Assessment Methods under ABET EC2000 at University of Washington – Lessons Learned: What Works and What Doesn't

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Abstract

Assessment methods used by the departments comprising eleven programs undergoing re-accreditation at the University of Washington College of Engineering (UW COE) under ABET EC2000 sometimes varied significantly. A post-visit analysis of these various assessment methods provided insight into lessons learned as to how well each method worked for each department. Although many assessment methods were, in general, similar from department to department (e.g., surveys or coursework) the implementation (and success) of these methods often differed considerably from department to department. Of even more interest were those methods that were unique to departments (e.g., self-assessments of individual courses) and the success of these methods. Comparison and contrast of these assessment methods replete with lessons learned can provide valuable feedback not only to individual departments within the UW COE, but also for departments at other universities still preparing for their first visits under ABET EC2000.

Introduction

Assessment of programmatic and learning outcomes and objectives is a required aspect of the EC2000 criteria mandated for accreditation by the Accreditation Board for Engineering and Technology (ABET)[1]. Defining (and communicating) program objectives, educational processes, assessment /evaluation, and feedback are essential aspects of how engineering programs achieve their academic aims. Teaching students how to learn as well as assessing how well students learn are integral parts of this new paradigm in engineering education.

How much and how well students learn can be assessed if engineering instructors (who seldom have formal training in pedagogy) are cognizant of such concepts as Bloom's taxonomy of cognitive domain[2] and Sousa's illustration of the complexity and difficulty within the taxonomy[3]. The lowest to the highest levels of complexity of the taxonomy include knowledge, comprehension, application, analysis, synthesis, and evaluation. While complexity is associated with the level within the taxonomy, difficulty establishes the amount of effort required within each level[4].

Communication (oral or literary), when coupled with experiential learning exercises reinforces the information assimilated during the exercises. Indeed the "cone of learning" shown in Figure 1 clearly indicates that greater than 90% retention can be achieved if a learning experience

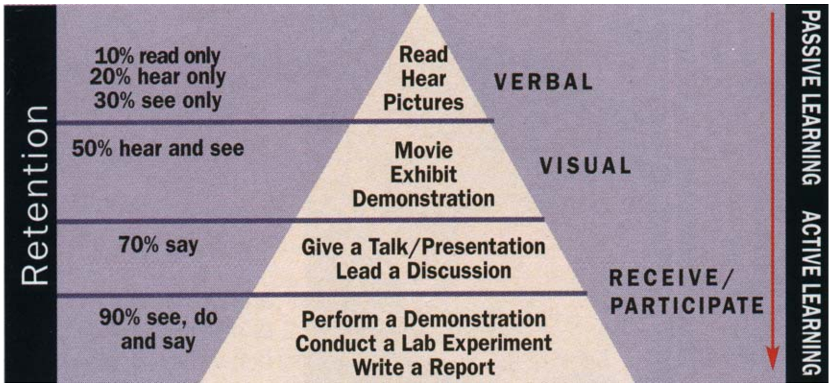

Figure 1 – Cone of learning showing increased retention of information with active learning (from Ref [5])

involves a "do-say" aspect. A laboratory experiment with a formal written laboratory report is an example of such a "do-say" exercise. This 90% level of retention is in contrast to only 10% retention achieved through reading only such as in reading assignments out of a text book or an information search on the world wide web. The efficacy of active versus passive learning for increasing retention of new information is shown graphically in Figure 1.

These pedagogical observations give direction to the types of assessment methods that might be employed for determining how well a program is achieving its stated learning outcomes and goals. An obvious assessment method is to simply ask the constituents of a program (who must be identified and targeted a priori!!) questions about the program (e.g., questionnaires, surveys, course evaluations). Another obvious assessment method is to use an existing scheme such as the distribution of grades already assigned to various types of course work (e.g., homework, lab reports, design presentations). Less obvious assessment methods might be interpreting results of standardized national exams (e.g., Fundamentals in Engineering), self-assessment of individual courses by instructors, or even employing rubrics for students and instructors to categorically rank how well students have fulfilled the learning outcomes.

