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An Outcomes-Driven Approach for Assessment

Youakim Kalaani
Georgia Southern University, yalkalaani@georgiasouthern.edu

Shonda Bernadine
Georgia Southern University

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AC 2010-1158: AN OUTCOMES-DRIVEN APPROACH FOR ASSESSMENT:A CONTINUOUS IMPROVEMENT PROCESS

Youakim Al Kalaani, Georgia Southern University

Shonda Bernadin, GSU

An Outcomes-Driven Approach for Assessment: A Continuous Improvement Process

Introduction

Continuous improvement is an important issue in education because it defines the framework for assessment and evaluation, which is required by accrediting agencies. Consequently, an accredited ET program that accomplishes its mission and successfully achieves its program objectives and outcomes must have multiple levels of continuous improvement whose results are used to constantly update and evaluate the program for sustained improvement and continued success. A plan must exist that details program-level continuous improvement, as well as course-level continuous improvement.

In this paper, we describe an ABET-driven assessment plan that was originally developed to address some weaknesses and concerns identified by program evaluators during a previous accreditation visit. However, faculty of the Electrical Engineering Technology (EET) seized this opportunity to embark on a major program revision making use of its newly organized Industrial Advisory Board (IAB). As a result, a five-step process that consists of 1) program assessment planning, 2) data collection, 3) data analysis, 4) program review, and 5) program improvement actions was developed. During this process, the program objectives and outcomes are evaluated and revised to maintain currency and technical relevance. Using the results from step 5, a curriculum mapping worksheet (CMW) is modified and used to revise the course-level assessment and evaluation plan. The CMW is a matrix mapping each course in the EET curriculum to appropriate program outcomes and identifies assessment tools used to measure the success of each outcome. Moreover, the CMW provides a mechanism for correlating program-level outcomes with course-level outcomes using effective assessment tools to measure student performance. Based on the results of the assessment tools, continuous improvement actions at the course level and program level are identified and used to revise the program assessment and evaluation plan which may also provide useful information to other institutions seeking ABET accreditation.

Objectives and Outcomes

The program educational objectives have been defined according to the ABET Criteria for Accrediting Engineering Technology Programs[1], as "*broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve during the first few years following graduation*". The following objectives were approved by the IAB and EET faculty:

Within a short period after gaining employment, EET graduates should:

1. be able to apply knowledge of electrical devices and systems.
2. be able to use modern tools including computer systems and software.
3. be able to integrate theoretical and practical knowledge in the completion of assigned tasks.

4. be able to communicate effectively in spoken and written form.
5. be adaptive to a changing environments and new technologies.
6. exhibit an ability to assist others and contribute to multi-disciplinary teams.
7. have an awareness of contemporary professional, ethical, societal, and global issues.

Similarly, the program outcomes have been defined according to the ABET Criteria for Accrediting Engineering Technology Programs[1], as "*statements that describe what units of knowledge or skill students are expected to acquire from the program to prepare them to achieve the program educational objectives*". The following outcomes were approved by the IAB and EET faculty:

General skills EET students are expected to possess upon completion of their course work include:

(a) An appropriate mastery of the knowledge, skills and modern tools of electrical and electronic engineering technology including an ability to use computers and computer-aided design tools effectively.
(b) An ability to apply relevant knowledge to achieve feasible and practical results, while also adapting to emerging applications of mathematics, science, engineering, and technology.
(c) An ability to plan and conduct experiments in a disciplined manner (use and connect standard laboratory instruments, electronic devices and equipment), analyze, interpret, troubleshoot and apply experimental results to improve processes using sound engineering principles.
(d) An ability to apply creativity in the practical, cost effective and reliable design of systems, components or processes in the areas such as electronics, or electrical power and machinery.
(e) An ability to function effectively in laboratory groups and/or on design teams with members and tasks sometimes separated in time and space.
(f) An ability to identify, design, test, analyze, and solve technical problems using knowledge gained from a broad understanding of engineering disciplines including and outside electrical engineering technology.
(g) An ability to communicate effectively through the submission of professional (neat and accurate) technical reports and through individual and group presentations.
(h) Recognition of the need for, and an ability to engage in lifelong learning with an awareness of the significance of membership and contribution to IEEE and other similar professional organizations.
(i) An ability to understand professional, ethical, and social responsibilities
(j) A respect for diversity and knowledge of contemporary professional, societal, and global issues.
(k) A commitment to quality, timeliness, and continuous improvement.

The correlation between the program educational objectives (1) – (7) and the program outcomes (a) – (k) is illustrated in Table 1 below.

PROGRAM OBJECTIVES → PROGRAM OUTCOMES:	1. be able to apply knowledge of electrical devices and systems	2. be able to use modern tools including computer systems and software	3. be able to integrate theoretical and practical knowledge in the completion of assigned tasks	4. be able to communicate effectively in spoken and written form	5. be adaptive to a changing environment and new technologies	6. exhibit an ability to assist others wherever required and contribute to multi-disciplinary teams	7. have an awareness of contemporary professional, ethical, societal, and global issues
(a) An appropriate mastery of the knowledge, skills and modern tools of electrical and electronic engineering technology including an ability to use computers and computer-aided design tools effectively	√	√	√				
(b) An ability to apply relevant knowledge to achieve feasible and practical results, while also adapting to emerging applications of mathematics, science, engineering, and technology	√	√	√		√		
(c) An ability to plan and conduct experiments in a disciplined manner (use and connect standard laboratory instruments, electronic devices and equipment), analyze, interpret, troubleshoot and apply experimental results to improve processes using sound engineering principles	√	√	√				√
(d) An ability to apply creativity in the practical, cost effective and reliable design of systems, components or processes in the areas such as electronics, or electrical power and machinery	√	√	√		√	√	√
(e) An ability to function effectively in laboratory groups and/or on design teams with members and tasks sometimes separated in time and space				√		√	√
(f) An ability to identify, design, test, analyze, and solve technical problems using knowledge gained from a broad understanding of engineering disciplines including and outside electrical engineering technology	√	√	√	√	√	√	√
(g) An ability to communicate effectively through the submission of professional (neat and accurate) technical reports and through individual and group presentations			√	√		√	
(h) A recognition of the need for, and an ability to engage in lifelong learning with an awareness of the significance of membership and contribution to IEEE and other similar professional organizations				√	√	√	√
(i) An ability to understand professional, ethical, and social responsibilities					√		√
(j) A respect for diversity and knowledge of contemporary professional, societal, and global issues					√	√	√
(k) A commitment to quality, timeliness, and continuous improvement	√	√	√		√		√

Table 1- EET Program Objectives and Outcome Correlation

The relationship between the program outcomes and courses in the EET curriculum is shown in Table 2. While multiple direct and indirect measures of each program outcome are being used, the curriculum is structured and evaluated in such a manner that many course-level outcomes contribute to program level outcomes. The level to which course-level outcomes contribute to the satisfaction of program-level outcome was determined using a rating scale of 1 to 4, where 1 indicates a *slight* contribution level to the associated program outcome and 4 indicates a *strong* contribution.

