A Plan for Addressing ABET Criteria 2000 Requirements

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Abstract

This paper presents a simple plan to enable engineering programs to begin preparing for ABET Criteria 2000. It is aimed at engineering programs that have done no more than simply read the new criteria. The paper focuses on Criteria 2 and 3 of the new accreditation standard, two criteria that represent the major change from the old accreditation requirements.

Introduction

The new ABET Criteria 2000 [1] for accreditation of engineering programs is scheduled for full implementation in Fall 2001. Inherent in the new accreditation system is an on-going process of assessing the quality of the program and a focus on continuous improvement. The quality of an academic program is defined in terms of the objectives of the program. Since different programs have distinct objectives and operate in a variety of environments and cultures, Criteria 2000 allows academic programs the freedom to define their own individually tailored assessment plans. Understandably, ABET has been reluctant to specify a model plan for implementation. This would have the undesirable effect of curbing innovation and novelty among various academic programs.

To introduce the requirements of Criteria 2000, some conferences and workshops have been organized by ABET, ASEE, and NSF-supported engineering coalitions. Besides learning about the new Criteria, attendees have had an opportunity to share the experiences of academic programs that are further along on the learning curve. Notable among these are engineering programs that have recently been evaluated or will be evaluated this year under the new Criteria (Worcester Polytechnic, University of Arkansas, Michigan State University). In addition, experts from the fields of educational psychology, educational assessment, and institutional assessment have spoken at these meetings to help us cope with the new assessment terminology and procedures required under the revised accreditation criteria. This paper is an attempt to develop an illustrative plan for tackling the new requirements of Criteria 2000, namely, the emphasis on program objectives and the assessment of student learning outcomes.

The paper is aimed at engineering programs that have done no more than simply read the new criteria. No reference will be made to the four most dreaded terms in assessment practice: assessment rubrics, longitudinal tracking, verbal protocols, and triangulation! Some of the material presented here is based on a guide to outcomes assessment prepared by SUCCEED (an NSF engineering education coalition) [10], Leonard and Scales' work at Clemson University [6], and is influenced by several presentations made at the Rose-Hulman workshop, FIE conferences, and the ASEE/ABET conference held last summer [for example, 3, 7, 9]. The paper pays special attention to Criterion 3 of the accreditation standard, that is, outcomes assessment. This Criterion

has caused the most confusion and debate within the academic community. The ideas presented in this paper are intended to ease the transition from the old ABET guidelines to the new Criteria.

Changes in ABET Criteria

Since academic departments are familiar with the old accreditation criteria and know how to respond to them, it will be helpful to review briefly, what has remained unchanged and, how Criteria 2000 is different. These changes are summarized below.

What remains unchanged?

1. Required professional component of 1 year of Mathematics/Basic Sciences and 1½ year of Engineering Topics
2. Need for documented processes for admissions, transfer, graduation of students
3. Need for General Education component that complements the technical content of the program
4. Emphasis on the number, qualifications, experience, and diversity of faculty
5. Adequacy of classroom, laboratories, and computing facilities
6. Strength of institutional support and leadership of program
7. Adequacy of financial resources for facilities, maintenance of equipment, and development of faculty

What is new in ABET 2000?

1. No required minimum Humanities/Social Sciences credits (although your institution may have minimum credit requirements in Humanities and/or Social Sciences)
2. Calculus, General Chemistry and Calculus-based Physics are not explicitly required
3. Need to define outcomes corresponding to university/program objectives and measure them
4. Use of assessment results to guide curriculum reform and to further improve the program
5. Program criteria may have changed -- For example, IIE's program criteria have been revised

Although ABET no longer requires programs to satisfy minimums in Humanities and Social Sciences, these courses will still remain in engineering curricula in order to comply with some of the outcomes expected in Criterion 3 and to provide general education breadth. Clearly, engineering disciplines will the require a substantial amount of Calculus. However, programs are free to consider other mathematics coursework instead of Calculus if that supports their individual program objectives.

We now consider Criteria 2 and 3 of the new standard. Before strategies for addressing each criterion, the statement is reproduced directly from the most recent version of the ABET document.

ABET Criterion 2: Program Educational Objectives

Each engineering program for which an institution seeks accreditation or re-accreditation must have in place: (a) detailed published educational objectives that are consistent with the mission of the institution and these criteria, (b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated, (c) a curriculum and process that ensures the achievement of these objectives, (d) a system of ongoing

evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

Criterion 2 stresses the need to have formally approved program objectives that are published in an official document. Often, academic programs do have published objectives but various academic processes (curriculum revision, transfer credit evaluation, etc.) remain oblivious to and mostly independent of these objectives.

