating Senior Evaluation Form
- Faculty Student Outcomes and Assessment Document

The steps below should be completed within one week and is done every semester. Steps 2 to 7 are done every semester, while steps 1 to 7 are done every two years.

- FCC meets and discusses with AB the SO and its relationship with PEO and makes recommendations
- The SOP submitted to the FCC
- The SOP will be evaluated by the FCC along with the graduating senior survey
- The FCC consults with AB and makes its recommendation to the chairperson
- The chairperson recommends to the dean any proposed changes
- The Dean decides on proposed changes
- Proposed changes implemented

#### 4. CONCLUSION

The provided references talk about different methods for assessing the student outcomes and talk about the evaluation cycle to use. The need to have a process of assessing the student outcomes is of most importance in the ABET self-study document None does provide a complete process and describes in detail the process with the specific items needed to undertake this huge and complicated yet structured process. 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, namely, the Student Outcomes Portfolio Coordinator and the Student Outcomes Portfolio, will make it easy on the various committees to sail smoothly with this process. This process can be automated and updated regularly; thus, making it more appealing.

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**APPENDIX**

**Student Outcomes and Assessment Document**

<b>Course Number</b>	<b>EE 430</b>	<b>Course Name</b>	<b>Analogue Control Systems</b>		
<b>Number of Students</b>	<b>15</b>	<b>Term</b>	<b>Fall</b>	<b>Academic Year</b>	<b>2018-2019</b>

**Catalogue Description:**

***Credit Hours: 3***

**Control system analysis and design: classical and modern; transfer functions; state-space techniques; time-domain analysis and design; frequency-domain analysis and design; stability analysis; prototyping;**

**Modifications That Have Been Made to the Course Last Term:**

**1. More emphasis on teamwork: groups of 4 to 5 will work on assigned projects**

**2.**

**Grade Distribution:**

A	B	C	D	F	Total
5	5	3	2	0	15

**Program Outcomes (must agree with the desired outcomes as set by the accreditation agency)**

List the 1-7 ABET suggested SO

**Student Outcomes and Method of Assessment:**

Student Outcome	Method of Assessment	Where?															
		T1	T2	T3	T4	H1	H2	H3	H4	P1	P2	P3	P4	L1	L2	L3	L4
1	HTPL	x				x				x				x			
2	HTPL	x						x	x	x						x	x
3	HTPL		x			x				x	x						
4	HTPL			x				x			x			x			x
5	HTPL		x						x			x				x	
6	HTPL				x			x				x					x
7	HTPL				x				x			x			x		

**T: Test                      H: Homework                      P: Project                      L: Lab**

**Program 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)**

SO1				SO2				SO3				SO4				SO5				SO6				SO7			
E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U	E	G	A	U
2	6	4	3	2	6	4	3	2	6	4	3	2	6	4	3	2	6	4	3	2	6	4	3	2	6	4	3
SO1 Ave: 2.47				SO2 Ave: 2.47				SO3 Ave: 2.47				SO4 Ave: 2.47				SO5 Ave: 2.47				SO6 Ave: 2.47				SO7 Ave: 2.47			

**Example: Number of students in class: 15**

Outcome a															
E				G				A				U			
2				6				4				3			

**Outcome A average is  $[2(E) + 6(G) + 4(A) + 3(U)]/15 = [2(4) + 6(3) + 4(2) + 3(1)]/15 = [37]/15 = 2.47$**   
**The result is between Average and Good**

**Feedback from the Students:**

1. The teacher did not spend enough time explaining the time domain specifications
- 2.

**Instructor's Thoughts:**

1. Go slower on project five. Students needed more time
2. Need to introduce prototyping next semester
3. Extra project on state-space is needed
- 4.

**Proposed Changes to the Course:**

1. Prepare a handout on prototyping and use one lecture period to explain it
2. Increase the number of projects to seven by adding one on state-space design of an oscillating pendulum
- 3.

**Signature of the Instructor:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Signature of the Chair:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Signature of the Dean:** \_\_\_\_\_ **Date:** \_\_\_\_\_

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