CURRICULUM-MAPPING WORKSHEET **An indication of the degree to which course-level outcomes contribute to the indicated program-level outcomes (a-k)**													
Course	**Number**	**Title**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
TENS	2146	Elec. Dev. & Meas.	1	1	1		1	1					
TEET	2341	Circuit Analysis I	1	1	1	1	1	1	1				
TEET	2441	Digital Circuits	1	1	1	1	1	1	1				
TEET	2433	Microcontrollers	2	2	2	2	2	2	2	1	1	1	
TEET	3145	Circuit Analysis II	2		2	2	2	2	2		2	2	1
TEET	3241	Electronics I	2	2	2	2	2	2	2	2		2	1
TEET	3243	Electronics II	3	3	3	3	3	3	3	3		3	2
TEET	4610/20	EET Senior Design I &II	4	4	4	4	4	4	4	4	4	4	4
TEET	3341	Electric Machines	4	4	4	3	4	3	3	2			3
TEET	3343	Electrical Dist. Systems	4	4	4	3	4	4	3	4	4	3	
TEET	4340	Digital Communications	3	3	3		3	3	3		3	3	3
TEET	5531	Programmable Controllers	4	4	4	3	4	4		4			
TEET	5542	Computer System Design	3	3	3	3	3	3	3	3		3	3
TEET	5245	Communications Electronics	3	3	3		3	3	3		3	3	3
TEET	5238	Industrial Electronics	4	4	4	3	4	3	3	3	2		3
TEET	4090	Robotics	3	3	3	3		3		3			
			4 – Strong, 3 – Moderate, 2 – Some, 1 – Slight										

Table 2- EET Curriculum Mapping Worksheet (CMW)

A good example of how multiple course-level outcomes contribute to a program-level outcome would be with respect to the program outcome g. Rubric-based analyses of laboratory reports are made in five courses in the curriculum. An attempt was made to sample reports at various levels (sophomore-junior-senior) in the curriculum. Rubric-based assessments of presentations from at least two different courses also contribute to satisfying this outcome. In addition to having the instructor assess the presentation, student-peer evaluations and additional faculty evaluations (other than the instructor) are reported. Along with course exit and senior exit surveys addressing communication skills, the program-level outcome is considered assessed by these multiple course-level measures from across the curriculum.

Assessment and Evaluation Plan

There are five major components of the Assessment and Evaluation Process: *Program Assessment Planning, Data Collection, Assessment and Data Analysis, Administrative Program Review,* and *Program Improvement Actions*. The process then loops back to Data Collection for successive cycles. Figure 1 is a schematic of this process. Since the IAB members provide insight and direction for ensuring that our program objectives and outcomes are current and appropriately meet the industry expectations of EET graduates, they are an integral part of the first stage, *Program Assessment Planning*. During this stage, the highest priority constituents (i.e. IAB members) evaluate the current state of the EET program by reviewing the program outcomes and program objectives. This activity is typically done during each fall semester IAB meeting. During this review, IAB members assess the appropriateness of each program objective and each program outcome relative to industry expectations of EET graduates, using the results of the data collected from our major constituents during the previous assessment cycle. The committee members document their feedback by completing two surveys. IAB members also provide feedback on several focus areas including Strategic Direction and Guidance, Continuous Program Improvement, Curricular Control & Enhancement, and Recruitment and Retention. The program coordinator collects the feedback from the IAB members and summarizes it in the form of a list of recommendations and/or modifications. It is the duty of the EET faculty to ensure that the recommendations/modifications of the IAB conform to the mission of the institution, college and department, and the feasibility of implementation. The objectives and outcomes are then appropriately modified.

