AC 2010-1207: A SYLLABUS-BASED ASSESSMENT AND EVALUATION TOOL FOR ABET PROGRAM ACCREDITATION

Greg Nordstrom, Lipscomb University
Associate Professor of Electrical and Computer Engineering

John Pettit, David Lipscomb University
Department Chair, Associate Professor of Electrical and Computer Engineering
A Syllabus-Based Assessment and Evaluation Tool for ABET Program Accreditation

Abstract

The ABET engineering accreditation criteria cover all aspects of program evaluation, from high-level institutional program educational objectives down to individual program outcomes, including evaluation of a program’s continuous improvement processes. A successful ABET evaluation indicates a functional, viable, and self-perpetuating program of engineering study. To provide faculty with an efficient and effective mechanism for gathering and evaluating program data, Lipscomb University has developed a syllabus-based ABET assessment and evaluation tool. This tool provides an easily navigable framework to guide faculty through the process of planning and conducting individual course assessments, feeding critical, timely information to program evaluation and improvement processes, and producing archival records of all course assessment activities. This paper presents the tool, shows its use in course assessment and evaluation, and discusses our experiences with the tool as a run-up to our 2009 ABET program review and evaluation.

Overview

Institutions seek ABET\(^1\) accreditation to assure a quality educational experience for students in Applied Sciences, Computing, Engineering, and Technology programs of study. ABET accreditation is based on standards of quality set collaboratively by its member technical and professional societies\(^2\). Institutions seeking accreditation begin by making a request for evaluation to ABET. Once approved, a lengthy self-study questionnaire is prepared by the institution, documenting the degree to which its administration, facilities, faculty, curriculum and students meet the accreditation criteria set forth by ABET. Once the self-study has been submitted and reviewed, an ABET evaluation team conducts a campus visit, at which time they review program course materials and samples of student work, interview faculty and administrative personnel, and resolve any questions raised by the self-study. A successful evaluation results in a six-year program accreditation.

While an ABET evaluation involves examination of large amounts of program material and an in-depth analysis of program detail, a key element in achieving a successful evaluation is the existence of a well defined, organized and functioning process of continuous improvement involving all stakeholders. A transparent, well-understood process of improvement is indispensable for making measurable goal-oriented program changes, and only through a continuous process of data collection, assessment, evaluation, and results-driven change can a program remain viable in the long term.

Program Improvement Process

Within the Electrical and Computer Engineering department at Lipscomb University, our process of continuous improvement closely follows the ABET “Assessment for Quality Assurance” model\(^3\) and includes two major loops of activity: 1) an “Objectives” loop where data related to
our Program Educational Objectives (PEOs) are assessed and evaluated and 2) an “Outcomes”
loop where data related to our Program Outcomes (POs) are assessed and evaluated. Together,
these loops produce evaluation results that inform various program improvement efforts, which
in turn drive program change. This process is shown in Figure 1 below.

![Figure 1. Departmental ECE Program Improvement Process](image)

**PEO Assessment and Evaluation**

As indicated in Figure 1, the process of establishing, refining, and evaluating PEOs yields two
critical measures of PEO performance:

- A measure of the validity and applicability of the PEOs themselves, and
- A measure of our graduate’s success at meeting those PEOs.

As indicated, source data for PEO evaluation comes almost exclusively from sources outside the
department offering the program of study and is gathered largely by surveys and interviews.
While subsets of this data are gathered and evaluated annually, the overall PEO evaluation cycle
is three years long.

**PO Assessment and Evaluation**
In contrast to PEO source data, PO evaluation is based exclusively on data gathered from within the department, and yields three key performance indicators:

- The degree to which our POs support our PEOs,
- The degree to which our curriculum supports the POs, and
- A measure of our student’s success at meeting those POs.

Within the department, PO assessment and evaluation efforts are ongoing and repeat on a one-year cycle. This annual cycle is shown in Figure 2.

