

AC 2007-1215: ADVANTAGES OF USING PERSONAL RESPONSE SYSTEM TECHNOLOGY TO EVALUATE ABET AND MECHANICAL ENGINEERING PROGRAM OUTCOMES

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Advantages of Using Personal Response System Technology to Evaluate ABET and Mechanical Engineering Program Outcomes

Abstract

Personal Response System (PRS) is a tool typically employed to promote active learning in class, to increase participation, to measure conceptual comprehension, and to support Millennial Learners. At Gannon University, the evaluation and assessment activities of various Engineering programs' outcomes, including those related to ABET outcomes, have been done in the last 5 years through a web-based exit survey. This presents the challenge that students are not forced to take the survey and typically a 100% response is never achieved. By introducing PRS as a means of assessing the outcomes, a 100% feedback is obtained through an immediate evaluation process. To conduct the study, seven courses in the Mechanical Engineering program were selected in order to insure a representation of the four years of undergraduate studies. Once the outcomes assessments are reviewed, action items are created for each class. These action items are implemented closing the loop. This paper describes the implementation of PRS as an outcomes evaluation tool and the advantages of this technique over the ones employed at the moment. Finally, the lessons learned and challenges experienced will be discussed.

Introduction

The Department of Mechanical Engineering at Gannon University has been challenged by the low response to surveys. Since Spring 2002, the evaluation and assessment activities of various Engineering programs' outcomes, including those related to ABET outcomes, have been done through a web-based exit survey. The online course exit survey is given for each mechanical engineering course the student is enrolled in a particular semester. This web-based exit survey assesses how well the course objectives for that course have been met and how well the assessment tools are working. In addition, the course objectives are directly linked to the program objectives and ABET outcomes. The web-based survey is done outside class; therefore, it has been difficult to gather data and convey to students the importance of their feedback. The university course evaluations, which are done during class time, are generic and do not address the specific course outcomes and program objectives. Alumni feedback has also been a challenge. A survey is given every year that contains questions pertaining to how well the program educational objectives have been realized in the workplace. Currently, only a 5% feedback is typically obtained from these surveys.

In an effort to meet this challenge and obtain a 100% response, Personal Response Systems (PRS) were adapted to evaluate the individual course outcomes. PRS are typically used to promote active learning. Students can listen to the lecture and then simultaneously respond to questions posed by faculty with the click of a button. In this pilot study, seven courses in the Mechanical Engineering program were selected in order to ensure a representation of the four years of undergraduate studies. In the following sections, ME programs outcomes are summarized, a brief description of the assessment process currently in place is presented, the implementation of the Personal Response Systems is described, and the results of this pilot effort are presented and discussed.

Mechanical Engineering Program Outcomes and Educational Objectives

The Program Educational Objectives are based on the University Mission, the goal of the Mechanical Engineering department, and the outcomes expected by ABET¹. The University Mission states that each undergraduate is offered outstanding teaching and a value-centered education in both liberal arts and professional specialization, in order to prepare students for leadership roles in their careers and society.

The Mechanical Engineering program/curriculum is reviewed by several groups. These groups are the Mechanical Engineering Faculty, Faculty on the College ABET Committee, students, industrial engineers and business leaders (through the Engineering Advisory Council and the Industrial Review Board) and alumni. In 2003, after several revisions and input from the above mentioned groups, a set of six educational objectives was developed with the inclusion of the primary aspects of the current feedback process. The future implementation of the PRS to assess the Program Educational Objectives will be discussed later in the article.

The program outcomes are derived and judged based on the ABET criteria and special requirements for the Mechanical Engineering Degree. These outcomes are consistent with the Program Educational Objectives and the University Mission. Table 1 presents the mechanical engineering program outcomes. The objectives of all required and elective mechanical engineering courses are correlated to the program outcomes². Table 2 presents the relationship between the seven mechanical engineering courses selected for this study and the program outcomes.

