AC 2011-883: ASSESSMENT OF ABET PROGRAM OUTCOME J, "A KNOWLEDGE OF CONTEMPORARY ISSUES"

Anca L. Sala, Baker College

Anca L. Sala, Associate Professor, is Chair of the Engineering Department at Baker College. Dr. Sala coordinates several engineering and technology programs, teaches and develops engineering curriculum, and leads the ABET accreditation activities in the department. She is an active member of ASEE, ASME, and OSA.

Tom Spendlove, Baker College, Flint
James Riddell, Baker College, Flint

James A. Riddell is Dean of Engineering and Technology at Baker College of Flint. He is currently a member of ASEE, ASME, SME (past chair) and SAE (past chair.)

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Abstract

Engineering education is expected to equip future engineers not only with professional knowledge, abilities and skills but also the ability to see "the big picture" and the capability to address society's issues. The latter outcomes are based upon Program Outcome (j), "A Knowledge of Contemporary Issues", from ABET's EAC (a)-(k) Criteria for Accrediting Engineering Programs. At our institution we have traditionally assessed this Program Outcome (PO) through the Senior Design Project as well as technical elective courses, such as the "Alternative Energy, An Introduction for Engineers" course. We have recently added another assessment tool for this purpose which relates more directly to the PO. We developed an assignment to prepare students, as well as a survey and rubric to assess the achievement of PO (j). We administered these tools to two groups of mechanical engineering students, a sophomore group and a senior group. Results of the pre- and post-assignment surveys and an analysis of the tools effectiveness will be presented. The assignment also benefited and assessed students' communication and life-long learning skills. Future work will also link the results of the surveys to data on achievement of one of our Program Educational Objective, which requires graduates to "maintain awareness of societal and contemporary issues and fulfill community and society's needs".

Introduction

The Mechanical Engineering program at Baker College has recently gone, successfully, through the ABET reaccreditation process. While the assessment processes we have been using for Program Educational Objectives and Program Outcomes are adequate, faculty reevaluated how effective the assessment was for certain Program Outcomes. As stated in the ABET 2009-2010 "Criteria for Accrediting Engineering Programs" [1], "Engineering programs must demonstrate that their students attain" the (a) - (k) Program Outcomes. Out of these outcomes, Program Outcome (j) requires that students attain "a knowledge of contemporary issues". Several papers presented at the ASEE Annual Conference in recent years discussed the topic of contemporary issues in engineering education. One paper[2] describes a survey that allowed the authors to gather data on the knowledge of contemporary issues held by their students. Other papers [3, 4] discuss Program Outcome (j) in conjunction with Program Outcome (i), "a recognition of the need for, and an ability to engage in life-long learning". Finally, a problem-based learning approach is described[5] to help address Program Outcomes (j), and (h), "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context".

As discussed in previous papers, Program Outcomes (h), (i), and (j) are difficult to assess using traditional assessment tools. At Baker College we have assessed PO (j) in the Senior Design Project, which is scored using a rubric that includes an item related to contemporary issues. More recently we have also assessed this PO in the new course "Alternative Energy, An Introduction for Engineers", which is essentially entirely dedicated to a contemporary topic. This latter course however is a technical elective and is not taken by all students in the program. Faculty thus

discussed the possibility of introducing new direct assessment tools to help evaluating how well our Mechanical Engineering students achieve PO (j). These assessment tools should allow us to evaluate the state of current knowledge of contemporary issues our students have, but also provide for means of improving this knowledge. The goals were thus two-fold: to gather current data and also to create assignments for students that will result in improved knowledge. A Pre-Test will be used in the beginning of the process and a Post-Test at the end.

Baker College is operating on a quarter schedule, with 10-week fall, winter and spring quarters. The student population in the Mechanical Engineering program is diverse, age and experience-wise. A majority of students work either full-time or part-time and attend the program in the evening. The average age of students is 29 years old. The paper discusses the newly developed assessment tools and the results we obtained by administering these assessment tools in the Mechanical Engineering program in fall quarter 2010.