In this paper, the multitude of assessment methods used by departments for each program in the College of Engineering (COE) at the University of Washington (UW) for satisfying the assessment needs of ABET EC2000 criteria is presented and described. Then, each type of assessment method is discussed as to its success or lack therefore within the departments for each program and for the college overall. Finally, some conclusions are drawn regarding which assessment methods work, which do not, and directions of assessment methods of the future.

Assessment Methods

Starting in 1999, the COE at UW began to prepare for re-accreditation under the ABET EC2000 criteria. A COE committee comprised of an associate dean as chair and the ABET coordinators from each department within COE as members was established. This committee met once per month during each academic year to present information, "compare notes", and provide a forum for topics of mutual concern as well as those specific to certain departments/programs.

One of the outcomes of this COE committee was an awareness of both the commonality and the diversity of the approaches each department and hence each program was taking toward not only the overall accreditation process but also the assessment of programmatic goals and outcomes.

The COE was also quite helpful in providing support through workshops and seminars by outside speakers on assessment methods and learning outcomes as well as inside speakers for college wide issues (e.g., co-op program and writing requirements/assessment). One area of discussion that produced the greatest amount of concern (i.e., angst) among the coordinators was assessment. Almost predictably, departments chose various assessments based on their experience with the particular method, the availability of resources, ease of implementation and other factors not necessarily related to the quality and /or quantity of the information gathered. Table 1 shows a summary of the types of assessment methods used by each department/program leading up to the submission of the program self studies to ABET in July 2001 and the site visit to UW by ABET in November 2001.

Table 1 – Summary of Assessment Methods for Each Department/Program

Department/Program	Assessment Methods	Constituents Involved
Aeronautical and Astronautical Engineering	i) Pre-req coursework grades…….	- Students
	ii) Interviews……………………..	- Jr. level student on preparedness - Instructors on core courses - Sr. level student on exit/grad
	iii) Lab experience……………….	- Students
	iv) Design projects……………….	- Students
	v) Reviews……………………….	- Student peers - Instructors - Outside experts
	vi) Self Assessments……………..	- Faculty/instructors
	vii) Seminar attendance………….	- Students
	viii) TA evaluations……………...	- Students - Instructors
Ceramic Engineering	i) Completion of required courses	- Students
	ii) Experiential learning………….	- Students (research, design, co-op, intern)
	iii) Feedback……………………..	- Student (course evaluations, focus group, exit surveys, counselors) - Alumni surveys - Visiting committee
	iv) Faculty Assessment…………..	- Faculty (course self evaluation, annual review, collegial evaluation)
	v) Participation in professional societies…………………………..	- Students
	vi) Benchmarking w/ peer depts…	- Faculty
	v) Writing evaluation…………….	- Students

Table 1 – Summary of Assessment Methods for Each Department (continued)

Chemical Engineering	i) Surveys………………………... ii) Faculty meetings……………... iii) Meetings/Debriefing………… iv) Comprehensive programmatic review…………………………….	- Alumni (2 and 5 year out) - Employer (annual) - Faculty - On campus corporate recruiters and industry representatives - Faculty, UW administration
Civil and Environmental Engineering	i) FE exam………………………. ii) Grades (GPA)………………… iii) Surveys………………………. iv) Writing assessment…………. v) Feedback……………………… vi) Comprehensive programmatic review…………………………… vii) CELT study………………….	- Students - Students - UW alumni - Students - Instructors - Visiting committee - Faculty, UW administration - Faculty, instructors
Computer Engineering	i) Course grades…………………. ii) Course evaluations…………… iii) Self assessments……………... iv) Surveys………………………. v) Capstone design………………. vi) Writing assessment…………. vii) Affiliate feedback……………	- Students - Students - Faculty - Students (entrance/exit, co-op) - Industry employers - Alumni - Students - Students - Instructors - Industry employers - Alumni
Electrical Engineering	i) Course evaluations……………. ii) Course portfolios……………... iii) Surveys………………………. iv) Focus groups…………………	- Students - Students - Students - Alumni (1 & 5 year, biannually) - Students - Instructors
Forestry and Ecological Engineering	i) Course grades…………………. ii) Focus groups…………………. iii) Feedback…………………….. iv) Rubrics………………………. v) Surveys………………………..	- Students - Students - Visiting committee - Students - Instructors - Students (grads) - Industry employers