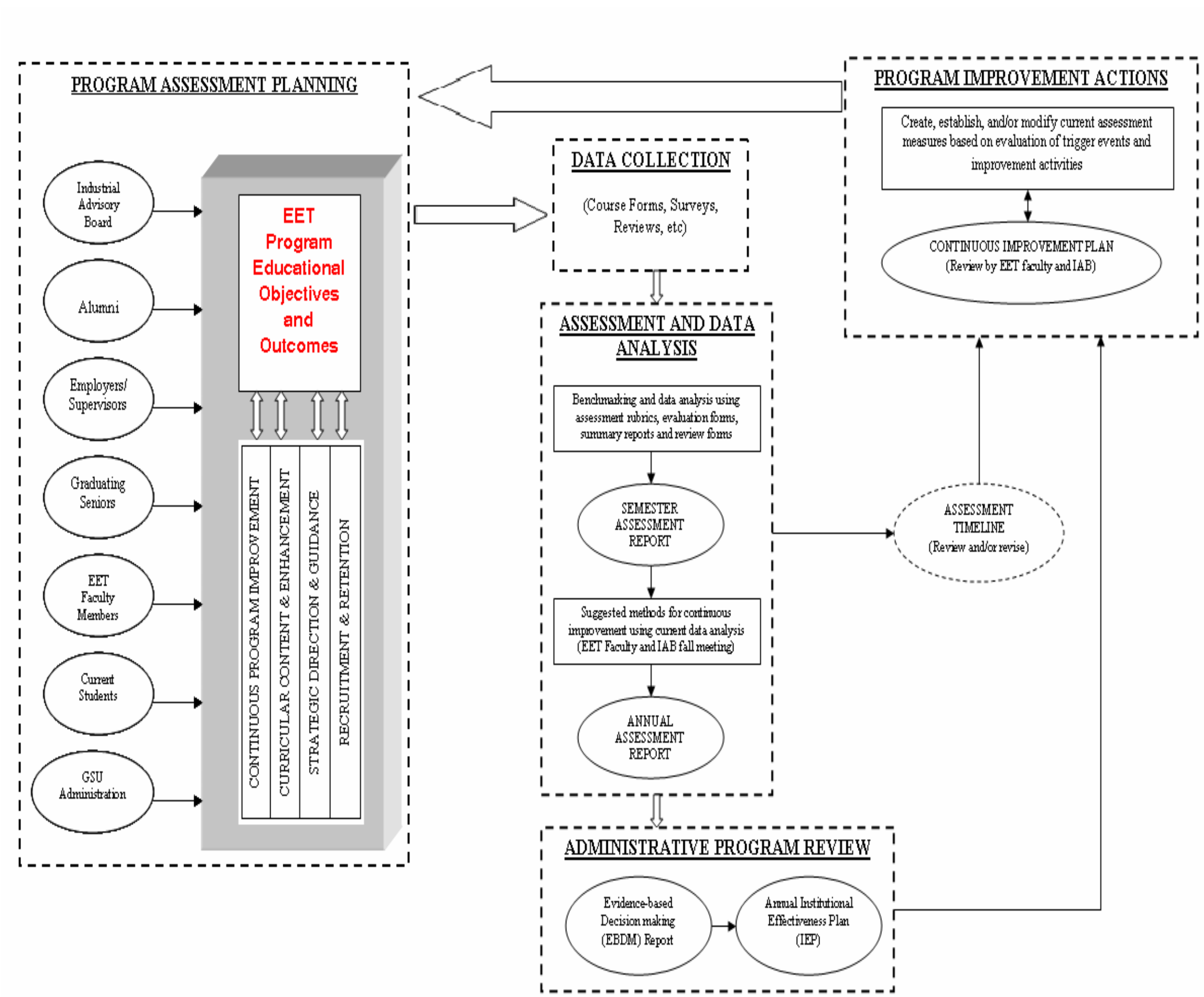

Figure 1- The Assessment and Evaluation Process

Assessment Tools Used for Evaluation

Multiple assessment tools have been identified by EET faculty as qualifying measures for evaluating the program outcomes. These measures can be categorized as:

I- Direct Measures:

- Multiple course-level outcomes, typically measured with standards established in a rubric that contribute to a program level outcome.
- Single and multiple faculty assessments of a student presentation using a rubric-based assessment tool.
- Peer assessment of a student presentation using a rubric-based assessment tool.
- Faculty evaluation of a senior project.
- Faculty evaluation of student laboratory reports. Assessment is made from selected technical courses from across the curriculum.

II- Indirect Measures:

- Industrial Advisory Board review of the continuous improvement process, curriculum, and courses.
- Peer assessment of the ability to function in teams.
- Student Self-Evaluation and faculty evaluation of performance on a project.
- Student Course exit survey assessing course-level outcomes that contribute to program level outcomes.
- Senior Exit Survey addressing program level outcomes at the time of graduation.
- Alumni Survey addressing overall program objectives.
- Employer Survey addressing work related skills that meets program objectives.

Multiple course-level and indirect assessment measures collected during the *data collection* phase of the continuous improvement process are shown in Figure 2. During this phase, assessment tools are administered and feedback on current program outcomes and objectives is collected from the constituents.

Before proceeding to the descriptions of each tool, a brief discussion on how rubrics were developed will be given. For the purpose of this paper, we identify a rubric as a graded range with defined performance requirements. It can also be considered as a scoring guide that specifies the skill or category being assessed with an associated numerical rating scale indicating the level of student performance. For example, Table 3 is an illustration of a performance on a capstone senior project with categories 7, 8, and 9 highlighted to indicate emphasis on measuring intangible skills such as quality, timeless and continuous improvement.