Table 1 Mechanical Engineering Program Outcomes

ABET Criteria	
a.	Apply knowledge of Mathematics, Science, and Engineering
b.	Ability to design and conduct experiments; Analyze and interpret data
c.	Design system, component, or process to meet needs
d.	Function on multidisciplinary teams
e.	Identify, formulate and solve engineering problems
f.	Understand professional and ethical responsibility
g.	Ability to communicate effectively
h.	Broad education necessary to understand impact of engineering solutions
i.	Recognition of need to engage in lifetime learning
j.	Knowledge of contemporary issues
k.	Ability to use techniques, skills and modern tools
ME Department Specific Competencies	
l.	A knowledge of Chemistry and in depth knowledge of physics
m.	An ability to apply advanced mathematics including statistics and linear algebra
n.	An ability to work professionally (including system design and realization) in both thermal/fluid and mechanical systems

Table 2 Relationship between ME Courses and Program Outcomes

Course	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Required Courses														
ME205 Digital Computer Usage	X				X		X				X			
ME214 Strength of Materials	X				X						X			
ME215 Strength of Materials Lab	X	X					X				X			
ME315 Materials Science	X				X			X		X				
ME334 Kinematics of Mechanisms	X		X		X						X			
ME354 Senior Design Lab	X	X	X	X	X	X	X	X		X	X		X	X
Technical Elective														
ME410 Thermal Systems Design	X	X	X		X		X				X		X	X

Mechanical Engineering Program Assessment Process

Several venues are employed currently to evaluate the objectives, outcomes, and the effectiveness of the ME program. The assessment tools include university course evaluations, ME web-based course exit surveys, senior exit surveys, Engineering Advisory Council meetings, Review Board meetings, alumni surveys, and ME faculty meetings, amongst others. An assessment process is in place to provide feedback based on the above evaluations for continuous improvement in the program. The following six steps summarize the current assessment practice:

1. Assessment process done employing several evaluation tools.
2. Results of assessment are fed back to the ME faculty, Engineering Advisory Board and/or the Industrial Review Board, depending on the issues.
3. Action plan is developed. These action items drive the changes in the courses, program and curriculum.
4. Action items are incorporated next academic year or next semester depending of the case.
5. Action plans from previous semesters results are reviewed to assess if any additional action needs to be taken. This is done for a particular semester's plan until all items have been brought to closure (back to step 1).

Personal Response Systems

Since about 1998, the simplest remote Personal Response Systems (clickers) were adopted in academic environments as faculty explored ways to increase student interaction. This technology has been successful in motivating and engaging students, raising exam scores and course success, increasing participation and attendance, measuring conceptual comprehension, enabling immediate feedback, promoting higher-order learning and experimental teaching, and supporting Millennial Learners^{3,4}. In this study, a different application is proposed for this

technology: assessment of course effectiveness. A short summary of how to implement these systems follows.

Turning Point, the software employed to create the evaluations, is very similar to the traditional PowerPoint software. Slides are created for each course to be evaluated with the Personal Response System. A tool bar at the top of the presentation screen allows managing the questions. This tool bar (refer to Figure 1) allows the presenter to (a) see the number of individual's who have responded to the current question, (b) determine if the question polling is open, (c) repoll the current question, or (d) view the response grid of all of the questions and participants, amongst other options.

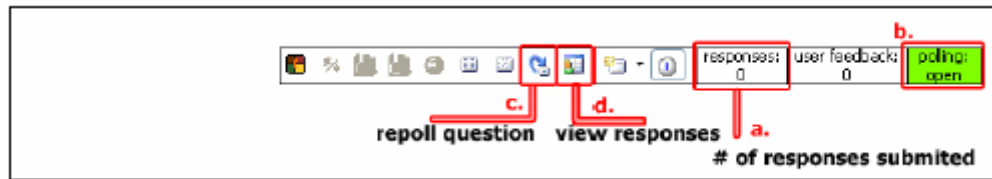


Figure 1 Tool bar used to manage the presentation

Each participant is given a clicker, which resemble TV remote control units. Figure 2 presents a picture of this device. The clickers use infrared or radio frequency technology to transmit and record participant responses. A receiver, connected to the computer, collects and records the responses. A successful transmission is acknowledged on each participant's keypad via a visual green light signal.



Figure 2 Clicker

Once the slides are created, the evaluation runs almost as a typical PowerPoint presentation. Figure 3 presents an example of the slides created for the evaluation. The only extra job the presenter has while the presentation is running is to make sure that all the participants have answered the questions before closing the poll and moving to the next slide. With the aid of the tool bar, this is a simple task. The number of responses is displayed by the tool bar as mentioned earlier. Once the presenter has gone through the entire presentation, the session must be saved in order to collect the data.

