

# Developing Course Assessment Tool to Measure the Degree of Achieving Course Learning Outcomes

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## ABSTRACT

The civil engineering program at Indiana University-Purdue University Fort Wayne (IPFW), established in the fall of 2006, is the most recent addition to the Department of Engineering, which offers B.S. degrees in civil, computer, electrical, and mechanical engineering. A key component for a successful program is to establish and implement an effective assessment process to measure the degree of achieving program outcomes, identifying weaknesses, and recommending improvements. In December 2008, the Civil Engineering Assessment Plan (CEAP) was developed based on the department's existing "one-assessment-plan-fits-all" format that was developed for all programs in 2004. Currently, there is a need to depart from this approach and modify the current plan to take into consideration the individual needs of each program. A major deficiency in the current plan is the process of evaluating course outcomes, which lacks consistency and documentation.

The goal of this paper is to present a new tool developed to improve the assessment and address ABET criteria for developing an assessment-based improvement system capable of establishing consistency in the assessment process, create a better documentation process, and measure the effectiveness of educational and learning of engineering students. A new faculty assessment form developed to document assessment data and provide an analysis of assessment results for course outcomes is also presented. The faculty members acknowledged the effectiveness and ease of use of the new tool that helped in improving assessment at the department level and supported ABET accreditation of the new civil engineering program.

**Keywords:** Assessment, ABET, Learning Outcomes, Civil Engineering Programs.

## 1. INTRODUCTION

The Civil Engineering (CE) program started at IPFW in 2006; the only public program offered in the area that enables students to get excellent education while living at home and attending school. The focus of the CE program during the first two years was on: a) developing new curriculum that meets the needs of the northeast Indiana and the Accreditation Board of Engineering and Technology (ABET); b) developing syllabi that are current, relevant, and of high quality for all CE courses and meet IPFW and Purdue University (PU) requirements and

approval; c) renovating and upgrading the Materials and Soil Laboratories and developing a new environmental engineering laboratory; d) recruiting and retaining new civil CE students; e) recruiting new CE faculty members; f) starting and promoting ASCE student chapter at IPFW; j) recruiting an advisory board to the program; h) supplementing the programs with all supporting elements including reference materials and manuals in the library and acquiring professional software packages; and i) actively teaching Fundamental of Engineering (FE) Examination preparation sessions for engineering students in Statics and for CE students in selected topics of their choice.

In December 2008, the CEAP was developed and approved, based on the department's existing "one-assessment-plan-fits-all" format that was developed for all programs in 2004. The assessment plan requires intensive effort to implement and lacks consistency and documentation in some aspects of assessment such as course assessment. Currently, there is a need to depart from this approach, and modify the current plan to take into consideration the individual needs of each program.

## 2. ASSESSMENT PROCESS

The educational objectives and program outcomes of the CE program are assessed using direct and indirect tools listed in Table 1<sup>1</sup>. The direct tools are methods used to evaluate students' knowledge or skills against a measurable outcome by direct examination or observation of student performance. According to ABET<sup>2</sup>, the indirect assessments of student learning "ascertain the perceived extent or value of learning experiences. They assess opinions or thoughts about student knowledge or skills." The focus of this paper is on the course assessment and the faculty assessment form and procedure.

The curriculum assessment is based on assessment of all courses in the curriculum by the instructors and the students. The senior design course is evaluated by the instructor and external evaluators evaluating the final presentation at the end of the course. The current assessment plan calls for assessing program outcomes based on course assessment conducted by instructors and students over a two-year period for all courses in the degree plan. Each course is evaluated at least one time. A course may be assessed more than one time. For example, in cases where one of the course outcomes or ABET outcomes are

not met and where a course is taught by a faculty member for the first time. The instructor who taught the course will provide reasoning and recommendations to help in achieving the course outcomes. The recommendations are shared with the instructor who is scheduled to teach the course in next offering. In addition, students evaluate the course intended outcomes during the last week of each semester.

