Supplementary Assessment Tools for the Enhancement of the Program Assessment Plan

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Abstract

The paper deals with the enhancement of engineering program effectiveness. This is accomplished by utilizing non-traditional assessment tools such as student forums, cooperative education, and the fundamentals of engineering (FE) exam. The interaction with the students in a non-academic setting, in the student forums, provides opportunities to change. The issue of what students can do with what they have learned, which is relevant to the academic programs, is accomplished in the cooperative education experience. The FE exam results give the opportunity to examine the curriculum. Using these non-traditional assessment tools enhances the curriculum to make the student better equipped for the work place.

Introduction

Currently, many engineering professional societies are in the process of developing the body of knowledge for their prospective professions. In 2001, the Accreditation Board for Engineering and Technology (ABET) Engineering Criteria was implemented in which emphasis was on outcomes rather than process. The criteria provide the opportunity for the university's constituents to have an input to define the educational goals and objectives. The core of the ABET Engineering Criteria is that the assessment system demonstrates both the educational objectives as well as programs outcomes are being measured. It is essential for educators to show that the results of those measurements are being evaluated and used to enhance the programs effectiveness. Results of many studies have shown the positive effects of well-integrated curricula where assessment methods were applied consistently.

Engineering programs utilize assessment methods that include both direct and indirect measures[1]. Many articles have been written about important assessment tools such as alumni feedback[2], employer's survey, constituents' input, etc[3, 4]. It appears that there is a lot of emphasis on surveys. Faculty assesses the outcomes in the classes they teach and are very creative in developing assessment methods. Traditional assessment techniques are not always adequate to measure student learning. Diane Rover[5] lists many important questions for educators to ask and answer regarding what to teach and how to teach it.

This paper deals with the program effectiveness. It stresses the importance of assessing departments and programs in conjunction with assessing students. It shows that the use of the

following non-traditional assessment tools enhances the approach of the assessment process:

1. Cooperative education student evaluation
2. Cooperative education employer evaluation
3. Coordinator report
4. Student forums
5. Nationally normed examinations

Educators prefer classroom assessment because they are comfortable with their systematic approach. The above tools are not intended to replace the faculty assessment of student learning outcomes. Rather, they are supplementary methods to enhance the assessment plan. It is not necessary that we use an analytical approach in which the assessment methods are applied to each individual student. It is important to remember that there is no one right way to do assessment, no two programs are alike, and take advantage of what resources are available in the assessment process[6].

The rest of the paper is organized in the following manner. First, the paper discusses the importance of cooperative education experience as it applies to assessing the program outcomes. Next, the relevance of student forums as an assessment tool is presented. After that, the use of the FE exam is evaluated as a part of the assessment plan. Finally, closing the loop and the concluding remarks about using the non-traditional assessment tools to enhance the curriculum are presented.

Cooperative education

The cooperative education (co-op) program at Indiana University-Purdue University Fort Wayne (IPFW) allows qualifying students to alternate periods of academic study and practical work experience in the engineering field. The university co-op office and the department co-op faculty coordinator actively encourage participation in this program. In addition to expand opportunities for post-graduation employment, the experience is beneficial to the students in the program to enhance and assess what is learned in the classroom.

A survey of fifteen companies conducted by the Industry-Government Roundtable for Enhancing Engineering Education ranked importance of knowledge elements, skills, and experiences that can be expected by engineering managers and engineers for Bachelor of Science (BS) entry-level engineers[7]. Educators must shift the focus from teaching-centered approach to learning-centered. This necessitates the assessment of the industrial use of the materials that are learned in the classroom.

The co-op program is vital in such assessment using the following 3 methods:
1. Student feedback: IPFW cooperative education students are required to submit an academic written report as well as an evaluation survey for every semester they worked. The feedback is an important way of understanding the value of the co-op experience and the results can be used as indirect assessment measures.