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Table 1 – Summary of Assessment Methods for Each Department (continued)

Industrial Engineering	i) Surveys………………………..	- Student - Alumni - Co-op students
	ii) Focus groups………………….	- Senior level students (CIDR) - Junior level students (IE Dept)
	iii) Interviews…………………….	- Students (exit)
	iv) Course evaluations (3a-k)……	- Students
	v) Capstone design………………	- Students
	vi) Feedback……………………..	- Visiting committee
	vii) Writing evaluations…………	- Students
	viii) Coursework (Professional Practice)…………………………..	- Students
Mechanical Engineering	i) FE exam………………………..	- Students
	ii) Surveys………………………..	- Students (grad, exit) - Alumni (1 and 5 year) - Visiting committee - Industry employers
	iii) Self assessment of courses……	- Student (course evaluations) - Faculty, Instructors
	iv) Feedback……………………....	- Visiting committee
	v) Faculty assessment……………	- Faculty (collegial evaluations)
Metallurgical Engineering	i) Completion of required courses	- Students
	ii) Experiential learning…………..	- Students (research, design, co-op, intern)
	iii) Feedback……………………....	- Student (course evaluations, focus group, exit surveys, counselors) - Alumni surveys - Visiting committee
	iv) Faculty assessment…………....	- Faculty (course self evaluation, annual review, collegial evaluation)
	v) Participation in professional societies……………………………	- Students
	vi) Benchmarking w/ peer depts…..	- Faculty
	v) Writing evaluation……………...	- Students
Paper Science and Engineering	i) Coursework (homework, quizzes, exams, lab manuals, lab reports)…..	- Students
	ii) Capstone design………………..	- Students - Industry reps
	iii) Surveys………………………....	- Alumni – Industry employers
	iv) Portfolio (self selected)………..	- Students

Discussion

The various assessment methods used by each department/program can be grouped into several broad types: Surveys, Coursework, Grades, Feedback/Evaluations/Interviews, Standardized Exams, and Capstone Design. Each of these assessment types is discussed in the following as to its success (or lack therefore) as employed in particular programs/departments.

Surveys: Of the eleven departments/programs, all of them used some type of survey to assess both technical and non-technical programmatic goals and learning outcomes. Surveys are very flexible in both content and administration. However, surveys also have the potential for being very difficult to construct intelligently so as to gather the desired information. In addition, deciphering and interpreting large amounts of information from surveys can be problematic. Some of the departments/programs conceive and conduct their own surveys which increase the workload in those departments. Other departments/programs use existing information from surveys conducted by the UW which decreases the flexibility of the survey but also decreases the workload on those departments.

Chemical Engineering noted that the despite ten year's of experience surveying their alumni, the ABET evaluator was concerned about the lack of one to tone correlation of survey questions with ABET criteria. This concern did not detract from the Department's documentation of continuous improvement of the program using the survey results.

Civil Engineering felt that the external assessment method of alumni surveys complemented their internal assessment methods such as FE exams etc. Overall, they felt the surveys worked well.

Industrial Engineering observed that surveys seemed to entail expenditure of lots to time for less valuable information than other assessment methods.

Mechanical Engineering reported that their survey process is fairly new although they have developed three types: graduating seniors, alumni (1 year and 5 years after graduation), and industrial advisors and employers. E-mail requests for completing surveys seem to be the most successful. However, quantitatively (and objectively) interpreting the results seems to be problematic.

Coursework: Of the eleven departments/programs, five use coursework to assess how well programmatic goals and learning outcomes are achieved. Some departments/programs use homework, lab reports, and design presentations from individual courses as assessment tools. Others use self-selected student portfolios to determine overall student performance. A variety of materials collected combined with the volume of material can complicate the evaluation of this assessment. In addition, interpretation of performance on the coursework can vary depending on instructor, type of assignment and grader.