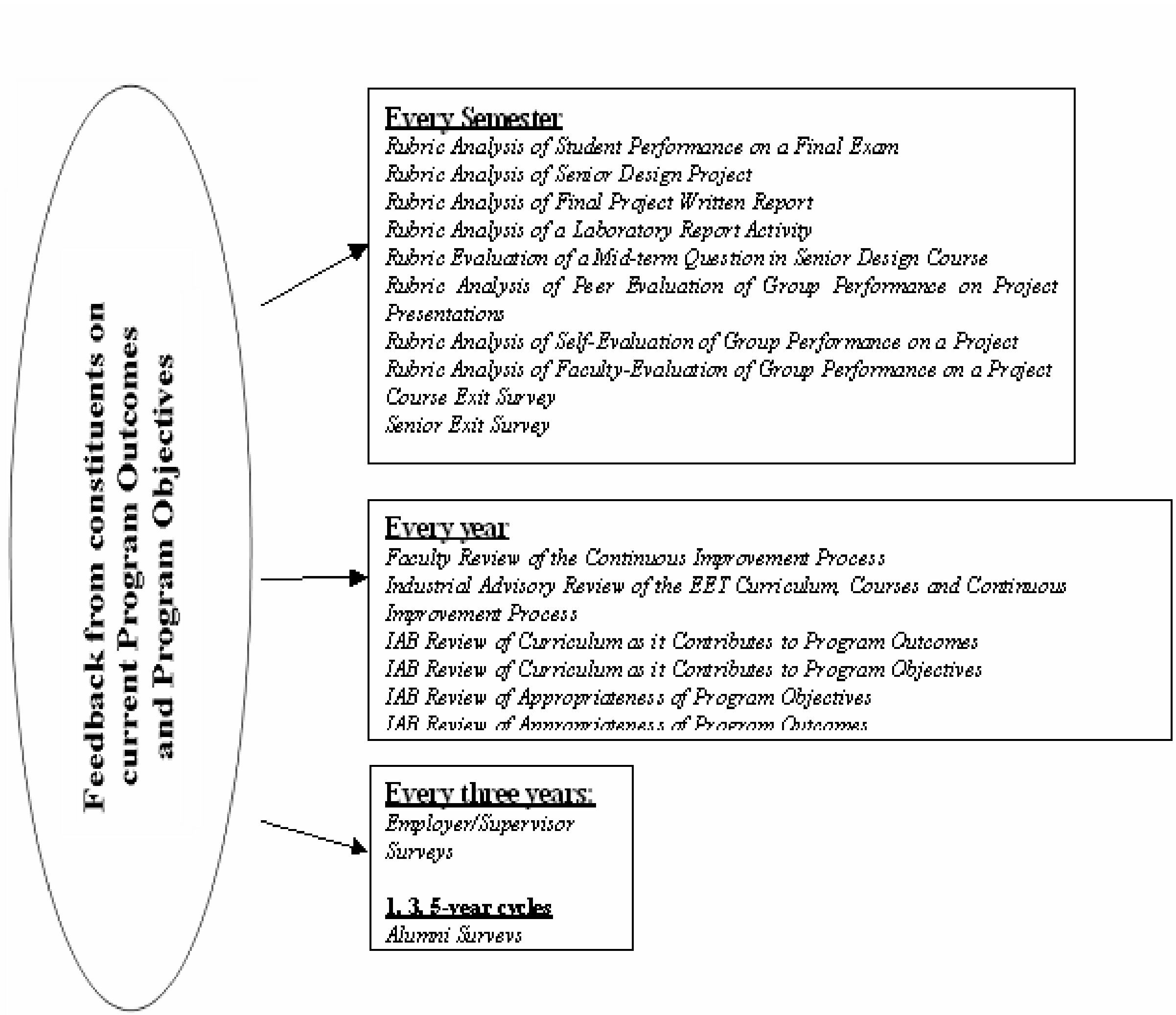

Figure 2- Data Collection Phase and Frequency of Measures

The first column in this rubric identifies the performance categories or skills that are being addressed by this assignment. The next four columns indicate the ratings a student can receive for this category based on their demonstration of mastering the skill. Using a generic template, program faculty develops appropriate rubrics for the course level outcomes in their respective courses. These course-specific rubrics are then collected as an appendix of the Continuous Improvement Effort (CIE), so future faculty can re-use the same measurement tools and definitions/standards.

An assessment summary based upon the rubric is compiled—as shown in Table 4. The summary contains a rubric score for each student at each skill that was assessed. An average rubric score for each student is calculated, and used to determine if a particular student is performing below expectation. An average rubric score for each outcome measure is also calculated and compared to a desired performance benchmark.

	Overall Review-Rubric **Rubric Definition for TEET 4630 - Overall Performance on the Senior Project** Course: TEET 4630 (Senior Design) Date: Evaluator:				
	Category	**Points**			
		4	3	2	1
1	Use of CAD Tools	Designed and tested the circuit with CAD tools	Used CAD tools to design circuit without testing	Learned the use of PCB design CAD tools but was not comfortable using the tool	Knew very little about the use of PCB design CAD tool
II	Use of Computers	Used for report, research and design and simulation and test	Used for writing report, research and design	Used for writing report and research	Rarely used a computers
III	Identify Design	Had a very clear idea about the circuit and its operation	Used to understand the circuit but could not explain the operation of the circuit	Understood only a part of a circuit	Had poor grasp of an electronic circuit
IV	Test	Tested properly by following the exact procedure	Tested but didn't follow the procedure	Tried to test but did not know the techniques	Hardly understand about the testing of a circuit
V	Trouble shooting	Whole system was working fine.	Fixed the problem of the circuit without expected results	Poor understanding of the circuit operation	Tried but unable to trouble shoot
VI	Apply creativity	Added new circuit block to modify circuit as needed	Tried to modified but got poor results	Planned to apply new circuit block but failed to implement	Attempted to implement modification but failed
VII	Solve technical problems	Understood clearly why the initial design was modified and the requirements	Used to understand the problems of the circuit but failed to identify the requirements	Used wrong procedure to solve the problems in the circuit	Very poor understanding of the circuit
VIII	Timeliness	Completed the PCB design and full filled all the requirements on time	Initially designed PCB didn't work and then took more time for designing a new PCB	PCB design timeline exceeded because of several failures	Unable to design a working version of PCB
IX	Quality process	Soldering and Etching process was completed nicely and smoothly	Etching process was done nicely but the soldering quality was not so good	Both the etching and soldering quality are not so promising	Didn't complete the soldering
X	Continuous Improvement	Improved and modified the design after midterm presentation	Modified the design for improvement but remain almost the same	Didn't implement any new modification in the design	Had very little clue for improving the design

Table 3 - Sample Rubric for a Capstone Project

For instance, if an average score falls below 2.5 out of 4, the corresponding measure is flagged, an instructor review is triggered and the CIE report is completed by the instructor and submitted to the program coordinator. Suggested improvements are implemented during the next course offering, and the outcome is again measured. If the measure falls below the benchmark in three successive measurings, an EET faculty-wide review is triggered leading to a documented improvement strategy.

	Description of Project Measures										
Student	Use of CAD Tools I	Use of Computers II	Identify Design III	Test IV	Trouble shooting V	Apply creativity VI	Solve technical problems VII	Timeliness VIII	Quality process IX	Continuous Improvement X	Rubric score on a scale of 4
1	4	4	3	3	3	3	4	4	4	2	3.40
2	4	4	2	2	3	3	3	4	4	1	3.00
Table truncated for space limitation											
22	4	4	4	4	3	3	3	4	3	3	3.50
23	3	4	3	3	2	3	2	4	2	2	2.80
Average	3.83	4.00	3.22	2.96	2.83	3.17	3.17	3.65	3.04	**2.48**	3.23
Benchmark and Trigger Action: If a composite score falls below 2.5, the corresponding measure is flagged, an instructor review occurs, the continuous improvement effort (CIE) report is completed and submitted to the program coordinator, improvements are implemented the next course offering, and the outcome is again measured. If the measure falls below the benchmark three successive measuring, an EET faculty-wide review is triggered.											

Table 4 – Capstone Project Assessment Summary

As can be seen in Table 4, the rubric average dealing with continuous improvement fell below the 2.5 benchmark. The course instructor completed a CIE report which documented a strategy for instructional improvement and submitted it to the program coordinator. A copy of the actual CIE report is shown in Table 5 below.

Continuous Improvement Efforts (CIE) Report	
Course/Activity Measured: TEET 4620- Senior Project	**Semester: Spring 2008**
Prepared by: Dr. K	
What *issue* was triggered that prompted change?	**Course Outcome:** Category X: Continuous Improvement
What *tool* was used that prompted the change? (For example, student feedback, faculty observations, IAB suggestions, rubric analysis of Student performance, etc)	Assessment rubric of a Capstone Project
What was the *change* or improvement?	This course needs to be offered in two semesters to allow students to improve on their projects. Invite IAB members to attend and grade final project presentation.
What was the *result of implementing* the change? (i.e. did the change correct the issue?)	To be implemented the next time this course is offered (Spring 2009)

Table 5 – Continuous Improvement Efforts Report

Outcomes of the Multiple Assessment Measures

The following tables are an outcome-by-outcome based matrix which contains the multiple course-level outcome measurements and indirect measurements that contribute to fulfillment of the program outcome. With the exception of IAB measurements which are summarized in their own section, this serves as a guide to the specific measures within a one complete academic year assessment process. Benchmarks, measurement frequency, and responsible evaluator are also indicated along with a statement of the number of triggered benchmarks. Table 6 summarizes the matrix data for each program outcome. Corresponding matrices are referenced for details on the continuous improvement actions taken as a result of triggered measurements.