Figure 2. Program Outcomes Assessment and Evaluation Process

A few weeks before the start of a new academic year, the department chair evaluates program evaluation data from the previous academic year and produces a spreadsheet of PO evaluation results. The department faculty then review these results and revise a second, key spreadsheet called the “Program Outcomes Assessment Matrix.” This spreadsheet assigns weightings to the various program outcomes, determining which courses will be used to assess and evaluate which POs (we use a 1-5 scale where weights of 4 or 5 are selected for formal assessment). Because our
department is small, the entire faculty is able to participate in assigning weights to individual courses. In larger departments, this would likely be done by a PO evaluation committee.

At this point, faculty have a clear understanding of which POs are to be evaluated within their individual courses and how those evaluations will fit into the upcoming annual program evaluation. What remains is to review the results of previous course offerings in light of the revised POs, update the course and its associated assessment instruments and indicators, teach the course, assess the gathered data, and evaluate the individual course as prescribed by the “Program Outcomes Assessment Matrix” mentioned above.

Once a course has been taught, it is critical that each faculty member also review and critique the assessment instruments and assessment indicators used to evaluate the course. This ensures the validity of not only the course material, but the evaluation material as well. Finally, the course evaluation materials are archived and used in the program evaluation process.

While having a process in place is necessary for comprehensive program evaluation activities, it is not sufficient. As shown above, only when individual faculty members engage in an ongoing practice of data gathering, analysis, and evaluation will the program evaluation be successful. And it is precisely this part of the process—the individual course assessment and evaluation activities—for which our syllabus-based assessment and evaluation tool was designed.

The tool addresses many of the needs described above. It provides an easily navigated framework to guide faculty though the process of planning and conducting individual course assessments, it feeds critical, timely information to program evaluation and improvement processes, and it produces an archival record of all course assessment activities. It is lightweight and flexible, requiring a minimum of effort to manage, and provides a high level of transparency, showing program evaluators what data was gathered, how that data was assessed, and the rationale for resulting evaluations. And finally, the tool promotes a common “language” of assessment within a department or group of evaluators, providing a more consistent approach to assessment and evaluation across all program elements.

The Syllabus-Based Assessment and Evaluation Tool

A well-planned syllabus gives structure and focus to a course. It states the course objectives, enumerates expected student performance, and outlines the plan of study for the semester, helping instructor and student alike stay abreast of key topics, assignments, and deadlines. Furthermore, it links course objectives to specific ABET program outcomes. For these reasons, it was natural to extend the instructor’s syllabus to include course assessment and evaluation information, linking plans to outcomes and creating an archival document of the evaluation process. Note that this “extended” syllabus is an instructor-only product, not intended for students.

We call this extended syllabus a Syllabus-Based Assessment and Evaluation Tool. The tool is presented using a recently taught section of our EECE 4254 Microprocessors course. As mentioned earlier, assessment and evaluation activities are governed by entries in the Program Outcomes Assessment Matrix, excerpted in Figure 3 below.
As can be seen in Figure 3, EECE 4254 addresses several POs, and although EECE 4254 has several outcomes with weights of 4 or 5, only outcome “c” and “k” (highlighted in red) have been selected for formal evaluation.

**Pre-Course Activities**

The first part of the tool reminds the instructor to review previous evaluation/assessment data along with the Program Outcomes Assessment Matrix before teaching the course. Normally, prior evaluation data will be available from the extended syllabus associated with previous offering of the same course. If not, this information can be gathered by interviewing previous instructors and/or the department chair. The review is documented with dates, comments, and recommendations regarding the upcoming course, including changes to lectures, homework/lab assignments (if applicable), projects, quizzes and tests. This is demonstrated in Figure 4 below. Non-bold entries represent data provided by the instructor.
**Evaluation and Assessment Activities**

*Before teaching this course, do the following (done annually, in Aug or Dec):*

Review previous evaluation/assessment data (should be recorded at end of previous offering’s syllabus), and the current Program Outcomes Assessment Matrix. Based on the review, update program outcomes and/or course content as necessary. Supply dates and comments below.

Review completed on 8/19/08. Analysis and recommendations are:

1. **Program Outcomes Assessment Matrix:**
   
   No additions or deletions of outcomes and no changes to coverages of existing outcomes are recommend.