Table 1 Direct and Indirect Assessment Measures

Criterion	Tools	
	Direct	Indirect
Educational Objectives	1) Performance Appraisal by Employers (Direct Supervisor)	1) Alumni Survey 2) Admittance to Graduate School 3) Industrial Advisory Board
Program Outcomes	1) Faculty Course Assessment 2) Capstone Senior Design • External Evaluators • Faculty Members 3) Fundamental of Engineering (FE) Examination	1) Students Interim Assessments: • Course Outcome Survey • Laboratory Evaluation • Engineering Students' Forums 2) Exit Interview 3) Internship and Co-op Education Coordinator/supervisor Survey

### 3. OLD ASSESSMENT FORMS

The faculty members in the Department of Engineering use a standard assessment form to evaluate their courses. At the end of each semester, three types of courses are assessed: individual courses scheduled for assessment, any course taught by a new instructor, and any course taught before and did not achieve its outcomes. The instructors of these courses complete the forms and submit them to the assessment committee via an assessment email used as a depository for all correspondence pertaining to assessment. The goal of the form is to check if each course ABET outcomes is met. Figure 1 shows part of the instructor assessment of ABET outcome (a)<sup>3</sup> in a typical CE course.

Students enrolled in the course evaluate the course outcomes during the last week of classes. The form has a list of course outcomes and asks students if they “feel” that they have learned the intended course outcomes. Students have two choices for each outcome: yes or no. Figure 2 shows the results of students’ evaluations as well as a summary of the faculty assessment for a typical CE course during the spring 2010 semester. It is worth noting that current procedures do not require this form.

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering

- What measures were used in the outcome assessment? (please check all that apply)
 

<input type="checkbox"/> Homework	<input checked="" type="checkbox"/> Quizzes	<input checked="" type="checkbox"/> Exams	<input type="checkbox"/> Projects
<input type="checkbox"/> Final Exam	<input type="checkbox"/> Lab Reports	<input type="checkbox"/> Presentations	
<input type="checkbox"/> Others (specify)			
- In general, was the outcome achieved (based on the rubrics listed below)?
 

<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
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Comments: The average in the homework and quizzes problems mapped to outcome (a) indicated that more than 70% of students got an average of 70% or higher. If your answer is NO, please outline a plan that will help in achieving this outcome:

Figure 1 Part of Faculty Assessment for ABET Outcome a.

No.	Outcomes		Assessment	
	ABET	CE Program	Outcomes	Criteria
1	a	1	Achieved	Tools used: Homework, Quizzes, Exams, Project, and Presentation. Criteria: The average in the tools used such as homework and exams mapped to related outcomes indicated that more than 70% of students got an average of 70% or higher.
5	e	2		
7	g	8		
8	h	9		
11	k	6		

Figure 2 Summary of Students’ and Instructor Assessment of a Typical CE Course.

### 4. NEW ASSESSMENT FORMS

The following are key items considered in developing the new assessment forms to improve the current assessment process

- Streamline course assessment: currently, the students’ evaluation is based on a survey that measures their perception of achieving course outcomes. However, the faculty assessment of the course evaluates the ABET outcomes of the course. Usually, several course outcomes are mapped to the same ABET outcome. In order to establish consistency between the two assessments, it is recommended that instructors evaluate the course outcomes as well. In addition, it is necessary to develop a new form to join the results of both assessments into one document.
- Establish Consistency in the Assessment Process: currently, no unified guidelines are available for instructors to follow when evaluating the course ABET outcomes. Therefore, each course is evaluated differently based on criteria set by the instructor. In some cases, the instructor reports that the course outcomes are met without supportive evidence. The course assessment needs to be consistent and follow the same guidelines. This will help in integrating course assessment into curriculum assessment.
- Integration of the Assessment Process: the current assessment process is fragmented and focused on closing the loop at a micro level especially with the curriculum assessment. The individual course assessments need to be combined to evaluate the curriculum. A second possible improvement might include assimilating the results of all measures and evaluating the overall performance of the program outcomes and program objectives.
- The Big Picture-Assessment Framework: there is a need to develop a framework for the current assessment process as outlined in Figure 3. The black links represent the current process and red lines are the suggested improvement. For example, closing the loop for each individual course exists, but the framework lacks a feedback link to the curriculum.
- Extensive Assessment Process: the current plan calls for an assessment report by the end of each semester, which demands substantial resources and does not contribute much to improve the assessment process. It would be more beneficial to have a report at the end of each assessment cycle, which takes two years to complete.

