Assessing the Assessments: Sometimes the Results are Surprising

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ABSTRACT: The Manufacturing Engineering Technologies and Supervision Department at Purdue University Calumet has been actively involved with course embedded assessment techniques for more than three years. The assessment project has spanned the engineering technologies programs, the computer graphics technology program, and the organizational leadership and supervision programs. During those three years, the faculty members have learned much about structuring course-embedded assessments and using those assessments for continuous improvement in support of program goals and ABET outcomes. This paper will outline the basic premises and methods of our assessments, then compare data from traditional and online courses, and discuss how "soft" skills such as teamwork, communication and peer review, and creative problem-solving can be assessed in both traditional and online courses. Specific data from engineering technology, computer graphics technology, and organizational leadership and supervision will be discussed, as well as statistical data comparing results from online courses and traditional courses. In the assessment process, we found surprising results, particularly in the summative assessment process of collecting data for continuous improvement and ABET outcomes. Some possible explanations for the results will be offered.

Background

In the late 1990's, engineering and technology educators received perhaps the greatest shock of their careers – accreditation was changing to outcomes-based assessment from a decades-old list of topics. After the shock wore off, it took several years of hard work for most educators just to understand outcomes-based assessment, let alone perform any meaningful assessments.

The difficulty most engineering and technology educators have with outcomes-based assessment can be easily understood by studying the mental models developed by Ned Herrmann [1]. This four-quadrant model of the brain shows most technical and analytical functions reside in quadrant A – the left cerebral side of the brain. Based on data generated by Herrmann International, most engineering and technology educators map strongly in that quadrant. Hence, most engineers, technologists, and educators in those areas prefer to work alone in search of a single, correct answer. However, the new ABET guidelines include such items as teamwork, appreciation for diversity, communication, understanding of the need for lifelong learning, and other "soft" topics that fit in the right side of the brain.

To successfully adapt to the new accreditation paradigm, engineering and technology educators must step back and take a holistic or "whole brain" look at their program to find ways to assess and prove that students possess the desired outcomes upon graduation. This definitely requires skills from the right side of the brain to balance the left brain dominance of engineering educators.

Introduction and Definitions

With education now directed toward customer- or constituent-focused programs, the need for continuous improvement grows more important. In order to be responsive to students, business and industry, academia must assess the needs of those groups, meet them, and continuously improve. One of the key factors in a continuous improvement (CI) program is assessment.

There are two basic types of assessment, formative and summative. Formative assessments tell "where we are now"; what the students know and what they need to learn to accomplish course objectives. Formative assessments attempt to determine whether the students are learning what they should be learning. [2] Summative assessments tell how well the course went; they are conducted at the end of the course to give information on how to improve for the future. Summative evaluation assesses the completed course, and helps instructors know how well they have achieved goals and learning outcomes established before going into the course. [2] Depending on the type of assessment, formative or summative, different assessment methods may be used. This paper discusses both formative assessment methods used in class to assess student learning, especially in the "soft skills", and also the summative assessment data collected at the end of courses to determine how well the course met the course and program objectives. The survey data collected is the collection of students' assessment of how well or poorly a course fulfilled the course and program objectives.

This paper will also compare formative assessment methods for both traditional and online courses. For purposes of this paper, the term traditional refers to a typical college course where the instructor and students meet face-to-face in a classroom or laboratory at the same time in a synchronous fashion. Similarly, the term online refers to a course where material is prepared by an instructor (including audio, video, and written formats) and presented to the student over the Internet in an asynchronous fashion. The student can access the class from any Internet-enabled computer at any time, and the student learns from the course material on his or her own. The authors have no experience with courses presented through TV or synchronous web courses, so no comments directed towards those types of courses will be presented.

Basic Premises and Methods

Faculty at Purdue University Calumet started earnestly studying and applying course assessment techniques starting in the Fall 2001 semester. Since then much has been learned and the literature about assessing engineering and technology programs has grown tremendously. These efforts are disseminated in [3]-[6]. What we have found works quite well is a three page spreadsheet which tracks summative assessment data and a summary of formative assessment data. The first page shows course objectives, instructor assessment methods of student learning, and student assessment of the objectives. The second sheet tracks how well students feel the course fit into

program outcomes and ABET a-k criterion. The final sheet provides a place for the person responsible for the course to record course changes, such as ideas for future improvements, or comments on how well modifications in the course worked. The interested reader is encouraged to refer to [3]-[6] for specific examples. These assessment forms have been refined over the past four years, and now all departmental courses are assessed in this manner. Much useful data, some quantitative and some anecdotal, has come from these assessments, and specific data will be discussed in a later section.