As depicted, there were a total of 37 direct course-level measurements (e.g. rubric analysis of final exams, rubric evaluations of group presentations, etc.) and a total of 91 indirect course-level measurements used during this assessment cycle that contributed to program outcomes. There were 17 course-level measurements that were triggered and required continuous improvement actions. Corresponding documentation highlighting strategies for continuous improvement is found in the CIE documentation reports.

TABLE 4 – Summary of Triggered Benchmarks for each Program Outcome in Matrix of Multiple Course-level and Indirect Measures

Program Outcome	Total Number of Measurements Used		Total Number of Measurements Triggered		Total Number of Measurements triggered for each Program Outcome	Continuous Improvement Actions Taken
	Direct	Indirect	Direct	Indirect		
A	9	8	5	3	8	See Table 4A
B	8	10	5	0	5	See Table 4B
C	4	9	1	0	1	See Table 4C
D	1	9	0	0	0	See Table 4D
E	4	8	0	0	0	See Table 4E
F	1	7	1	0	1	See Table 4F
G	6	8	1	0	1	See Table 4G
H	1	8	0	0	0	See Table 4H
I	1	8	0	0	0	See Table 4I
J	1	8	0	0	0	See Table 4J
K	**1**	**8**	**1**	**0**	**1**	**See Table 4K**
TOTAL	37	91	14	3	17	

Table 6 – Summary of Triggered Benchmarks

Program Outcome k. A commitment to quality, timeliness, and continuous improvement			**Related TAC of ABET Criterion:** 2k	
	Measurements Contributing to Indicated Outcome Assessment Tool(s)	**Measurement Tools and Benchmark Status**	**Assessment Frequency**	**Responsible Assessor**
1	Rubric Evaluation of a Capstone Project in TEET 4630	See Rubric Summary E4630-Project-Rubric (1) Triggered Benchmarks	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
2	TEET 4245 Student Exit Survey Question 15*	See Survey Summary TEET-4245-Survey No Triggered Benchmarks	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
3	TEET 3241 Student Exit Survey Question 15	See Survey Summary TEET-3241-Survey No Triggered Benchmarks	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
4	TEET 4090 Exit Survey Question 15	See Survey Summary TEET-4090-Survey-F06 No Triggered Benchmarks	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
7	TEET 4241 Student Exit Survey Question 15	See Survey Summary TEET-4241-Survey Phase II Implementation	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
8	TEET 4245 Student Exit Survey Question 15	See Survey Summary TEET-4245-Survey- S07 (0) Triggered Benchmarks	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
9	EET Senior Exit Survey Question 15	See Survey Summary EET-SeniorSurvey-F06 No Triggered Benchmarks	Every Senior Course Offering—students complete only once	Instructor reports summary results to Program Coordinator

* Question 15: After finishing this course, I have a commitment to quality, timeliness, and continuous improvement.

Table 4K – Summary of Triggered Benchmarks for Outcome g

Due to space limitation, only program outcome k mostly related to soft, intangible skills that are typically difficult to measure is displayed in Table 4K.

Students must rate their level of commitment in these soft areas on a scale of 1 to 4. As noted in the table there was one trigger for this outcome in the senior design capstone project course. Part of the corrective action for this result involved redesigning the senior design course as a two semester course, with project management goals assessment in the first semester part and project implementation and demonstration goals evaluated during the second semester of the course. This course redesign gives students greater appreciation for timeliness, quality and the continuous improvement of their capstone projects.

Continuous Improvement Efforts

For our course-level continuous improvement plan, the three assessment tools[2] are used by instructors to assess and evaluate their courses: a *course-level outcomes* form, a *continuous improvement efforts* form, and *student course outcomes evaluations* form.

As previously discussed, the Course-level Outcomes (CLO) form is completed by the instructor and submitted to the assessment committee at the end of each semester. This form states each course outcome relative to program outcomes; identifies the assessment tools that are being used to measure the student performance of each outcome, and the corresponding rubric analysis result for each assessment tool. The instructor completes and submits a CIE form for each outcome measure that falls below the benchmark. An example of a CLO form is depicted in Table 8.

The student-course-outcome (SCO) evaluations form is an indirect measure used to collect feedback from IAB members based on their perception of achieving the defined course outcomes. A rubric analysis is performed and if a particular outcome falls below the benchmark, a faculty-wide review is initiated.

	Course Learning Objectives *At the end of this course students will be able to:*	**Course Outcomes/ Evaluation Measured** *Throughout this course students will be able to:*	**Corresponding Program Outcomes (a-k)**	**Assessment Instrument/ Evaluation Measure**	**Actual Level (4 pt scale)**	**Action(s)/ Recommendation(s) for Instructional Objective Improvement**
1	Define basic communication system vocabulary including basic concepts and principles	- define basic communication concepts (bandwidth, modulation/demodulation, decibel notation)	a, b, f	Rubric of Exam 1	2.68/4.0	No action required
2	Determine the spectrum of periodic and non-periodic signals	- determine signal spectra of electrical signals	a, b, f	Rubric of Exam 2	3.04/4.0	No action required
		- implement common communications filters	a, b, f	Rubric of Lab 2	2.67/4.0	No action required
3	Analyze communication systems in terms of frequency response, filter implementation, oscillator circuits and receivers	- describe a phase locked loop circuit and its application to frequency synthesizers	a, b, f	Rubric of Exam 3 Problem A.6	3.20/4.0	No action required
		- analyze mixer circuits using frequency conversion principles	a, b, f	Rubric of Exam 3 Problem B.2	3.09/4.0	No action required
		- identify properties of receiver circuits	a, b, f	Rubric of Exam 3 Problem A.11	3.56/4.0	No action required
4	Analyze systems using common modulation techniques including Amplitude Modulation and angle modulation (FM and PM)	- describe amplitude modulation methods including SSB and DSB	a, b, f	Rubric of Final Exam Problem 1	3.36/4.0	No action required
		- analyze amplitude detection systems	a, b, f	Rubric of Lab 6-AM Analysis	3.8/4.0	No action required
		- describe characteristics of frequency modulation	a, b, f	Rubric of Final Exam Problem 3	3.22/4.0	No action required
		- analyze frequency modulation detection circuits	a, b, f	Rubric of Lab 6-FM Detection	2.11/4.0	Devote more lecture time to frequency detection circuits; give more assignments emphasizing FM modulation and detection
5	Simulate, test and verify communications systems using lab equipment	- Submit neat and professional lab reports	i, c, e, g, k	Lab Average	2.93/4.0	No action required