Industrial Engineering viewed coursework as providing interesting information but noted that the one time use of the assessment method had provided no continuity.

Materials Science and Engineering volunteered that while the completion of coursework was important, it may not tell a lot about the quality of how well learning outcomes have been achieved.

Grades: Of the eleven departments/programs, three use grades to assess how well programmatic goals and learning outcomes are achieved. Some departments/programs use GPA while others use individual course grades (e.g., minimum course grade of 2.0 indicates satisfactory achievement of course learning outcomes). An advantage of using grades is that they already exist in the university system and all students receive them. A disadvantage of using grades is lack of uniformity of how instructors assign grades, the fluctuation of grades from quarter to quarter because of variability in degree of difficulty of course material and averaging systems used for calculating final grades in repeated courses.

Aeronautical and Astronautical Engineering has found that the way to improve the success rate of the program did not come their program, but by tightening up their prerequisite structure. They found that the key to uniform success of the students was to ensure that they had similar backgrounds. The answer wasn't just taking the courses, but in doing well in them. Feed back through student interviews, and overall performance of students, shows that performance in pre-requisite courses as measured through grades is important.

Civil Engineering recorded that grades are an internal assessment tool that quantifies how well learning outcomes are achieved.

Feedback/Evaluations/Interviews: Of the eleven departments/programs, eight use feedback/evaluations/interviews to assess how well programmatic goals and learning outcomes are achieved. Feedback ranges from focus group discussions, discussions with counselors, and recommendations from visiting committees or industrial affiliates. Evaluations include course evaluations by students, self assessment by course coordinators/instructors, writing evaluation of student, annual reviews/collegial evaluation of faculty, or ten-year review of departments/programs. Interviews may be exit interviews, meetings with recruiters, debriefing of returning co-op students or interns. An advantage of this type of assessment is the flexibility of who and what is assessed. A disadvantage is the breadth of information obtained combined with the volume of information that may make it difficult to evaluate the information.

Aeronautical and Astronautical Engineering explained that interviews are the best way to get the students' perspective. Having "institutionalized" entrance and exit interviews over the past seven years, they have learned how to get pertinent feedback from the students. The students are very candid and the Department has been able to pinpoint weaknesses in their program. They have worked hard to eliminate these weaknesses.

Civil Engineering noted that feedback from the visiting committee complemented the internal assessments, albeit in a more qualitative sense.

Industrial Engineered found that while course evaluations were not very useful because it was hard to know what the results really mean, evaluations such as focus groups or interviews with seniors were very useful for gathering opinions well as discerning trends or the effects of changes over time. Writing evaluations indicated the obvious in that students' writing became better over time (i.e. with practice).

Materials Science and Engineering reported that although qualitative, feedback from senior was especially valuable although feedback from alumni could be rather dated because it often referred to specific (and out of date) courses). Visiting committee feedback was very valuable because it was targeted and detailed. Evaluations from individual courses was only as useful as individual decided to make it. Writing evaluations were needed to ensure that students could write although the Department felt that it could pay more attention to this aspect of the degree requirements.

Mechanical Engineering solicited feedback from the visiting committee and found the results frank and useful although somewhat qualitative. The visiting committee described how they liked being asked what they thought rather just being told what was being done in the Department. In addition, course evaluations were used as part of self-assessments of individual courses by the course coordinators and instructors for those courses. Course evaluations were useful as one part of these self-assessment but were not necessarily viewed as useful as standalone assessment methods.

Standardized Exams: Of the eleven departments/programs, two use standardized exams (i.e., Fundamentals of Engineering exam) to assess how well programmatic goals and learning outcomes are achieved. An advantage of this type of assessment is that the exam is written, administered and graded by someone outside the department/program. In addition, the standardized grades for the program can be compared to those from the state and nation. A disadvantage is that the department has little or no control over the content of the exam or the assignment of grades.

Civil Engineering explained that the FE exam provided an external assessment of an internal audience. Overall the exam provided a standard by which to quantitatively assess graduating student's proficiency compared to their local and national counterparts.