2. **Lectures:**
   
   The lectures for this course are in good shape. Based on last year’s course evaluation, I’m adding both the Freescale CPU12 Reference Guide and the Freescale CPU12 Reference Manual documents as required texts (I will be supplying them to the students).

3. **Labs:**
   
   The lab topics will stay the same as last year, with one possible exception. Depending on the final project (which will most likely be an autonomous robot) I will either create a new speed controller lab, or use the PWM lab from last year.

4. **Final project:**
   
   I intend to have the students do an autonomous robot this year, but will entertain the idea of interfacing and controlling the Mitsubishi 6-axis industrial robot instead. The final decision will be based on student input and will be made shortly before the project proposals are due (currently set for 10/30/08).

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**Figure 4. Pre-course review and comments, completed before teaching a course**

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**Post-Course Activities**

After teaching a course, the instructor is guided through two complimentary assessment and evaluation activities. Both are explained below.

1. **Sampled Assessments.** This section documents the results of using the various assessment instruments associated with the course. A single instrument may cover multiple POs, and may contain multiple elements pertaining to the same PO. Regardless, only POs selected for formal sampling (POs with weightings of 4 or 5 as documented in the “Program Outcomes Assessment Matrix”) are covered by these instruments. As shown in Figure 5, a “Standards of measure and resulting judgments” table associated with each instrument is included in the tool. The table lists the specific POs covered by the instrument, all metrics used by the instrument in assessing the PO, the standard of measure used in the assessment, and the final judgment (evaluation result). Assessments can be objective or subjective, and the tool provides hints on how to rate a PO using either type. Figure 5 continues our example by showing how one instrument (“Microprocessor-based final project”) was used to evaluate POs “c” (“ability to design a digital system”) and “k” (“ability to use modern engineering tools”). Accompanying each table is a narrative describing the rationale for all subjective
judgments, a critique of the assessment instrument itself, and a review of the instrument’s indicators, including comments on how well the indicators ensure outcomes are being achieved and how such indicators might be revised in the future.

<table>
<thead>
<tr>
<th>Instrument: Microprocessor-based final project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standards of measure and resulting judgments:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Indicator/metric</th>
<th>Objective/Subjective</th>
<th>Standard</th>
<th>Judgment*</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>Percentage of projects that satisfactorily address all phases of the design process (proposal, requirements, design, build, test, delivery)</td>
<td>Subjective</td>
<td>80%</td>
<td>Very High</td>
</tr>
<tr>
<td>c</td>
<td>Aggregate average percentage of students on each team who made substantial technical contributions to the design of the project.</td>
<td>Subjective</td>
<td>80%</td>
<td>High</td>
</tr>
<tr>
<td>k</td>
<td>Percentage of students who scored &gt; 70% on the state-machine portion of the final design.</td>
<td>Objective</td>
<td>80%</td>
<td>Met (87%)</td>
</tr>
</tbody>
</table>

*Subjective measurements represent Very Low, Low, Medium, High, or Very High probability that the standard was met. Objective measurements are Met or Not Met and should include the achieved score.

Rational for judgments (if subjective):

(Outcome c) There was only one project team this semester, and their final report shows that all phases were satisfactorily addressed, as did my personal observations of their work during the project phase of the course.

(Outcome c) As the team was somewhat small this semester, team members did considerable amounts of work to complete the final project. They equally divided the design, construction, and reporting tasks.

(Outcome k) The students used Solid Edge to create the initial structural design for their robot, used the Freescale Codewarrior programming tool suite to design and debug their robot software, and used the Axiom USB BDM programming pod to download code into the robot/microprocessor in situ, without the need to remove the CSM-12C32 development module from the robot.

Critique of the assessment instrument:

The final project is a sound and accurate measure of our students’ ability to “design digital systems that meet a performance specification representative of current industry practice.” No changes are recommended.

Review and revise the assessment instrument’s indicators to ensure outcomes are being achieved:

“Percentage of projects that satisfactorily address all phases of the design process (proposal, requirements, design, build, test, delivery)”: This indicator accurately assesses the necessary breadth of exposure our students receive to a full-scale engineering project. No changes to this indicator are recommended.