USING PERSONAL RESPONSE SYSTEMS TO ASSESS ABET OUTCOMES

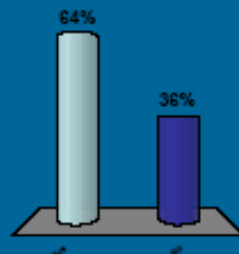
Course: ME354 Senior Design Lab

Personal Response System (PRS): Rules

- When polling is open, press the button that corresponds to your choice
- Your answer is registered when you see the light on your PRS blink once
- You may change your answer until polling is closed

Have you ever used PRS in class?

1. Yes
2. No

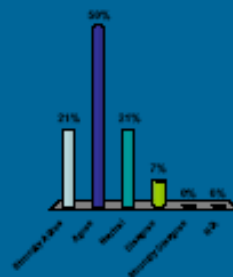


Let us get started

This course has allowed you to...

Apply knowledge of Mathematics, Science, and Engineering

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree
6. N/A



Ability to design and conduct experiments; Analyze and interpret data

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree
6. N/A

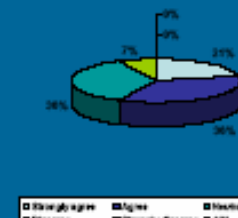


Figure 3 Example of slides created for the assessment of the ME program outcomes

Results

Turning Point features a report generation tool. Table 3 and Figure 4 present two formats to present the data: results by question and graphical results by question, respectively. The current version of Turning Point has nineteen different types of reports. This data is based on the 'Likert' assessment scale. Table 3 and Figure 4 present the percentages of the students' responses to six categories (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree, and Not Applicable) for the question pertaining to how well the student believed the specific outcome was met. The graphical representation in Figure 4 is a suitable to present the data for a specific question, in a specific course, in a specific year. For comparing assessments over time, a different format will be required.

Table 3 Segment of report generated by Turning Point (Course: ME354)

Turning Results by Question			
Session Name: ME354 12.5.2006 3.13 PM.tpz			
Created: 1/17/2007 11:20 AM			
1.) Have you ever used PRS in class?			
	Responses		
	(percent)	(count)	
Yes	64.29%	9	
No	35.71%	5	
Totals	100%	14	
2.) Apply knowledge of Mathematics, Science, and Engineering			
	Responses		
	(percent)	(count)	
Strongly Agree	21.43%	3	
Agree	50%	7	
Neutral	21.43%	3	
Disagree	7.14%	1	
Strongly Disagree	0%	0	
N/A	0%	0	
Totals	100%	14	

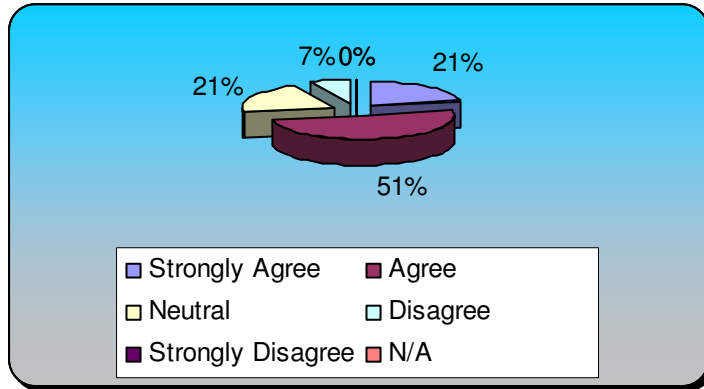


Figure 4 Graphical results corresponding to question 2 from Table 3

Summaries of the results for the seven courses are presented in Tables 4 (refer to Table 1 for the outcomes). There is a higher flexibility in terms of data manipulation when employing this technology. In addition, there is immediate feedback and the presenter can ensure that all participants are present the day the survey is administered. Therefore, 100 % feedback is obtained.

