POSITION PAPER: PROGRAM OBJECTIVES, OUTCOMES, AND ASSESSMENTS: A CALL TO RETHINKING THE ABET CRITERIA

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Abstract

It has been more than a decade since ABET introduced the Engineering Accreditation Criteria. The key differences with the earlier set of criteria were that, on the one hand, specific curricular requirements were eliminated or considerably reduced; and, on the other hand, programs were required to meet new requirements with respect to program objectives, student outcomes, and assessments. The reasons for the changes were that the earlier criteria were considered too rigid and forced programs to devote too much time and resources to meet their requirements. While the flexibility of the new criteria with respect to curricular requirements has been welcomed by programs, this position paper argues that the new requirements with respect to objectives, outcomes and assessments have turned out to be extremely burdensome for programs to meet. Moreover, the paper also argues that these requirements have not had any positive impact on the programs, certainly nothing proportional to the large amount of resources that programs have had to devote to meeting them. This paper calls for a fundamental rethinking of the criteria.

Introduction

It has been over a decade since ABET introduced, following extensive discussions, the Engineering Accreditation Criteria, henceforth EC. The motivations for designing a new set of criteria were, primarily, the following issues:

1. The existing accreditation criteria were too long and encouraged a rigid, bean counting approach that stifles innovation;
2. The existing accreditation process demanded excessive time commitments;

Item (1) referred, in particular, to detailed curricular requirements that were part of the earlier criteria. Item (2) referred to the fact that programs had to devote considerable time and effort to demonstrate that every single, detailed requirement was, in fact, satisfied. Following a number of meetings and workshops where these (and related) issues were discussed, the first version of EC (then called EC 2000) was introduced. The "bean-counting" curricular requirements were eliminated; but new requirements with respect to objectives, outcomes, assessments, and program improvements based on the results of the assessments were introduced.

While the flexibility of the new criteria with respect to curricular requirements has been widely welcomed, the new requirements have presented major challenges to programs. While one could have perhaps attributed the problems of the first few years following the introduction of the new criteria to the natural problems one can expect when such major changes are introduced, the fact is that many programs, several of which have gone through or are going through a second evaluation under EC, have major difficulties with the criteria related to objectives, outcomes, and assessments as reported by ABET's own statistics as well as in such papers as [1]. In this paper, we explore some of these difficulties and argue that the real problem lies not with the programs in question but with the criteria; and that a fundamental rethinking of the criteria is urgently called for.

Program Objectives

The criterion related to program educational objectives (PEOs), in particular the EC definition of the term, is rather curious. The classic definition of the term "educational objectives" comes, of course, from Bloom's work [2]. Although that work has since been refined in some respects, the basic idea that educational objectives refer to specific abilities/skills (such as analyzing, classifying, etc.) that we want students to acquire in specific topics or domains, is what is generally understood by the term. And, indeed, when EC was originally introduced in the late nineties, this was more or less the sense it was used in. However, around 2003-2004, ABET redefined the term to mean, "description of what graduates of the program are expected to attain within a few [typically 3-4] years of graduation". Such non-standard definitions not only lead to con-

fusion, this particular definition serves no useful purpose either. For example, it results in such PEOs (in the case of Purdue's ECE programs [3]) as:

The objective of the BSEE and BSCmpE degree programs is to prepare graduates who will be successful in their chosen career paths. Specifically, graduates of these programs will be capable of achieving success in post-under-graduate studies as evidenced by:

- satisfaction with the decision to further their education;
- advanced degrees earned;
- professional visibility (e.g., publications)
- international activities (e.g., conferences, research, etc.)

and success in the profession as evidenced by:

- career satisfaction;
- promotions/raises;
- professional visibility (e.g., presentations);
- entrepreneurial activities.