The students write a 3-5 page technical report in which they summarize the tasks, plan, project management, learning outcomes, accomplishments, and the work experience. Currently, there is

an emphasis to include a communication instruction in the engineering curricula[8]. For example, a co-op coordinator can assess the ability of students to communicate effectively (ABET outcome g). This is a unique assessment tool because of the nature of the work and the industrial element of the co-op assignment compared to a traditional academic report. In general, the co-op students write better than traditional students due to the industrial experience. As co-op student writes technical reports, memos and makes presentations. In addition to the technical and engineering fundamental components, realistic engineering economics, marketing, feasibility, and manufacturing elements are required in the communication, both written and oral. Thus, the students' feedback can be utilized to improve the programs' outcomes in two ways:

- The coordinator feeds the information to the assessment committee regarding the communications outcome. The assessment committee studies the results and makes the recommendations to the curriculum committee to strengthen the communications skills.
- When the teams are formed (ABET outcome d), they should be a mix of co-op and traditional students so they learn the business aspect of communications. The use of audience-appropriate vocabulary, content, and style are very important elements in communication, which the co-op students can share with other students.

Furthermore, the co-op students at IPFW submit a standard survey form regarding the learning outcomes of the co-op work experience. The statements are divided into three categories:

- Personal development learning outcomes
- Professional development learning outcomes
- Academic development learning concepts

Table 1. Learner outcome statements at IPFW

Academic Development Learning Concepts	S	I	N	U
Ability to compile information.				
Ability to analyze information.				
Ability to demonstrate technical knowledge in your academic discipline.				
Ability to use computer skills.				
Demonstrated ability to use decision-making skills.				
Ability to use problem-solving knowledge and skills.				
Ability to integrate theories learned in the classroom with actual "hands on" experiences.				
Opportunity to apply what was learned in the classroom.				
Knowledge about a specific academic discipline.				
Improved interest area as related to my academic discipline.				
Improve communication through:				
a. Oral skills.				
b. Listening skills.				
c. Writing skills.				
d. Using a variety of media to transmit ideas.				

S = Significantly Improved I = Improved N = Not at all Improved U = Uncertain

The level of achievement can be used as a classroom and program assessment. The majority of the above co-op learning concepts can be mapped to the program's outcomes. Hence, it can be used as a measure of preparing the student to have a successful career.

2. Employer evaluation: In order for the student to receive a passing grade in his/her co-op assignment, the employer evaluation must be returned. A program assessment by an independent engineer is a frank appraisal of the outcome strengths and shortcomings. The feedback can be used to assess existing outcomes and enhance the outcomes to satisfy the changes affecting the engineering profession. There are items such as professionalism, academic preparedness, and various skills that are used by the department as a tool to measure the achievement of some of the outcomes.

The engineering practice continues to evolve, but engineering education has not changed at the same rate. The need to change engineering education has led industry and constituents to question the relevancy of engineering programs. According to the analyses conducted by The American Society of Mechanical Engineers[9], it is common for engineers to participate in or lead project management teams, which require working knowledge of procurement, financial analysis, sales and marketing, and other non-technical matters.

The employer evaluation is a measure of student's competence, and therefore can be used to assess the program outcomes. The IPFW cooperative education employer evaluation consists of two parts: Performance factors survey and comments. The performance factors assess the achievement, during work terms, in theses areas:

- Professionalism
- Academic Preparation
- Skills

The achievement of understanding the professional and ethical responsibility (ABET outcome f), and the ability to use techniques and skills (ABET outcome k) are difficult assessment tasks for educators when it is done solely based on academic performance. However, a supervisor can assess these outcomes easily based on a daily industrial performance. On the other hand, the academic preparations can be mapped directly to the program outcomes. The academic preparedness factors at IPFW are shown in Table 2.

Table 2. Academic performance factors

Performance Factors	Levels of Performance					
Academically Preparations	1	2	3	4	5	NA
Ability to integrate theory (academic learning) and practice (co-op experience).						
Academically prepared for this job (course preparation).						
Communicates clearly in written form.						
Communicates clearly verbally.						
Demonstrates ability to design.						