Table 8- Example of Course-level Outcomes Form

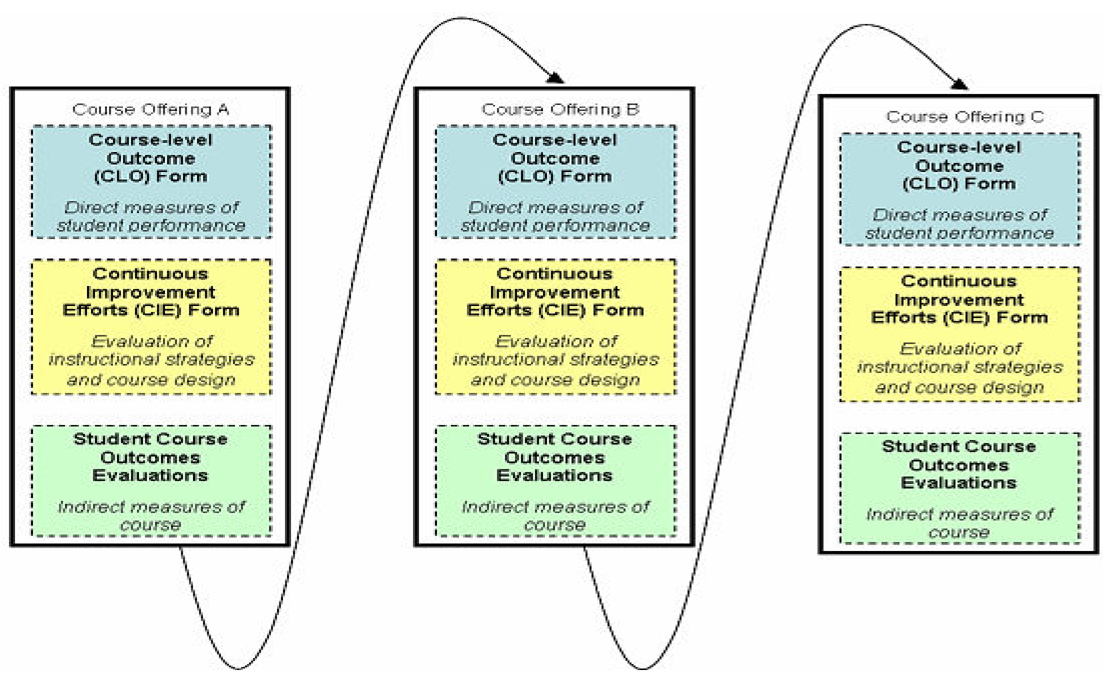

Figure 3 -Flow Diagram of Course-level Assessment & Evaluation Process

Figure 3 illustrates the entire course-level continuous improvement process which uses information collected from the three assessment tools (CLO, CIE, and SCO).

The six-year assessment cycle started in Fall 2006 which means that, based on our continuous improvement plan, the EET assessment process was scheduled for a mid-cycle review at the end of the 2008-2009 academic year. At the end of spring 2009, the EET faculty gathered collective data and analyzed it to show the effectiveness of the CIE implementation. The results of our three-year assessment cycle review illustrated the composite findings for the data collected for indirect methods of evaluation that were collected for *program objectives* including employer feedback, alumni feedback and IAB feedback.

Table 9 shows the analytical result of the rubric-assessment of the indirect measures collected from our constituents for our EET program objectives. They are further illustrated in Figure 4.

Program Objectives	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Employer Survey	2.89	3.11	2.82	2.50	3.00	3.17	3.00
Alumni Survey	3.36	2.96	3.20	3.36	3.20	3.20	4.00
IAB Survey	3.58	3.22	3.07	3.12	3.42	3.45	3.33

Table 9 - Program Assessment Cycle Fall06-Spring2009

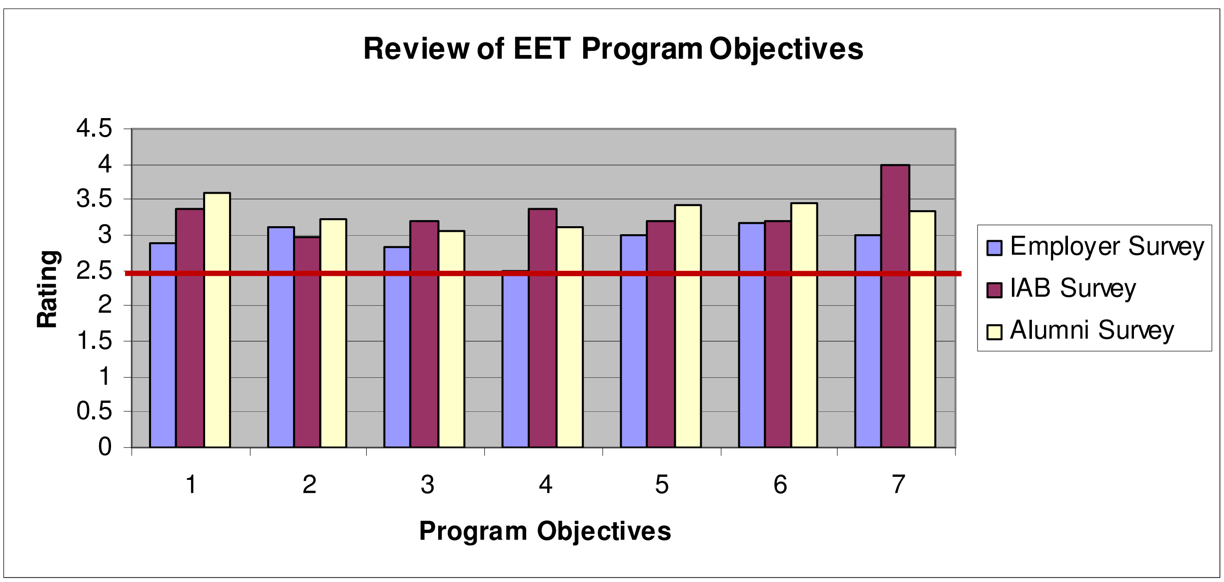

Figure 4 –Mid-cycle review of EET program Objectives (Fall 2006-Spring 2009)

Based on the results presented, it was observed that EET program objective 4 (be able to communicate effectively in spoken and written form) barely met the target performance expectations over the first three years of the assessment cycle according to the observations of our EET employers. The corrective action was taken to incorpoporate more student projects and presentations into EET courses at all levels including 2000-level courses through 5000-level courses. Most of the upper-level courses already require students to submit a captsone project in written and oral format. We concluded that to adequeately prepare students for professional work environment, we would also introduce more presentation skills in the lower level courses. Tables 10 – 12 show the analytical results of the rubric-assessment collected from our constituents over the first three years of the assessment cycle. They are further illustrated in Figures 5, 6, and 7.