Other than in the initial clause that says these are the objectives of the Electrical Engineering (EE) and Computer Engineering programs, there is absolutely no indication of what field these objectives refer to! They could be the "PEOs" of a program in anything from anthropology to zoology! What exactly does anyone learn about the Purdue programs by looking at these "objectives"? Not only does ABET require each program to come up with such PEOs, the program is required to periodically "review" and "revise" them using a process that involves the program's constituencies. Why? Is it likely, for example, that a program's constituency might decide that "career satisfaction" is no longer important and should be scratched from the list?

The criterion serves no useful purpose. Anyone who has spent even a short amount of time in any domain of engineering or technology would agree that the main objective of any program in the domain should be to ensure that its students are, to the best of their abilities, well grounded in the essential principles of whatever field of engineering the program is focused on, and to ensure that they are well prepared for professional practice, and perhaps for advanced study in the field. One could perhaps argue that it may be useful for a program to determine what its educational objectives should be, rather than

having to accept something like the ones stated in the preceding sentence. But any program that wanted to do this could certainly do so even if the criterion did not exist so this is not an argument that justifies the criterion. In any case, what does not make sense is to use a definition, such as the one ABET has adopted, for the term PEOs, that leads to objectives such as Purdue's. We should add that this is not intended as a criticism of Purdue's programs which are among the best. Rather, it is a criticism of Criterion 2 of EC. The criterion should be abandoned or, at least, ABET should revert to a standard meaning of the term program objectives.

Student Outcomes

One item that has remained constant in EC since it was originally introduced are the *student outcomes* (SOs), (a) through (k) of Criterion 3. Over the years, though, the importance that ABET and program evaluators attach to these outcomes has steadily gone up. Originally, programs were encouraged to come up with their own SOs and map them to (a) through (k). More recently, program evaluators seem to expect these specific outcomes included explicitly in the program's set of SOs. And, indeed, the guidance that ABET provides to evaluators seems to suggest just that. In one respect, this is helpful since programs do not have to go through an elaborate process, as in the case of PEOs, to arrive at their SOs.

On the other hand, several of the (a)-(k) outcomes are much too broad and imprecise. Consider, for example, outcome (a): *the program must demonstrate that its students attain an ability to apply knowledge of mathematics, science, and engineering.* Wouldn't every single component of a typical engineering program (other than its general education portion) contribute to this outcome? In fact, why would a program even consider including, in its curriculum, a component that did *not* contribute to it? Or outcome (e): *the program must demonstrate that its students attain an ability to identify, formulate, and solve engineering problems.* Isn't that essentially equivalent to saying that it must be an engineering program? What else would an engineering program do *other than* developing its students' abilities to identify, formulate, and solve engineering problems?

Would any engineering program in a legitimate college come even close to *not* meeting such broad

outcomes? Note that the outcomes do not specify what level of ability students must attain in these outcomes, just that they must attain "an" ability. One could argue that the reason for such imprecision is to afford individual programs flexibility in determining which outcomes to stress over which others. That may be true but the criterion does not, in fact, require that if one outcome is achieved at a low level of ability, the level of achievement of another must compensate for it.

One also gets the impression that ABET recognizes these potential problems in Criterion 3 and it is for this reason that Criterion 5, Curriculum, requires the program to include, in its curriculum, some very clearly identified pieces. Thus, the main part of this criterion requires that the professional component of the program include: one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline...; one and half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study; students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and multiple realistic constraints.

To put it differently, it is not clear how a program whose curriculum includes the courses required by the Curriculum criterion –assuming also that these courses are legitimate courses that pass ABET program evaluators' inspection during the site visit– can possibly fail to ensure that its students achieve outcomes such as (a) and (e). So if these curricular components are required, what purpose is served by Criterion 3?