To ensure compliance to Criterion 2, the following steps should be taken. First, determine if your program has formally approved and officially published educational objectives. If you do not have program objectives that are formally approved and published, a special faculty meeting should be arranged to discuss and agree on a set of objectives. Before finalizing the list of objectives, verify that the program's objectives are consistent with the University and College's objectives. For instance, if the University has, as one objective, an emphasis on globalization of the curriculum, then your program objectives should not include one that only emphasizes issues relevant to the local community and diminishes the importance of the global community. Once approved by the faculty, these objectives should be published (the appropriate place for disseminating objectives is through the University bulletin). Moreover, there must be a plan to periodically (say, once every two years) review these objectives and ensure that they serve the needs of the constituencies you serve. Most importantly, all academic processes must be geared towards the achievement of these objectives. A simple method of addressing this in, say, curriculum revision, is institute a requirement that any proposed change in course content should describe how it affects achievement of one or more objectives.

ABET Criterion 3: Program Outcomes and Assessment

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program are being measured. Evidence that may be used includes, but is not limited to, the following: student portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

Engineering programs must demonstrate that their graduates have: (a) an ability to apply knowledge of mathematics, science and engineering, (b) an ability to design and conduct experiments, as well as analyze and interpret data, (c) an ability to design a system, component or process to meet desired needs, (d) an ability to function on multi-disciplinary teams, (e) an ability to identify, formulate, and solve engineering problems, (f) an understanding of professional and ethical responsibility, (g) an ability to communicate effectively, (h) the broad education necessary to understand the impact of engineering solutions in a global/societal context, (i) a recognition of the need for and an ability to engage in life-long learning, (j) a knowledge of contemporary issues, (k) an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

A workable outcomes assessment plan should include the following components.

1. List desired student learning outcomes.
This will include the outcomes prescribed in Criterion 3 as well as other outcomes resulting from either the objectives of the institution or the academic program or from the Program Criteria specified by the appropriate professional society. As example, the industrial engineering department at our university will need to add the following two outcomes to the eleven listed above:

- motivation to pursue graduate study (resulting from the published objective of the academic program which states that "our graduates will have the background and motivation necessary for post-baccalaureate study in industrial engineering").
- ability to design, develop, implement and improve systems that include people, materials, information, equipment and energy (arising from the specific Program Criteria stipulated by the IIE [5]).

2. Select outcome indicator(s) for each outcome
An outcome indicator as defined by Leonard and Scales [6] is a qualitative or quantitative device to determine the degree to which program outcomes have been achieved. Examples include test scores, survey averages, portfolio evaluation scores, etc. Inherent in the concept of an outcome indicator is the choice of an appropriate assessment tool.

3. State curricular practices relevant to the outcomes
Review curriculum to examine what is presently being done to enable the fulfillment of the program objectives and the realization of the desired outcomes.

4. Specify a performance target for each outcome indicator
The performance target is the expected achievement level of the outcome indicator at the next assessment. It is a numerical value (analogous to a "set point" in Control Theory) that the actual results will be compared with.

5. Schedule the assessment activity
For each type of assessment, specify who is responsible, when (how often) will the assessment be done, and who will receive the results of the assessment.

6. Continuous Improvement
Based on the results of the assessment and a comparison of the actual results with the performance target, the faculty (or the curriculum committee) should discuss strategies for reducing the amount of under-achievement of the performance target. If the performance target is exceeded, there needs to a discussion of whether the target itself should be raised for the next assessment cycle.

All data, reports and minutes of meetings should be stored for future reference. In an on-going study of this type, the only way to study the effectiveness of a particular strategy is to go back and review what was done in the past. In any case, these records will be vital to demonstrate your intentions and actions to your ABET evaluator.

Illustrative Examples

The plan outlined above is illustrated through two example outcomes. The two outcomes listed here include one that is translated from one of the objectives of our university, and the other is an explicit ABET required outcome. Note that it may be possible to merge two or more objectives into a single outcome. On the other hand, one objective may give rise to a number of outcomes. For example, see the Self-Study Report submitted by the industrial engineering program of Georgia Tech [4].

Example 1

Statement of Objective

To help students to improve their interpersonal and communication skills [NC A&T Objective as published in the University Bulletin]

Outcome

Graduates of the BSIE Program will have the ability to communicate effectively

Outcome Indicator

Communication ability score on written report and oral presentation of capstone design project.

Curricular Practices

Students are assigned projects in INEN 335, 415, 420, 432, 424, 490, and 495 in which they are expected to present their approach and recommendations, both orally and in the form of a technical report.

Performance Target

At least 80% of the students will receive a score of 7 or more on a 10 point scale.

Assessment Schedule

Scored by instructor and industry sponsor using a standard form. Every student will be evaluated at the end of each semester. The report of aggregate student scores on written and oral ability will be submitted to the undergraduate program committee chair.