1 = Outstanding 2 = Very Good 3 = Average 4 = Marginal 5 = Unsatisfactory NA = Not applicable

The comments include curriculum recommendations that could impact the outcome of the co-op student's performance and any specific courses or special training that should be taken by the student that would be especially helpful in his/her effort to achieve career goals. The employer performance appraisal is very useful regarding to what the students can do with what they have learned.

3. Coordinator report: Among other responsibilities, the co-op faculty coordinator at IPFW makes a company visit. The purpose of company visit is to ensure that the co-op experience is rewarding as well as the assessment tool, which is a vital component of experiential education and the learning process. Usually, the return rate of the traditional alumni and employers surveys is very low. During the company visit, the coordinator meets with the student and their supervisors.

One of the most important aspects of education is the ability to transfer academic knowledge to job performance. This is a difficult objective and outcome to be assessed on campus. On the other hand, the co-op coordinator can assess the program effectiveness regarding this issue through the discussions with students and supervisors, at the company visit. The expectations of companies that employ engineers are changing. In addition to sound academic background, companies want engineers to be:

- Self-directed
- Market-focused
- Agile
- Continuous expansion of knowledge

A Sample of the categories that can be checked during the visit:

Table 3. Checklist

CATEGORY	OCCASIONAL PROBLEM	SERIOUS PROBLEM
Limited technical ability		
Lack of experience		
Inability to transfer academic training to job requirements		
Negative reaction to supervision		
Lack of initiative		
Sense of ownership for learning (more self directed)		
Ability to compile information		
Ability to analyze information		
Demonstrate willingness to learn		
Demonstrate professional work habits.		
Demonstrate analytical problem solving skills		

Upon completion of the company visit, analyzing the students' reports and supervisors' reports, the coordinator submits an assessment report to the assessment committee.

Student forums

There is a lot of focus on assessing program educational objectives and outcomes - ABET criteria 2 and 3, but less emphases on the other ABET criteria. Many articles were written about surveys and questionnaires, exit and other interviews, exams, and portfolios. In addition, educators interact with students in the academic atmosphere on a daily basis, but given a little credit on the personable interaction.

Among the many issues that can be discussed at a student forum to assess the program and the university are:

- Advising procedures
- Monitoring student success
- Transfer credits
- Efficiency of course offering
- Pre- and co-requisites
- Adequacy of classrooms
- Classroom atmosphere
- Library resources
- Interaction with professional engineering societies

Educators have created many written surveys and questionnaires, classroom and program assessment plans, and statistical analysis methods. Educators need to do more to foster faculty-student interaction. Student forums are useful to gather ideas, details, new insights, and can be helpful in designing surveys and questionnaires. They can be used in conjunction with quantitative studies to confirm the validity of an issue or concern. Student forums are very useful as a supplementary tool to other established methods and are not to replace the rigor of the traditional assessment methods.

While it is sometimes difficult to assemble the students, faculty, and administrators, student's organizations can play a role in arranging these forums. This will allow the students to assume ownership and feel they are part of the assessment process, not by just doing the surveys. Therefore, the forum can be held to provide in-depth information regarding an issue generated from a survey. At IPFW, at least once a year, the engineering professional societies organize a student forum in which all engineering students are invited. The chair, sometimes the faculty of the department and the secretary attend the meeting. For example, The IPFW chapter of The American Society of Mechanical Engineers took the lead in organizing the last forum. The main issue was the availability of open computer labs on campus. This could be done at the exit interview or a usual survey at the end of the semester but it would be too late. Educators always thrive on providing an atmosphere conducive to learning and sometimes the student voices in an organized forum strengthen the issue. Briefly, student forums are a quick and inexpensive method of gathering information. They can be used indirectly to assess the achievements of the program outcomes. It is away to know how the students manifest their motives, attitudes, and values.

Fundamentals of Engineering (FE) Examination

The assessment method requires many direct and indirect tools for the evaluation of many aspects of the outcomes. Perhaps, for the purpose of comparison, an external norm objective scoring exam should be used as a measurement tool. Commercial, norm-referenced, and standardized exams can be adopted as an assessment tools for some of the programs outcomes. They significantly reduce the faculty time demands in preparing and grading, compared to locally developed exams. Some institutions of higher educations are being pressured by constituents to compare their academic programs with reference to a regional or national standard.