Table 4a Results for ME205 Digital Computer Usage (Fall 2006), 26 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Strongly Agree	23				23		8				42			
Agree	65				61		27				42			
Neutral	8				8		57				4			
Disagree	4				8		4				4			
Strongly Disagree							4				4			
N/A											4			
TOTAL (%)	100				100		100				100			

Table 4b Results for ME214 Strength of Materials (Fall 2006), 14 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Strongly Agree	29				36						7			
Agree	57				43						57			
Neutral	7				14						36			
Disagree	7													
Strongly Disagree														
N/A					7									
TOTAL (%)	100				100						100			

Table 4c Results for ME215 Strength of Materials Laboratory (Fall 2006), 12 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Strongly Agree	25	33					8				17			
Agree	67	25					42				50			
Neutral		17					42				25			
Disagree							8				8			
Strongly Disagree		8												
N/A	8													
TOTAL (%)	100	83					100				100			

Table 4d Results for ME315 Materials Science (Fall 2006), 12 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Strongly Agree	59				42			50		17				
Agree	33				50			25		67				
Neutral								25		8				
Disagree					8									
Strongly Disagree														
N/A	8									8				
TOTAL (%)	100				100			100		100				

Table 4e Results for ME334 Kinematics of Mechanisms (Fall 2006), 12 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Strongly Agree					8									
Agree	25		33		17						25			
Neutral	17		17											
Disagree	17		17		42						17			
Strongly Disagree	41		33		33						58			
N/A														
TOTAL (%)	100		100		100						100			

Table 4f Results for ME354 Senior Design Lab (Fall 2006), 14 students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	j	k	L	m	n
Strongly Agree	21	21	14	21	29	36	43	7		14	14		14	28
Agree	51	36	58	29	43	36	43	64		43	36		14	29
Neutral	21	36	14	29	21	21	14	29		43	14		30	29
Disagree	7	7	14	21	7						36		21	7
Strongly Disagree						7							21	
N/A														7
TOTAL (%)	100	100	100	100	100	100	100	100		100	100		100	100

Table 4g Results for ME410 Thermal Systems Design (Fall 2006), 3 undergraduate students enrolled

Objectives ⇒	a	b	c	d	e	f	g	h	i	J	k	L	m	n
Strongly Agree	100	67	100		100		100				67		67	100
Agree		33									33		33	
Neutral														
Disagree														
Strongly Disagree														
N/A														
TOTAL (%)	100	100	100		100		100				100		100	100

Lessons Learned

Faculty's perspective: The web-based exit survey has worked in the past when an incentive has been given to students (i.e. points or extra credit). In addition, if the students do not take the survey, the instructor and the student receive daily electronic reminders to fill out the web-based survey. Students often delete this email and do not act. Therefore, this measure is not effective nor has achieved 100% participation.

In an effort to address less than 100% participation, the new method using PRS was implemented on a trial basis. Assessment via PRS takes only five to seven minutes, depending on the amount of outcomes related to the course. Before the survey, the presenter has the opportunity to explain to the participants what the program outcomes and objectives are, if needed. Immediate feedback is given to the participants, if the presenter chooses to do so. During the Fall 2006, 100% feedback was achieved on the seven pilot courses. The plan is to implement this tool in all the ME engineering courses in 2007.

Two drawbacks were observed during the implementation of PRS. The first one is that PRS does not allow for students to provide quantitative measures while the web-based survey does. Secondly, if all the students are not present the day the assessment is scheduled, it has to be

delayed to obtain 100% response. The first drawback is not a major concern since the university course evaluation also provides an opportunity for the students to give quantitative evaluations of the program outcomes. The second drawback is a slight inconvenience for the instructor.

Student perspective: It was found that students wanted clarification in terms of the wording of the outcomes. This allows for interaction and, clearly, an assessment of the statements. Students preferred to do the survey during class time, and they enjoyed the use of technology. The participants felt that their confidentiality was kept. In addition, students requested to see the results immediately. Typically, the results of the surveys are not available to students.

Alumni and Mechanical Engineering Educational Objectives: To increase the alumni response and implement the Personal Response System, a decision has been taken at the department level to invite alumni to one dinner per semester. The pilot dinner will take place in 2007. During this gathering, the survey will be conducted in the same fashion as it has been done for the students during class time. This, we believe, will increase the feedback, provide enough data to assess the program educational objectives, and help maintain the relationship with the mechanical engineering alumni in the area.

Conclusions

The implementation of Personal Response System to obtain 100% feedback during the evaluation of ABET Outcomes has been successful. This study proves the versatility of this technology and its vast array of applications. Positive feedback was obtained from the students. To date, only seven courses have been assessed with this method. After approval, this technique will be implemented on all the ME courses.

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