The methods used to collect summative assessment data vary by course. Online and traditional courses that use a computer lab have been using Blackboard's (course management program) survey function in the program's assessment tools to collect data. Other traditional courses use the same questions, but in paper and pencil format.

Comparison of Summative Assessment Data in Traditional and Online Courses

It is the authors' experience that courses offered online and in traditional formats yield similar summative data, with one exception. One author has noted that students who evaluate instructors in online classes generate more "neutral" or "neither agree nor disagree" answers in online classes than they do in traditional courses. [7]

Questions on course objectives and program objectives, however, yield similar results. Some sample results for course objectives are listed in Tables 1 through 5. The data in the tables are representative of courses in two of the programs mentioned earlier in the paper: Organizational Leadership and Supervision (OLS) and Mechanical Engineering Technology (MET). The classes were chosen because they represent a range of courses in the program, and because there is data for both traditional and online class formats. The OLS courses are often used in ABET accredited programs for the "soft skills" they include. The MET courses are ABET-accredited program courses. The authors have found that the same assessment method works equally well for both types of courses. The OLS course chosen is one which is ABET reviewed as a supporting course for ABET-accredited programs. For each of the tables, course objectives for each course have been shortened for the sake of brevity. Each question in the survey for students in the summative evaluation begins: *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?* Questions are rated on a 5-point Likert scale of Not Applicable to Excellent. Each of the choices on the scale is listed in the tables below.

Table 1. Spring 04 Traditional Class—Human Relations in Organizations (n=9)

Course Objective *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?*	Excellent	Good	Average	Poor	Not Applicable
Team-building skills and identify theories of leadership.	33%	44%	22%	0	0
Dominant theories on motivation and attitudes.	22%	67%	11%	0	0
Personal communication style and styles of others.	33%	55%	11%	0	0

Values and ethical decision-making.	22%	67%	11%	0	0
Positive reinforcement and employee reward systems.	44%	44%	11%	0	0
Conflict resolution and conflict resolution style.	44%	44%	0	11%	0

Table 2. Spring 04 Online Class Section A—Human Relations in Organizations (n=21)

Course Objective *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?*	Excellent	Good	Average	Poor	Not Applicable
Team-building skills and identify theories of leadership.	33%	62%	5%	0	0
Dominant theories on motivation and attitudes.	38%	52%	10%	0	0
Personal communication style and styles of others.	33%	43%	24%	0	0
Values and ethical decision-making.	43%	43%	14%	0	0
Positive reinforcement and employee reward systems.	38%	52%	10%	0	0
Conflict resolution and conflict resolution style.	43%	33%	19%	5%	0

Table 3. Spring 04 Online Class Section B—Human Relations in Organizations (n=14)

Course Objective *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?*	Excellent	Good	Average	Poor	Not Applicable
Team-building skills and identify theories of leadership.	57%	36%	7%	0	0
Dominant theories on motivation and attitudes.	43%	57%	0%	0	0
Personal communication style and styles of others.	36%	57%	7%	0	0
Values and ethical decision-making.	43%	36%	21%	0	0
Positive reinforcement and employee reward systems.	50%	36%	14%	0	0
Conflict resolution and conflict resolution style.	57%	43%	0	0%	0

Table 4. Fall 04 Online Class--CNC Applications (n=9)

Course Objectives *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?*	**Excellent**	**Good**	**Average**	**Poor**	**Not Applicable**
Explain the terminology used to describe CNC machine tools.	56%	11%	33%	0	0

Explain the basic types of CNC machine tools and the manufacturing operations for which they are best suited.	33%	44%	22%	0	0
Describe the major factors in the development of CNC machines.	33%	33%	33%	0	0
Prepare G and M code programs and the documentation for the manufacturing steps required to produce machined parts.	44%	11%	44%	0	0
Explain the advantages of Computer Aided Machining software.	11%	33%	56%	0	0

Table 5. Fall 04 Traditional Class--Computer Integrated Design & Mfg (n=7)

Course Objectives *A specific objective of this course is to help the student understand . . . How well did this course meet this objective?*	**Excellent**	**Good**	**Average**	**Poor**	**Not Applicable**
Explain the use and applications of parametric design.	71%	29%	0	0	0
Explain the use and applications of finite element analysis (FEA).	71%	14%	14%	0	0
Explain the use and applications of computer aided manufacturing (CAM) systems.	57%	14%	14%	0	14%
Use the parametric design, FEA, and CAM systems to design, analyze and manufacture mechanical components.	57%	43%	0	0	0

Reviewing the data in the tables, there is generally a trend that the students rate the courses high (excellent or good) in meeting course objectives. The poor and average ratings often represent the opinion of one student. An instructor may choose not to modify the course based on one student's perceptions of how well a course met its objectives. If 70%-90% or more of the students rate the course as having met its objectives in the excellent to good category, the conclusion that the course is working in its current state is probably justified.