Continuous Improvement

Suppose only 60% of the students had a score of 7 or more. What needs to be done? Increase opportunities for oral presentations; invite model speakers in seminar classes; arrange coaching classes on public speaking, etc.

Example 2

Statement of Objective

None

Outcome

Engineering graduates will have an ability to apply knowledge of mathematics, science and engineering [ABET 2000 Criterion 3(a)]

Outcome Indicator

Passing rate on the Fundamentals of Engineering (FE) Examination administered by the NCEES.

Curricular Practices

All required engineering courses teach how to use knowledge of science and mathematics to model real life problems in industrial engineering. Homework, Quizzes and examinations test the students' ability to apply this knowledge.

Performance Target
At least 75% of the Seniors who take the FE Exam will pass it.
Assessment Schedule
The Associate Dean of the college of engineering will request the FE exam scores of each student from NCEES during April every year. The report will be categorized by department and by student performance on different subjects tested on the exam and forwarded to the department chair.
Continuous Improvement
Suppose only 50% of the Seniors pass the FE Exam. What should be done?
Identify which subject areas did our students under-perform in? Find ways to increase number of students who take this particular course. Alternately, include this material in existing course(s) in an interesting and meaningful way.

Choice of Outcome Indicators for Mandatory Outcomes

The selection of appropriate outcome indicators or assessment instruments is an important question. The engineering education community is just beginning to understand the variety of tools that are available and, in particular, the suitability of a specific tool for measuring a given outcome. For most of us who are novices in assessment practices, the following recommendations should suffice, at least during the initial assessment cycle.

My proposition is that all the required ABET outcomes can be effectively measured with just three instruments -- the FE examination, student portfolios and the capstone design project. The following lists categorize each of the eleven required ABET outcomes into one (or more) of these three instruments. In the interest of space, the outcomes are expressed in abbreviated form and use the same label as used in ABET Criterion 2000.

<u>FE Examination</u>:
a. ability to apply knowledge
e. ability to solve engineering problems

<u>Student Portfolios</u>:
b. ability to design experiments and interpret data
c. ability to design a system
f. professional and ethical responsibility
g. communication skills
h. global and societal context
i. life-long learning
j. knowledge of contemporary issues
k. ability to use modern tools

<u>Capstone Design Project</u>:
a. ability to apply knowledge
c. ability to design a system
d. team ability
g. communication skills

The performance of students in the FE examination is clearly a useful measure of the students' ability to apply knowledge and to solve problems. Portfolios can be a versatile outcome indicator for tracking a number of outcomes. An independent and expert evaluator or a team of evaluators will be needed to judge the enhancement of these abilities. For instance, a faculty member in the English department can be called upon to rate student writing samples in the portfolio. A recent article by Olds [8] provides a good starting point for building portfolios. Although the paper is directed towards student writing assessment, the same ideas should work with any type of portfolio. Finally, the performance of the students on the senior capstone project as evaluated by a team of program faculty can assess the remaining outcomes.

Finally, there remains the larger question of what should be done when the assessment results indicate unsatisfactory achievement of outcomes. It will be up to the creativity, motivation and time available within the academic department to come up with suitable strategies. It appears that most of this effort on continuous improvement will center on curriculum renewal. A starting point to analyze the existing curriculum and designing curriculum changes can be found in [2].

Teamwork Within the Engineering College

The responsibility for assessment of a program and curriculum reform rests with the individual academic department. Yet, there can be a considerable advantage in cross-departmental teaming to facilitate these activities. At North Carolina A&T, the "ABET 2000 Planning Committee" (consisting of the Undergraduate/ABET Coordinators of each academic program) is considering how assessment work can be shared. For instance, we plan to administer a single survey of our employers instead of sending out one from each department. This not only reduces administrative overhead, it also reduces the potential irritation of the companies when they are flooded by numerous surveys, all asking essentially similar questions!

Resources

A very important aspect of any plan is the allocation of resources. Each academic department will need to allocate significant faculty release time (say, 25%) to at least one individual who will lead the assessment effort. In addition, resources will be needed for training, and travel to workshops being organized under the auspices of ABET, ASEE, NSF and others.

Closing Statement

I close with two personal opinions. One, most faculty are not willing to invest the time and effort to learn "all there is learn" about assessment and then apply that knowledge to actual assessment on their campus. However, given that 2001 is only three years away, it is important to begin the assessment activity now, even though we have not yet mastered all the intricacies of the assessment discipline. Instead of first learning everything about assessment and then using the expertise to initiate the assessment work within our program, it may be helpful to take, initially, a simple approach to assessing outcomes and then "learn on the job." Second, I doubt that ABET evaluators will necessarily be looking for "how good were your strategies or by how much did you increase your scores." That would be tantamount to yet another chapter of beancounting by the evaluators. Instead, they will be looking for the faculty's overall level of commitment to improve the academic program while using the ABET Criteria as a systematic guideline.

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