Program Outcome J Assessment Tools and Methodology

In recent years, direct assessment processes have become the cornerstone of the assessment engineering programs undertake to obtain and maintain accreditation by the Engineering Accreditation Commission of ABET. Direct assessment is based on data collection, analysis and interpretation, with data coming from multiple-choice tests, open ended problems and projects, surveys, and many other instruments.

In order to assess Program Outcome (j) for our Mechanical Engineering program we developed several tools. These tools will allow us to gather information about student knowledge of contemporary issues, as well as serve as means for improving student knowledge in this area. Rather than starting with the information gathering only stage, faculty decided to be pro-active and develop assignments for students for the purpose of improving their contemporary issues knowledge. Thus faculty developed five different instruments, which are as follows:

a) Two-Question Survey.
This survey serves the purpose of gathering information about students' knowledge in contemporary issues. The survey will be administered two times in a quarter, in the beginning as a Pre-Test, and in the end as a Post-Test. The survey consists of two questions, one asking students to list five contemporary issues, and the second asking students to pick two of the five contemporary issues they listed previously and discuss each in a short paragraph. Students' answers to the Two-Question Survey will be scored by faculty using a rubric. This rubric is described in item d) below.

b) Written Assignment.
The purpose of the Written Assignment is to educate students further in contemporary issues relevant to engineers. For this assignment students will be asked to independently research topics that can be considered contemporary issues for engineers. Some sources are suggested as a starting point for research, such as the Mechanical Engineering magazine from ASME, the Capitol Update website of ASME[6], and the trade magazines available at efunda.tradepub.com[7]. Other sources of information however are acceptable. Students will have to select a topic they consider relevant, and write a short paper discussing this topic.

c) Class Discussions.
This assignment also serves the purpose of increasing student knowledge of contemporary issues, through learning from peers, and discussing various points of view on the same issue. Students will each be given about five minutes to present the topic they chose for their Written Assignment to the class. In five minutes students will have to present the topic, answer questions from classmates, and debate their point of view.

d) Rubric.
The rubric will be used to evaluate students' answers to the Two-Question Survey, the Written Assignment, and the oral Class Discussions. The rubric is developed and used by faculty to score students work in items a) - c), giving us an objective way to evaluate how well Program Outcome (j) is achieved.

e) Student Satisfaction Survey.
This survey will gather information about students' impression of the entire contemporary issues assessment. This survey, while not part of the direct assessment itself, is a useful tool for faculty to gather feedback from students on the entire assessment. The feedback can be especially useful the first couple of administrations of the new assessment.

Using the five instruments described above faculty believes a picture of students' knowledge of contemporary issues will emerge, together with ways to improve the process in the future.

Assessment Results and Discussion

The tools described above were administered in the fall quarter 2010 to two groups of Mechanical Engineering students: a sophomore group consisting of 13 students, and a senior group of 8 students. As described above, the Two-Question Survey was given once in the beginning of the quarter and once in the end. In between the surveys, students completed the Written Assignment and participated in Class Discussions on the topics chosen for the written paper. At the end of the quarter, in addition to the Post-Test, students were given the Student Satisfaction Survey.

Raw data was collected from:
- the Pre-Test and Post-Test administration of the Two-Question Survey described above in a)
- the short paper Written Assignment by students on a topic of their choice described above in b)
- Class Discussions as described above in c)
- Student Satisfaction Survey

The data collected from instruments a), b), and c) was scored by faculty using the rubric described in d). This Rubric is presented in Table 1 below.

Table 1. Rubric for assessing contemporary issues assignments.