Because the assessment method is relatively new, there is not a lengthy record of data in sequential semesters to evaluate. Some courses in the department are offered every semester and will rapidly generate enough data for in-depth analysis. On the other hand, some courses in the programs are offered only once a year, and will take several years to generate enough data for that type of analysis. Due to the relative newness of this type of summative assessment, the authors do not have the data necessary for a longitudinal analysis of this type. Work in this area is planned for the future.

Assessing "Soft" Skills with Formative Assessments

Soft skills, such as communication, teamwork, and diversity, have been assessed in a variety of ways. Part of the assessment includes traditional methods such as quizzes, tests and assignments. The authors have also used self-assessments for communication style, group exercises, and written assignments. Teamwork has been assessed with team projects or peer reviewed work, which covers both teamwork and communication skills. Diversity can be assessed with group work, and with individual self-assessment. All the authors have used peer review and group projects in various courses. The students seem to appreciate the methods used to teach and assess soft skills, since these program objectives are often rated highly.

In online classes, teams and peer review can both be used, although managing teams in an online environment can be a bit more challenging. See [8] for a fuller discussion of teams in online classes. Teams seem to run into the same problems, whether online or in traditional settings. The most common problem seems to be the underperforming or non-performing team member. The other team members resent the impact that such a member has on the team's performance (and therefore its grade). Team projects benefit from a peer review process, in which team members rate each other's performance. Such peer review assessments are usually made directly to the instructor, who may take them into account in team grades and individual grades for the group project. The most effective team projects seem to consist of a team grade, a peer review process, and an individual grade for the project based on your team's review of performance.

Peer review in online courses needs the same structured guidelines that it would in a traditional course to maintain the quality and appropriate tone of peer review and criticism. [8] One of the authors using peer review includes a grade for the quality of peer review criticism as well as for the final project which is peer reviewed. Both the student's final project and his/her review of other students' work are graded. The student's review of the work of peers is assessed for how well it follows the guidelines for the peer review. The instructor requires that the project be assessed on a 5-point scale on seven separate issues (introduction, contents, focus/clarity, development of ideas, organization, completeness, voice/style, and evidence of effort), and then the student must identify one commendable point and one improvable point in each final project reviewed. Students are then given the opportunity to redo their final projects in accordance with peer review comments to improve their grades.

"Soft Skills" in the Summative Data Process

Since the soft skills of communication, teamwork, and appreciation for diversity and life-long learning are incorporated in ABET standards, the second part of the three page spreadsheet mentioned above summarizes the students' ratings on how well a course met these a-k objectives in the summative phase of the course assessment. The same summative assessment which evaluates how well a course met its objectives also asks the students to rate how well the course fulfills the a-k objectives. Well-designed formative assessments, incorporating the techniques mentioned above, can help with meeting the a-k "soft" objectives. It is the authors' impression, based on anecdotal evidence, that students respond favorably to the types of structured formative assessments mentioned above. The authors' are hopeful that reviews of future data will bear out the anecdotal evidence in the summative assessment process.

Specific Assessment Data

The authors have reviewed their data, both summative and formative, for evidence that changes might be needed. Once specific formative assessment methods are identified by the instructor as appropriately gauging student learning on the course objectives, the second page of the three page spreadsheet summarizes this data into an overall picture of student performance on these formative assessment measures. Reviewing these on a holistic basis (seeing all the key assessment measures in summary form), seeing the student evaluation of the course, and looking at any unstructured student input which is solicited (the any other suggestions information), an instructor gets a very useful overview of how the course may or may not be working. While space does not permit us to identify every aspect of every course assessed, we have selected a representative sample to show the types of courses and changes we have made as a result of our assessment program, which is still relatively new.

Several changes that have been documented at the course level are:

CGT 116, *Geometric Modeling for Visualization and Communication* – a change from traditional lecture to cooperative learning for portions of the course has resulted in improved test scores. The course assessment system also noted that several course objectives were out of date and these were revised. These obsolete objectives were recognized because little data was available from the coursework to evaluate the objectives. When this was noted, the instructors realized that the lack of data was due to the material not being covered, and that was due to the obsolete nature of the material.