“Aggregate average percentage of students on each team who made substantial technical contributions to the design of the project.”: This indicator accurately assesses our students’ ability to successfully contribute to an engineering project team. No changes to this indicator are recommended.

“Percentage of students who scored >70% on the state-machine portion of the final design.” This indicator accurately assesses individual team members’ ability to apply basic state machine techniques to the design of a digital system. No changes to this indicator are recommended.

Figure 5. Sample assessment instrument results

2. Evaluation and Comments on Non-Sampled Outcomes. This section includes a narrative of the entire course, including instructor comments on non-sampled outcomes (remember, a course may cover several POs, but not all may be selected for formal sampling). As the
example of Figure 6 shows, comments typically cover the basic structural elements of the course, such as “Lectures,” “Labs,” etc., and include recommendations for improving future offerings of the course. In practice, this section is most helpful during the review that occurs before the course is taught again.

**Provide an “Evaluation and Comments” narrative of the course, including comments on non-sampled outcomes, along with recommendations for improving future course offerings.**

Another great semester! This year the class size was down, but the students were quite capable and motivated, and did well in most areas of study. The quizzes gave them a bit of trouble. I think future classes simply need a bit more warning about the need to score well on the quizzes, and their weight in the overall grade. The end-of-semester student evaluations were quite positive, with students rating themselves (accurately) in all areas. No outstanding issues and no unsatisfactory ratings were noted.

**Non-sampled outcomes:** As in previous semesters, the students successfully applied mathematics to solve engineering problems in a variety of ways this semester (notably in the characterization of IR sensors, the application of \( y = Ax + B \) correction factors to sampled sensor data and the linearization through fuzzy logic of highly non-linear input data.

**Lectures:** The lectures are in great shape, and coincide quite well with the labs. The Cady text is still a great choice and I recommend using it next year along with the Freescale User’s and Reference manuals.

I added a second midterm this semester to cover C programming and the various I/O modules and functions such as SCI, PWM, etc. (basically, topics between the first midterm and the start of the final project). The test results were somewhat disappointing (average was only 72.0). I think they need one or two more quizzes before this second midterm, and possible one or two homework problems focused specifically on RS232 decoding and transducer interfacing. (*NB:* We did a detailed in-class exercise concerning transducer design, but they still missed this on the midterm—they need more practice!)

**Labs:** Labs went very well this semester—pacing was fine and content matched lectures quite well. The only “hiccup” occurred during the IR sensor lab. A previous group of students had cut one of the configuration traces on the CSM-12C32 development modules, causing the ATD subsystem to lose it’s internal 5.0VDC reference voltage. This turned out to take the entire lab period to discover, but since the final project also required using the ATD subsystem to read IR sensors, I didn’t require them to complete that lab.

**Final Project:** The results of the final project were very good, as was the project design report. The *revised* project proposal was good, too, but only after they tanked the initial assignment (they earned 60/100). After returning the assignment to them, we did an extensive review of their submission and compared it to the requirements they were given. Many items were poorly addressed or not included at all. They asked if they could turn in a revised proposal and I agreed (10% late penalty). The revised proposal was a great improvement! I suggest giving future classes a sanitized version of this year’s (revised) proposal as a model.

**Figure 6. Evaluation and comments on the overall course and any non-sampled outcomes**

**Conclusions**

While appearing rather simple in nature, this tool has proved extremely helpful in planning, organizing and sustaining our department’s ongoing program improvement efforts, especially during the run-up to our successful 2009 ABET program accreditation. The tool provides a common basis for evaluation across all program courses, adds ease-of-use and transparency to our evaluation efforts, and produces a concise, useful set of program evaluation data.
Instructor feedback within the department has been quite positive. Instructors report an increase in course visibility, better and more efficient course planning, better course assessments and evaluations, and reductions in the time required to perform end-of-course evaluations. Also, the EECE program director (in our case, the EECE department chair) reports increased program visibility, more consistent reporting across all courses in the program, and a greatly improved process of on-going data gathering, analysis, and program evaluation.

Bibliography

1. ABET, [www.abet.org](http://www.abet.org), 2009
2. ABET Member Societies, [www.abet.org/gov.shtml](http://www.abet.org/gov.shtml), 2009