	Very Good	**Good**	**Fair**	**Poor**
Breadth of Topics - from Question 1 in Two-Question Survey	Covers a variety of engineering topics and disciplines. Five or more total examples	Five total examples that focus on one area (example - all energy related or two-word answers)	Less than five total examples	Less than five total examples, less than three words per answer
Relevance in the Context of Engineering Issues - from Question 1 in Two-Question Survey	All five examples apply to current engineering issues	Three or four examples apply to current engineering issues	One or two examples apply to current engineering issues	No examples apply to current engineering issues
Ability to Discuss Topic in Writing - from Question 2 in Two-Question Survey	Paragraph form, using more than one sentence, no mistakes in spelling or grammar, source included	Paragraph form, using more than one sentence, less than three spelling or grammar mistakes, or source not included	Paragraph form, using more than one sentence, more than three spelling or grammar mistakes, or source not included	Only one sentence written for explanation
Short Paper Writing Ability - from Written Assignment	Source included, written with audience (professor) in mind, no errors in spelling or grammar	One item from Very Good not included	Two items from Very Good criteria not included	No items from Very Good criteria included
Ability to Present and Discuss Orally - from Class Discussions	Clear presentation and explanation of the issue, includes source, uses most of the time allotted (4-6 minutes)	Does not include source or not within ideal time range (more than six minutes or less than four minutes)	Does not mention source or not within ideal time range, does not clearly present the issue	Issue not clearly presented, source not mentioned, not within time range

Faculty hypothesized that the Written Assignment and the Class Discussions should increase students' knowledge in contemporary issues, which should be visible in the results of the Post-Test compared to the results of the Pre-Test. These results are presented in Tables 2 and 3 below.

In addition to the results of the Pre- and Post-Tests, Tables 2 and 3 show the results of the evaluation of the Written Assignment, and the Class Discussions for the two groups of students. Each student was placed in one of the categories of Very Good, Good, Fair and Poor using the rubric presented in Table 1. Results were then summarized for the two groups of students: the 13 sophomores, and the 8 seniors. Data in Tables 2 and 3 represents the percentages of students in each category out of their respective group. For the Two-Question Survey, results of the Pre-Test and the Post-Test are shown in separate columns to allow for comparison of the results before and after.

Table 2. Summarized results of the assessment rubric for senior students.

	Very Good		**Good**		**Fair**		**Poor**	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
Breadth of Topics	50.0%	37.5%	50.0%	62.5%	0.0%	0.0%	0.0%	0.0%
Relevance in the Context of Contemporary Issues	50.0%	75.0%	50.0%	12.5%	0.0%	12.5%	0.0%	0.0%
Ability to Discuss Topic in Writing	37.5%	25.0%	50.0%	62.5%	0.0%	12.5%	12.5%	0.0%
Short Paper Writing Ability	37.5%		37.5%		25.0%		0.0%	
Ability to Present and Discuss Topic Orally	37.5%		50.0%		0.0%		12.5%	

The results in Table 2 show that, overall, senior students are doing well in regards to their knowledge of contemporary issues. The vast majority earned Very Good or Good scores in all items, with the exception of the "Short Paper Writing Ability". This is an area where more work is needed even at senior level. In terms of the Post-Test vs. Pre-Test results, the Table shows somewhat mixed results. In the "Breadth of Topics" and "Relevance in the Context of Contemporary Issues" items the percentages were very good to start with, at the Pre-Test time. Some improvement appeared to have taken place in the "Ability to Discuss Topic in Writing" item. More data will be collected and analyzed using the tools in order to derive meaningful conclusions, but even at the first administration of the assignments, their usefulness was appreciated by students as evidenced in the Student Satisfaction Survey results that will be presented further.

Table 3. Summarized results of the assessment rubric for sophomore students.