MFET 275, *Computer Numerical Control Applications* – one course objective was not being covered at all, so it was removed, and a new objective concerning computer aided manufacturing systems (CAM) instituted. The new objective was evaluated with a student project, and initial indications are the new objective/project combination works very well.

MET 325, *Applied Thermodynamics* – the course assessment system indicated a problem with the order the material was presented. The text for this course presented all theory first followed by applications. Students were having trouble remembering the theory when learning the applications. A simple change in order to present some theory followed by the accompanying applications resulted in improved student learning for a test semester. Later semesters confirmed this result. What was once a very demanding course has now become more reasonable for the student.

MET 461, *Computer Integrated Design & Manufacturing* – a specific objective of this course was to introduce the concept of lifelong learning. This concept was explained to the students early in the semester, and it was incorporated by slowly reducing the instructor's role from that of instructor to that of advisor. Data from the course assessment system indicate that the students understood the concept and that the objective had been met.

OLS477, *Conflict Management* -- the opportunity for students to redo their final projects was added as a result of summative assessment data gathered from students. The due

dates for final projects in the course were changed to allow time for resubmission of revised projects in accordance with peer comments. (As a side note, the author has also noticed that peers seem to be tougher on each other than the instructor is on them. The trend seems to be for the student scores on peer evaluations to be somewhat lower than instructor scores, but no statistical analysis of this data has yet been performed).

CGT 411 *Contemporary Problems in Applied Computer Graphics*—assessments revealed that students felt a little more prepared for the CGT job market, but were still confused and somewhat fearful about their particular career paths in the vast CGT field. Most courses within the CGT program incorporate group projects and collaborative learning. Some students disclosed that they felt they needed more self-direction. The following semester the course was modified, so that the group project was changed to peer-review collaborative learning groups. After self-examination and goal setting assignments, students with similar career interests were placed in like groups. The groups worked on similar goals, but each student created an individual project for his/her portfolio. The individual project was peer-reviewed and monitored by the group. Students were also required to learn a new skill, and present the new skill to the class. Each group shared in their research and skill development. Students not only developed their individual CG direction, but also enhanced their level of cooperative learning through peer review. Assessments following this course after modification were extremely positive and students' individual and group motivation during this course was high.

Without the new assessment system and documentation requirements the areas for improvement that became evident with use of the system would, most likely, have been overlooked.

Sometimes Surprising Results

Sometimes the survey results surprise the instructor. A standard question in the General Course Impact Section shown in Table 1 is "As a result of this course, my ability to function effectively on teams can be rated as," Oddly enough, this question received high marks from distance learning classes even though no group assignments were given. In another course, the "respect for diversity" objective is rated highly by both sections of the class, even though diversity is not a specific topic for this course. It is not uncommon for students to rate the course highly as meeting all a-k objectives, even though not every objective is covered in every class in the program. Sometimes the authors are surprised by the ratings of course objectives. As the instructor, one author knows that at least one week of class time and an entire chapter of the text are devoted to conflict resolution, yet at least one student rated the meeting of this objective as "poor". Although the author knows that statistically, this is the opinion of one student, there is still some thought given to how the material could be presented differently to avoid these results.

Alternative explanations for Surprising Results

Each course is not designed to meet every single program outcome or ABET outcome, yet courses which we did not expect to fulfill certain outcomes were often evaluated by students as meeting all program or ABET outcomes asked about in summative assessments.

The authors believe that the "halo effect" may account for some of the anomalous data found in the assessments. The "halo effect" can be either positive or negative. The "halo effect" is a rater error in which a perceived positive or negative important trait carries over into the judgment or assessment of other traits. Students who like a particular course or instructor may rate every question highly, without regard to the substance of the question asked.

Another alternative explanation is that instructors do not always realize what students are learning from a course. They may be learning more from the course than an instructor is aware of. Particularly in higher level courses, students may appreciate more of the program goals overall as they become more knowledgeable in the area.

Conclusion

The information gathered in support of outcomes-based assessment has been very useful for the authors. The three-page spreadsheet form attached has been a useful way to summarize the formative and summative assessment data for a particular course, which gives the instructor a needed overview, helping to highlight where changes might be needed or wanted in a course. For the authors and their programs, there are a number of changes and improvements which would not have been made in the courses without the use of these methods. However, the value of the information gathered must still be weighed, given the possible explanations for unusual or unexpected data. The value of summative assessment data is also a topic of much analysis, and such data may be subject to a number of flaws or influences apart from the halo effect. [9]

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