Program Outcomes	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
CLO's Average	3.14	3.14	2.25	3.26	3.40	3.14	3.18	3.41	3.20	2.98	3.18
Senior Exit Survey	2.63	2.95	2.74	3.42	3.11	2.84	3.16	3.42	3.47	3.16	3.42
IAB Survey	3.84	3.36	3.36	3.36	3.76	3.44	3.44	3.6	4	3.6	4

Table 10 - Academic Year 2006- 2007

Program Outcomes	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
CLO's Average	3.08	2.91	3.05	2.89	2.94	2.93	2.93	3.22	3.42	3.32	3.08
Senior Exit Survey	3.43	3.14	3.57	3.14	3.62	3.21	3.21	3.21	3.43	3.14	3.46
IAB Survey	na	na	na	Na	na	na	na	na	na	na	na

Table 11 - Academic Year 2007- 2008

Program Outcomes	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
CLO's Average	3.33	3.07	3.24	3.21	3.40	3.16	3.14	3.56	3.46	3.47	3.21
Senior Exit Survey	3.34	3.42	3.63	3.27	3.67	3.48	3.37	3.46	3.48	3.63	3.71
IAB Survey	2.75	3.35	3.54	2.95	3.5	3.26	3.3	3.17	3.2	2.7	3.34

Table 12 - Academic Year 2008- 2009

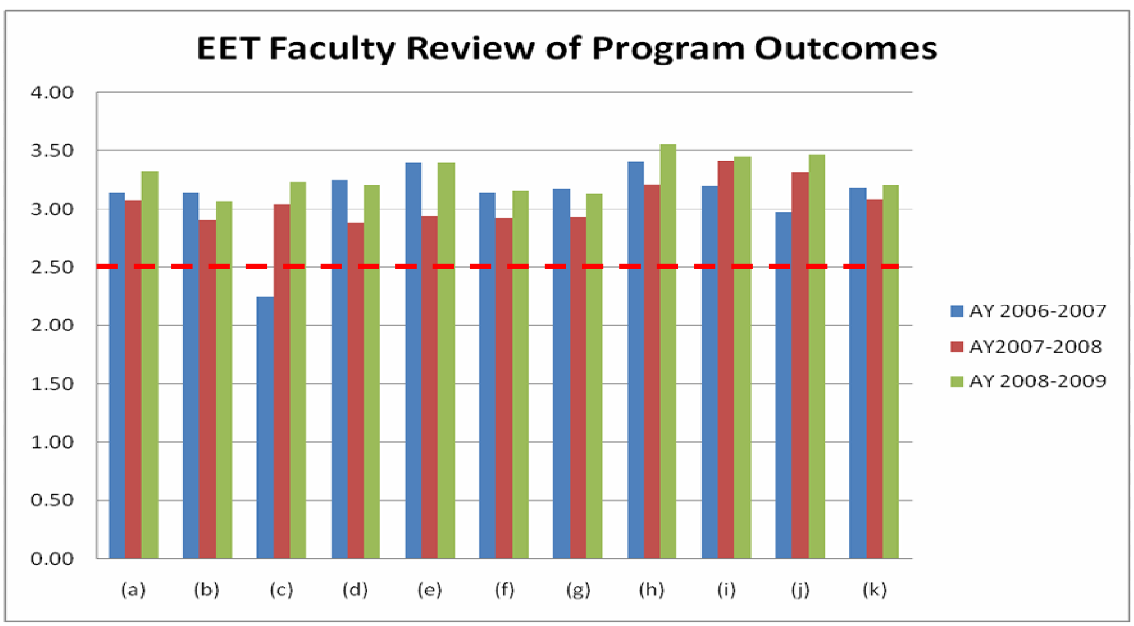

Figure 5 –EET Faculty Review of Program Outcomes 2006-2009

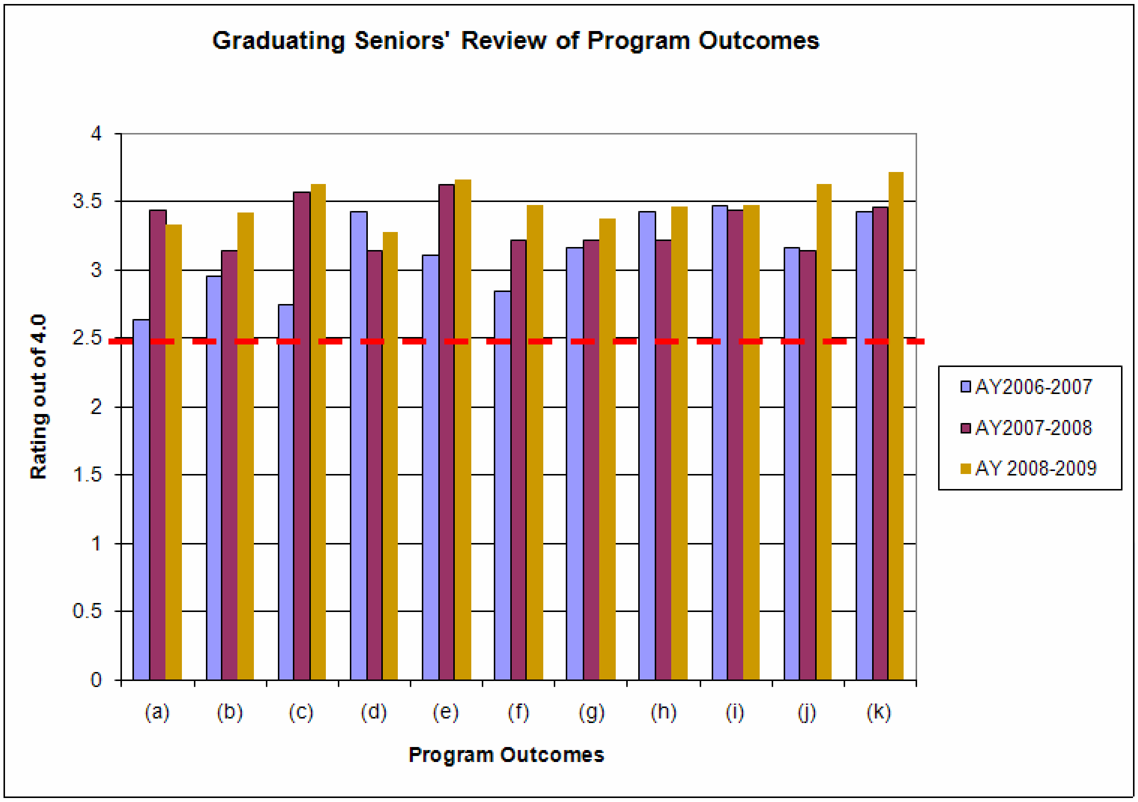

Figure 6–Garduating Senior Review of Program Outcomes 2006-2009

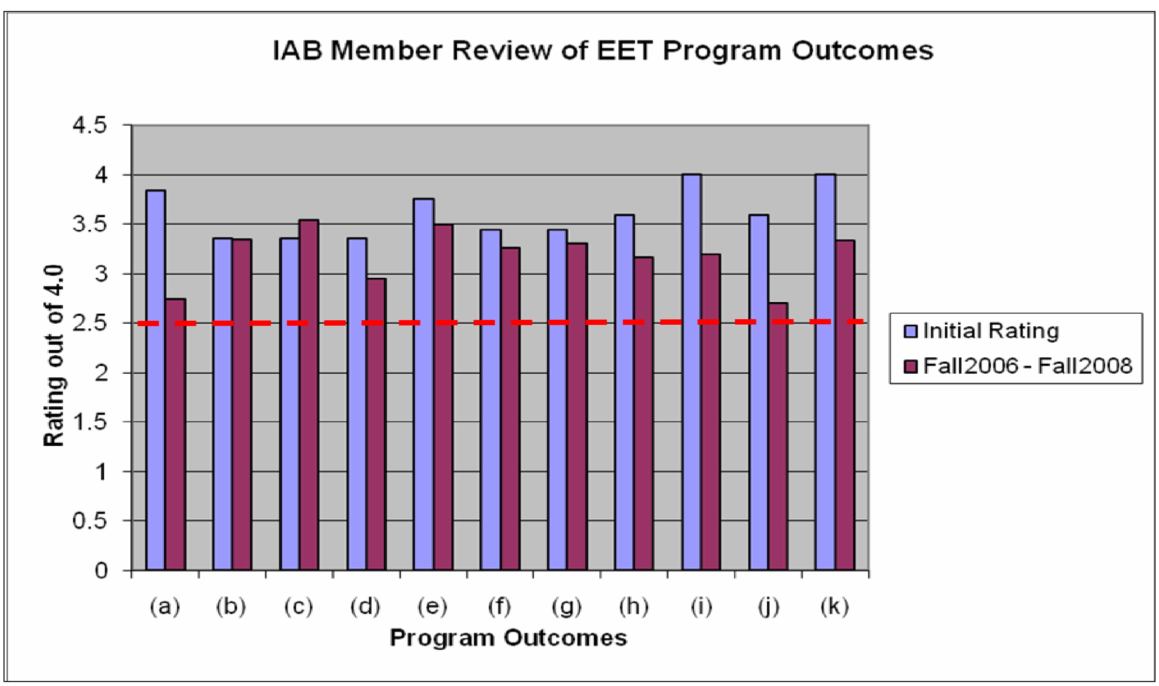

Figure 7 –IAB Review of Program Outcomes 2006- 2009

Observations from the 3-year assessment cycle are as follows:

- Incremental changes in outcomes are good indication of improvement progress. If there is a negative change by 0.5 or more, then the outcome is flagged.

- Significant improvement in Outcome (c) was achieved as a result of including more measures at different points within the curriculum to obtain a more accurate representation of student performance at all levels.

- Significant improvements in outcomes (a), & (e) which may be attributed to the following factors:

    - During the last 3 years, the EET Program has undergone significant improvements in teaching, advisement, and student engagement in project activities and professional organizations.

    - Overall student satisfactions with these efforts as reflected in student course outcomes and senior exit surveys.

On the other hand, measurable decrease in outcomes (i), (j) and (k) were observed which prompted actions to improve performance and awareness. The following continuous improvement actions were implemented as a result of the mid-cycle assessment review:

- Converting senior design project into 2-semester long course
- Inviting IAB members to attend final senior project presentations