The FE Exam is conducted by the National Council of Examiners for Engineering and Surveying (NCEES). NCEES provides a report that is specific to an institution detailing the performance outcomes of students. The report includes information that can be used as an external measure as well as a valuable comparison tool. ABET outcomes that can be assessed using the FE exam:

- Ability to apply knowledge of mathematics, science, and engineering
- Ability to identify, formulate, and solve engineering problems

Other possible or partial outcomes that can be assessed:

- Ability to design a system, component, or process to meet desired needs
- An understanding of professional and ethical responsibility

The results can be studied utilizing some analysis techniques or by simply looking at the raw data. For example, a statistical approach for analyzing the FE Exam results in the fluid mechanics section has been presented[10]. Educators are still divided when it comes to the acceptance of the FE exam as an assessment tool. The major advantages are:

1. Multiple choice exams always include a potentially high degree of error.
2. The guessing factor lowers the validity of the results.
3. There is a concern that faculty may teach to the FE exam.
4. The cost of the exam.

On the other hand, the FE report contains data that include individual topic performance and national performance with standard deviation. Thus, some of the advantages of using the FE exam as an assessment tool include:

1. Can be adopted and implemented quickly.
2. Compare the performance of students in one program with students from other programs.
3. Nationally normed exam addressing specific engineering topics.
4. A variety of formats to examine.

At IPFW, the FE Exam committee consists of four faculty members. The charge of the committee is:

- Find as much as possible for each area, e.g., computers, what type of material is being tested.
- Compare this material against the one present in our curriculum to see if there is a match or mismatch.
- Analyze our students' performance in the FE exam. This should include an inspection of their transcripts to determine which courses they took and when they took them.

- Report their findings and recommendations to the department.

The results of the FE exam should be linked to other assessment tools. One of the committee recommendations is that it is desirable that the contents of the exam are kept in view. The topics of the exam are consistent with the ABET requirements and will strengthen the programs. Many have been along the line of we are doing fine, good, and excellent. Areas needing attention have been categorized as follows:

- Deficiency: The student score is below the national average and the material is not currently covered in the curriculum.
- Weakness: The student score is greater than 10 points below the national average.
- Concern: The student score is more than 5 points below the national average.

This has led to some modifications of the courses and including new materials in the curriculum. The FE exam result data is only one indicator and should not be used to determine specific content. The faculty selects those areas that are relevant to their particular program and use only those in assessment.

Closing the loop

There are many attributes to measure in the assessment plan such as problem solving, design, ethics, and others. Hence, the input from all stakeholders is desired for meaningful engineering education assessment. An attribute can be measured reasonably by using one tool while different tools effectively assess other attributes. Two indirect tools for assessing ethics are the FE exam and the cooperative education evaluations. For example, according to the 2001 FE exam results, the percent of correct answers by the mechanical engineering students at IPFW were below the national percentage. Some educators argue that the FE exam results are not very reliable. The material for this subject, as given in NCEES Reference Handbook essentially covers the NCEES "Model Rules for Professional Conduct". Review questions indicate the purpose is to judge students' ability to understand proper interpretation of the rules in specific situations. To measure this in a real life situation the cooperative education program provides a prefect setting. The IPFW cooperative education evaluations address the knowledge of professional ethics and can be linked to the FE exam results. It is always a good practice to link the results of many tools in the assessment process. A direct tool for assessing ethics is the alumni survey. The results of the survey, conducted around the same period as the FE exam, validated the deficiency in ethics. Based on multiple measures of effectiveness, the curriculum committee took note of this issue and strengthened the ethical content in the curriculum.

Conclusion

Engineering programs seeking accreditation are required by the Accreditation Board for Engineering and Technology to document their continuous program improvement efforts and their outcomes. Examples of using non-traditional assessment tools within engineering education were highlighted in this article. The utilization of the cooperative education experience, the student forums, and the fundamental of engineering exam are discussed. Discipline specific assessment information can be gleaned from these tools.

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