Mechanical Engineering reported that use of the FE exam was a natural assessment tool because it provided a national standard to assess students for comparison to their peers at the state and national levels. In addition, the FE exam had the advantages of being conceived, administered, graded and reported by someone outside the Department, thereby both decreasing the Departmental workload and providing and objective viewpoint.

Capstone Design: Of the eleven departments/programs, three use capstone design projects to assess how well programmatic goals and learning outcomes are achieved. An advantage of using capstone design projects is that these projects represent the synthesis of coursework, therefore demonstrating an important step in attaining the professional engineering degree. A disadvantage is that assessing the intangible soft skills of capstone design projects (e.g., teamwork, communication, etc) can prove problematic and illusive.

Aeronautical and Astronautical Engineering reported that design projects illustrate the students' ability to problem solve, integrate disciplines, and work in teams. Smaller design projects are opportunities for students to practice these skills. The capstone design courses use these skills, and with close contact with faculty and TA's, get continual feedback. The instructors use design projects to assess the students' abilities in these skills. A clear transition in these skills is seen in the two years with the Department. Entrance interviews suggest that many students prefer to work alone (they don't trust groups). Exit interviews always show that group work is critical to success. Juniors entering the department have trouble with "open-ended" problems. Seniors leaving the program are much more comfortable filling in the blanks and using their judgment to solve the unknown.

Computer Engineering explained that since their capstone design course requirement is designed to meet the ABET professional component, they can be sure that those courses, which vary in content, nonetheless are consistent with respect to the ways in which students demonstrate competency in communication and satisfaction of realistic constraints.

Industrial Engineering viewed senior project assessment as very useful, because it provides their only non-perception based instrument. They have developed a rubric which faculty and industry advisors use to rate the ability of their students as shown by senior design projects.

Materials Science and Engineering noted that their senior project tells them a lot about the students, whether they can learn on their own, develop a work plan, carry it out and report the results in written and oral formats.

Summary/Conclusions

The various department/programs of the COE at UW employed a variety of methods to satisfy the assessment requirements of ABET EC2000. Assessment methods common to most programs included surveys, feedback/evaluations/interviews, and grades. Overall, the degree of success of these common methods varied from department to department but in general, the commonality of the methods indicated familiarity and therefore heightened level of “comfort” leading to greater degrees of success. Less common but still successful assessment methods included coursework, standardized exams, and capstone design.

It is interesting to note that a recent report[6] published by the American Society of Mechanical Engineers for 21 departments whose Mechanical Engineering programs underwent re-accreditation under EC2000 prior to 2001 presented, among other things, similar insights into assessment methods. Twenty-three different assessment methods were noted, many of which were used by only one department. Those methods used by more than one department included: proficiency exams, student performance, course assessment, faculty review, advisory board feedback, exit interviews/surveys, student groups, student surveys, alumni surveys, design projects, faculty assessment, FE exam, and employer surveys. Judicious grouping of these assessment methods results in the following comparisons to the categories already presented in this paper for the UW:

<u>Surveys</u> - exit interviews/surveys, student surveys, alumni surveys, employer surveys

<u>Coursework</u> – student performance

Grades – student performance

Feedback/Evaluation/Interviews - faculty review, advisory board feedback, exit interviews /surveys

Standardized Exams – proficiency exam, FE exam

Capstone Design – design projects

Many observations from the respondents in the report[6] agree with those of departments/programs at the UW. For example, feedback from the advisory board (a.k.a., visiting committee) was very important. Almost as equally important (i.e., very important) were exit interviews and surveys of graduates along with surveys of alumni. Interestingly the FE exam and employer surveys were of almost equal importance but not as important as the first three methods mentioned here.

In both the UW's experience as well as that of the respondents in the report[6], it is apparent that no assessment method seems unsuccessful although the degree (and hence success) to which individual departments at UW evaluated the assessment results varied. To quote a representative from one department: "….we got our accreditation renewed, so I guess the methods worked…" In the coming years, it is anticipated that departments/programs at UW will assess their assessment methods to determine modifications, adjustments and refinements.

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Biographical

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