- Conducting field trips and inviting guest speakers
- More involvement in IEEE student chapter
- Participation in student robotic competitions

Challenges

As emphasis in higher education is shifting toward a multifaceted approach to assessment[3], traditional evaluation techniques based on collecting samples of student work, such as tests, quizzes, and assignments are no longer adequate in measuring student achievements. In fact, many of the ABET accreditation criteria (a-k) are related to soft, intangible skills that are typically difficult to measure using traditional methods[4]. Therefore, innovative strategies that provide methods of assessment and measurement for these soft skills are constantly needed to adequately document and assess continuous improvement. We have tried to address some of these issues through the continuous improvement actions that have been cited; however, more direct strategies of how to adequately assess these soft skills are needed. Furthermore, the challenge of assessment data management remains one of the key issues in developing a continuous improvement plan that is effective and minimizes overhead for faculty. In other words, strategies for streamlining the assessment process must also be considered in a continuous improvement plan.

Conclusions

In this paper we described an outcomes-driven approach for program assessment that incorporates strategies for measuring program objectives and outcomes including soft skills such as *"A commitment to quality, timeliness, and continuous improvement"*. A five-step process that includes program assessment planning, data collection, data analysis, program review, and program improvement actions is presented that outlines the steps used for continuous program improvement. Additionally, we described mechanisms for correlating program-level outcomes with course-level outcomes using effective assessment tools to measure student performance. Based on the results of these tools, continuous improvement actions at the course level and program level were identified and used to revise the program assessment and evaluation plan. Furthermore, we described three levels of program assessment that use effective methods for continuous improvement. The results presented in this paper highlight several effective strategies that may prove useful to other institutions seeking ABET accreditation.

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