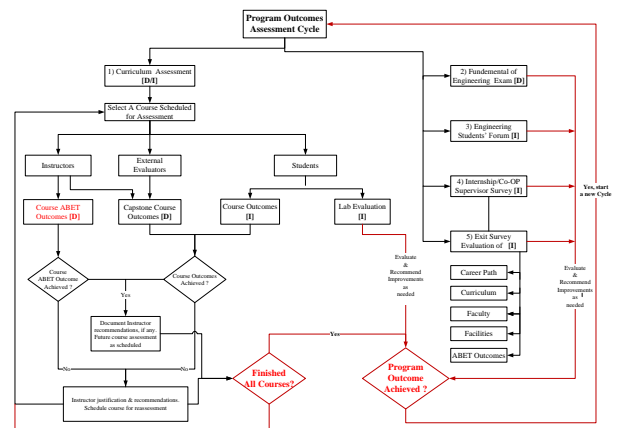


Figure 3 Proposed Modifications to the Framework of the Old Assessment Process.

Accordingly, the following forms are proposed:

- a) Modified “Student Assessment of Course Survey” Form: The current student survey asks students to evaluate each course outcome by choosing either “Yes” or “No”, where yes indicates achievement of intended outcome and no as a failure. In contrast, the proposed survey uses a 1-5 scale. The proposed analysis tool maps the survey results to ABET and program outcomes. Sample results are shown in Figure 4.
- b) Proposed “Faculty Assessment of Course Form” and Analysis Tool: Figure 5 shows the proposed simple and easy to use new form and analysis tools. The form was developed using Excel and has a drop-down menu. This form was tested as a pilot study during the ABET visit to IPFW in fall 2011.
- c) Final “Faculty Assessment of Course Form” and Analysis Tool: Figure 6 shows the modified and final version of the new form based on the recommendation of the pilot study and the concerns of the ABET team. The final version of the new form has the following modifications:

- 1) Criteria Definition: A list of six criterions that can be used in course assessment were identified and approved by the department assessment committee. Each criterion has a threshold that each outcome should meet.
- 2) Criteria Used: This section is used to list the criteria used in evaluating each outcome. In addition, it has the value of the assessment of students based on the data needed by each assessment criterion. In case the results are very close to the threshold, then the faculty member chose “Yes, adequately” as a conclusion of a course outcome assessment. In case the results of the assessment is way above the threshold, then the result should be “Yes, strongly”. Any value below the threshold, then the course outcome was not achieved.
- 3) Continuous Improvement: Three boxes contain the instructor comments on recommendations from the previous course assessment, instructor comments and observation on current semester, and recommendations to improve students' performance in achieving course outcomes in future. This section is critical to ensure continuous improvement among several faculty members teaching the course, and is an evidence of assessment based improvement. Table 2 presents a sample of comments and recommendations compiled for the spring 2012 assessment of various course.<sup>4</sup> The new tool was fully utilized in spring 2012. Several faculty members acknowledged the effectiveness and ease of use of the new system and recommended that the department replaces the old assessment tool with the new one.