Assessments

Perhaps the aspect of EC that programs have struggled the most with is Criterion 4 which requires programs to use documented processes for assessing and evaluating the PEOs and SOs and use the results of the evaluations to effect program improvements. The many papers in the ASEE and FIE Annual Conferences, indeed in the number of sessions at these conferences devoted to discussions of ways to meet the assessment requirements of EC , the annual Best Assessment Processes (BAP) Symposium devoted to the topic, etc., all speak to this struggle. Here too

the EC requirements have evolved over time. Originally, programs were allowed to rely heavily, even entirely, on such assessments as alumni surveys and exit-surveys of graduating seniors to carry out the assessments. But since about 2003, these *indirect* assessments are no longer considered adequate by themselves. Instead, programs are required to use some *direct* assessments which are based on assessment of actual student work.

In response, a typical approach that programs have adopted is to use *targeted questions* in examinations in particular courses in the curriculum, see, for example, [4, 5]. In more detail, particular courses in the curriculum are identified, and particular topics in those courses are associated with specific student outcomes. The faculty teaching the course are then required to ensure that the examinations (or quizzes etc.) in each section of such a course that they teach includes questions specifically targeted to those topics. The faculty are then required to provide a summary of the student performance in those questions. This summary is considered as providing the assessment data with respect to the particular outcome. Self-study documents for ABET evaluation provide summary tables of all the data, "proving", for example, that over 70% of the students in the program achieved outcome (a) of Criterion 3. Isn't that shocking?! Doesn't it mean that 30% of the students in the program did *not* attain *an* ability to apply knowledge of mathematics, science, and engineering?!

That is ridiculous, of course. What happened was that the program randomly picked a handful of questions from one or two particular courses and declared that student performance in *those* questions is the assessment of outcome (3.a). In fact, of course, given the breadth of this outcome, the *entire* curriculum contributes to it! Thus the only way to assess the extent to which the outcome is achieved would be to assess every single part of every course in the curriculum and somehow "add" them all up! In any case, self-study documents present these tables of numbers proving that the program has assessed the level of achievement of these incredibly vague and broad outcomes. Truly the proverbial "counting the number of angels who can dance on the head of a pin"! Moreover, the entire activity typically collapses after a couple of years since the task is a major burden on the instructors whose courses get "targeted"! If the program is lucky, the ABET evaluation is complete by then and the program faculty can

breathe a sigh of relief and get back to their classrooms and the real task of working with their students!

Summary and Proposal

The idea of careful assessment of various aspects of a course or a curriculum, evaluating the assessment results to identify weaknesses in it, and using the evaluation to come up with possible improvements can be a useful activity. However, requiring every program to have a continuing documented process to assess the extent to which the vague and broad outcomes of Criterion 3 are achieved and document the assessment results etc., has resulted in an enormous amount of completely meaningless activity in engineering programs across the country. Faculty who are responsible for getting their programs ready for the next ABET evaluation will (confidentially) attest to this. We, as engineering and computing educators, need to ask, what evidence is there to show that all of this activity has resulted in actual improvements in the programs?

The single study [6] that has been published regarding the impact of EC claims that the impact has been positive. But many of the items that the report looks at seem hardly related to the specific portions of EC that cause the most burdens, and the least rewards, for the programs. For example, one of the charts shows that the number of faculty who report using computer simulations in their courses has gone up considerably. But this has absolutely nothing to do with any of Criteria 2, 3, or 4. Interestingly, according to the study, employer perceptions of graduates' abilities with respect to some of the Criteria 3 outcomes has actually diminished from a few years before EC to a few years after EC!

It is time to rethink these three criteria from the ground up. Criterion 2 serves no useful purpose and should be omitted. Criterion 3, if it is to be retained, needs to be revised carefully so that it specifies useful outcomes, not the overly broad ones that are in it now. Criterion 4 needs to be revised carefully. If engineering faculty are required to continue producing nonsensical tables showing the percentage of their students who have achieved "an ability to formulate and solve engineering problems" on the basis of their performance in a couple of questions in a couple of courses in the curriculum, both faculty and students will lose all faith in the value of accreditation. It is the *criteria*, not engineering and compu-

ting programs, that are urgently in need of serious improvement.

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Biographical Information

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