	Very Good		**Good**		**Fair**		**Poor**	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
Breadth of Topics	46.2%	53.8%	30.8%	23.1%	15.4%	23.1%	7.7%	0.0%

Relevance in the Context of Contemporary Issues	30.8%	69.2%	61.5%	23.1%	7.7%	7.7%	0.0%	0.0%
Ability to Discuss Topic in Writing	23.1%	15.4%	30.8%	38.5%	0.0%	7.7%	7.7%	0.0%
Short Paper Writing Ability	15.4%		61.5%		7.7%		15.4%	
Ability to Present and Discuss Topic Orally	30.8%		53.8%		7.7%		0.0%	

The sophomore students showed minor improvement in the "Breadth of Topics" and "Relevance in the Context of Contemporary Issues" items from the Pre-Test to the Post-Test. Students were more likely to pinpoint specific issues such as 'Long term effects of the oil spill on the soil in the gulf after the spill' vs. previous answers like 'Alternative Energy'. The relevance also improved to either recall topics that were discussed in class or to bring up new issues that had arisen in the past few weeks. The ability to discuss their topics in short paragraphs slightly degraded between the Pre- and Post-Tests.

Even though the hypothesis of faculty about score improvements in Post-Tests vs. Pre-Tests did not seem to be verified, it is clear that all activities were useful in showing students the importance of having a good knowledge of contemporary issues and raising their interest in this area.

Tables 4 and 5 show the results from the Students Satisfaction Surveys. The data represents percentages of students in each category out of the entire group.

Table 4. Senior students' responses to Student Satisfaction Survey.

Class Discussions helpful?

Very helpful	Helpful	Neutral	Unhelpful	Very unhelpful	Total
3	4	1	0	0	8
37.5%	50.0%	12.5%	0.0%	0.0%	100.0%

Written Assignments helpful?

Very helpful	Helpful	Neutral	Unhelpful	Very unhelpful	Total
5	3	0	0	0	8
62.5%	37.5%	0.0%	0.0%	0.0%	100.0%

Comments from the senior group to the Student Satisfaction Survey included the following:
"Class discussions were more helpful."
"Encourage these types of exercise in other classes."
"Give a list of article ideas and assign each student an area, so all students don't do papers on environmental issues."
"Looking up the issues was very informative and I enjoyed and learned a lot."

"Papers work well."

Results show that senior students were interested in learning more about contemporary issues related to the engineering profession. Interestingly, a majority of them preferred the Written Assignment to the Class Discussions.

Table 5. Sophomore students' responses to Student Satisfaction Survey.

Class discussions helpful?

Very helpful	Helpful	Neutral	Unhelpful	Very unhelpful	Total
4	4	5	0	0	13
30.8%	30.8%	38.5%	0.0%	0.0%	100.0%

Written assignments helpful?

Very helpful	Helpful	Neutral	Unhelpful	Very unhelpful	Total
4	3	5	1	0	13
30.8%	23.1%	38.5%	7.7%	0.0%	100.0%

Comments from the sophomore group to the Student Satisfaction Survey included the following:
"My benefit was from exploring trade magazines of interest."
"Perhaps urge viewing the national evening news."

A fairly large percentage of the sophomore students (38.5%) were neutral about the contemporary issues learning and assessment. We believe this is due to the fact that sophomore students are less cognizant of the Program Educational Objectives (PEO) and Program Outcomes (PO), and have a narrower view of the program than senior students. Sophomore students focus more on completing gate courses in mathematics and science successfully so they can accede to the engineering core curriculum. At the same time this result shows that faculty have the opportunity to provide students with the wider view of the program, and make the PEO's and PO's very familiar to students early on in their program.

The fact that the senior group responded more positively to the contemporary issues assignments and assessment than the sophomore group can be seen as a reflection of the overall progress students have undergone as they moved through the program. However, the study needs to continue into the future in order to derive reliable conclusions, as the number of students included so far has been small.

Conclusions

The newly developed assessment tools seem effective in bringing ABET PO (j) to the attention of students and helping them develop their knowledge in this area. We will continue using these assessments in upcoming years. The tools can also be used to assess students' communication and life-long learning skills. Future work will include assessment of Program Outcomes (g) and (i) using the tools described. In addition, one of the Program Educational Objectives of the

Mechanical Engineering program is "To produce graduates who maintain awareness of societal and contemporary issues and fulfill community and society's needs". We plan to study the effect of the assignments described in this paper on the achievement of this Program Educational Objective.

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