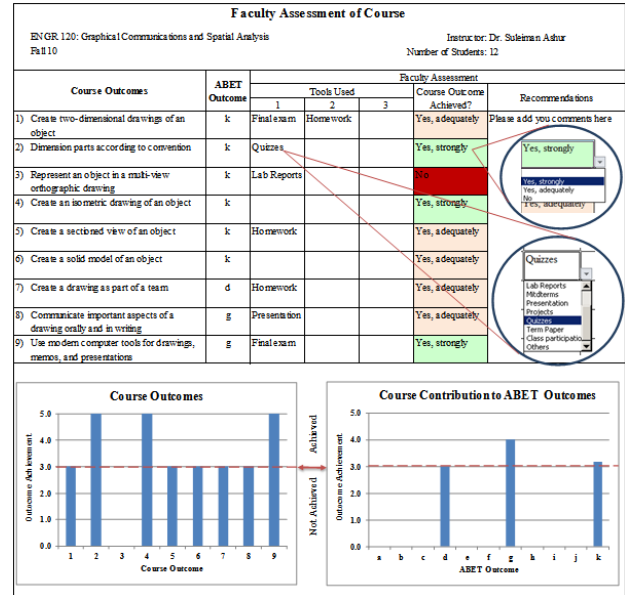


Figure 5 Proposed Faculty Assessment of Course Form and Analysis Tool.

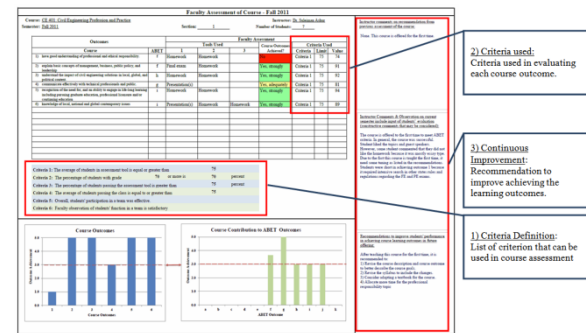


Figure 6 Fall 2011 Faculty Assessment of Course Form and Analysis Tool

Table 2 Samples of Faculty Comments and Recommendations for Improvement, Spring 2012<sup>4</sup>.

Course	Faculty Comments	Recommendation for Continuous Improvement
ENGR 120	The students are at many different levels of independence. Some students are ready for college engineering; some still want their high school teacher to walk them through everything. The course being taught in one long class period works out well. Some students are not ready for the testing and projects that come with College.	Have less homework problems and smaller projects. This will keep the amount of work the same but place more importance more spread out.
CE 252	Quite a few of students are struggling about the force analysis using free-body diagrams.	It is recommended that: - an instructor gives a review on free-body diagrams at the beginning of the semester. - Put more focus on free body diagram in Statics.
CE 315	This course composed of 11 heavy chapters. The students feel that it is too much information for one course. They also believe that taking the lab during the same semester will help them better understand many of the course subjects. I agree with the students. However, the reason for doing it this way because of our limited resources in terms of CE faculty members. I am the only instructor that can cover this course and four other courses in the structural & concrete.	I recommend splitting the course into two courses as typically covered in similar courses in majority of the other CE departments.

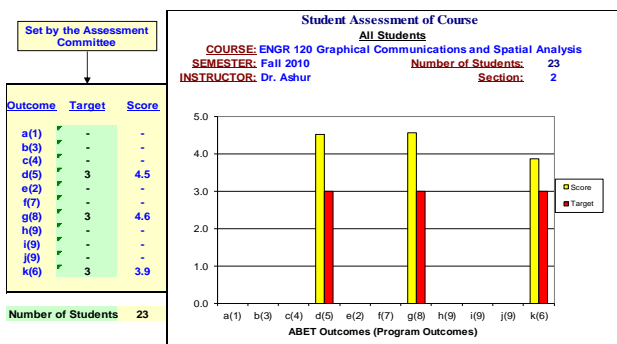


Figure 4 Proposed Student Assessment of Course Survey Analysis Tool.

## 5. SUMMARY AND RECOMMENDATIONS

This paper presents the new course assessment form that will be used in the Department of Engineering at IPFW. The new tool is easy to use, develops consistency among all courses, and provides an analysis of assessed course and ABET outcomes. The key component of an effective assessment process is to develop an assessment system that leads to continuous improvement of educational outcomes and objectives. In addition, it is critical to base modification and changes on assessment to create an assessment based improvement system. It is recommended that programs evaluate their assessment process and plans frequently in order to find ways to make them simple and more efficient. Faculty members acknowledge the ease of use and effectiveness of the new tool. As a result, the new tool was adopted and replaced the old tools of assessment.

## 6. REFERENCES

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