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Improving How We Develop and Assess Program Educational Objectives and Student Outcomes for ABET Accreditation

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Abstract

Developing program educational objectives (PEOs) and assessing student outcomes (SOs) to support continuous program improvement and to meet accreditation criteria can be challenging for engineering departments and programs. Departments must navigate a wide range of acceptable approaches as many accrediting agencies, including ABET, continue to update their expectations. However, as programs mature, they will typically gain a deeper understanding of and a better appreciation for outcomes-based assessment. In this paper, we present methods of developing and assessing PEOs and SOs that we believe to be clear, logical, practical, and impactful. As we will discuss, we have also used them within our own departments and to mentor faculty in other engineering departments. We conclude this paper with a discussion of several case studies as well as some lessons we have learned from recent continuous improvement activities and ABET visits.

Keywords: ABET, assessment, objectives, outcomes, continuous improvement

1. Introduction

Twenty-five years ago, ABET put forth a major change in its criteria for the accreditation of engineering programs. This resulted in much distress and puzzlement for university faculty and administrators as they attempted to meet recently implemented processes and evolving expectations. Perhaps the major reason for this was that at that time, the tenets and processes associated with outcomes-based assessment were not known to many engineering faculty.

ABET has continued to update its outcomes-based assessment processes since their introduction twenty-five years ago. The organization continues to host workshops and seminars at a variety of engineering society meetings to help faculty develop compliant assessment tools and evaluation methods. However, in spite of the useful information presented through such events as well as in journal articles related to assessment, both the novice and veteran alike can be overwhelmed with options, and confused about what is expected. Furthermore, these expectations can vary from evaluator to evaluator even within a single visit team. ABET continues to address this situation by requiring would-be program evaluators to complete online and in-person training before participating in accreditation visits (Rogers, 2009). Returning program evaluators must complete annual refresher training to stay up-to-date with changes in criteria and expectations.

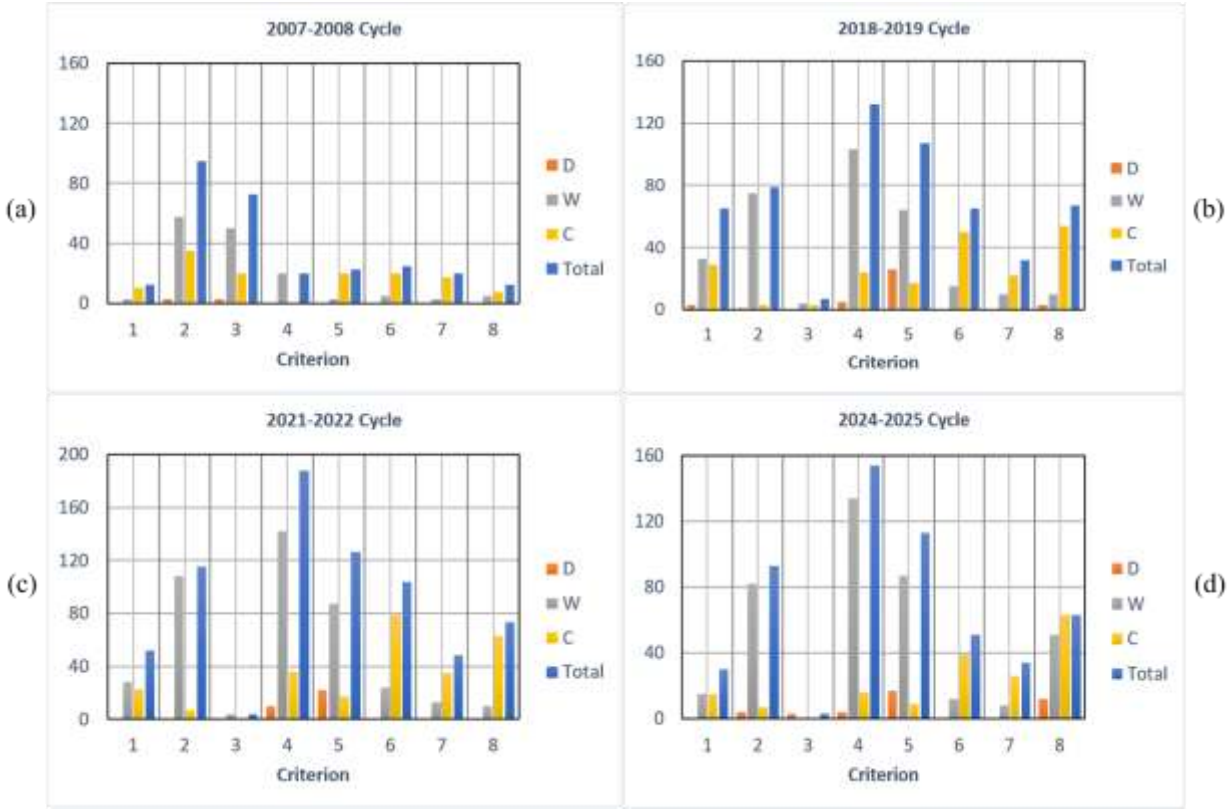
In preparation for an ABET accreditation visit, a program's self-study report must discuss three key elements: program educational objectives (PEOs), student outcomes (SOs), and continuous improvement processes. One might expect, then, that the literature would be replete with many examples of successful approaches used to develop and assess PEOs and SOs. However, a significant lack of actionable information remains for both new programs and established ones seeking process improvement. Even publications with “develop” or "developing" in their titles typically just urge readers to draft PEOs and SOs that match current ABET requirements.

For example, while Khan et al. (2016) discuss what PEOs and SOs should be as well as the differences between them, they merely present a final set of each without discussing the processes they used to develop them. Employing a somewhat difference approach, Yahya et al. (2021) use a dataset of PEOs from ABET-accredited engineering programs, and following an analysis of the relationships between PEOs and SOs, highlight important features of each. Many publications do, however, present a myriad of assessment tools, ranging in complexity from simple to highly sophisticated, that either has been successfully used by a particular program to support a recent ABET review (see, e.g., Abualkishik et al., 2022; Avelino & Sto Domingo, 2023; Horiuchi & Sotomayor, 2020; Mahajan & Bansal, 2023; Shafi et al., 2019) or is a synthesis of other approaches used by several other programs over the past few years (Yahya et al., 2021). Robinson and Hensel (2015) develop a student outcomes assessment process that involves not only evaluating student performance, but also evaluate the appropriateness of the program level *instructional strategies* that prepare students to meet the outcomes.

As a result, and as will be evident later on, many faculty still struggle to grasp the fundamentals of ABET outcomes-based assessment processes and requirements. Both novices and veterans of the assessment process require uncomplicated methods to develop PEO and SO statements, and straightforward assessment methods that can be implemented for their assessment. In fact, for a continuous improvement process to be truly sustainable, simple assessment processes are needed to secure faculty buy-in and support from those individuals responsible for program assessment and continuous improvement.

In addition, while many universities and their engineering programs have gone through several ABET review cycles since the introduction of outcomes-based assessment, information shared by ABET at its annual meetings, training workshops, etc. shows that programs are continuing to experience difficulties primarily with a few criteria, despite the many efforts by ABET, its evaluators, and faculty who have been through the process to provide guidance as to how best to approach and satisfy these criteria.

As an example of this phenomenon, consider the information shown in Figures 1a-d and 2a-d. These figures present a series of snapshots of the number of engineering programs that were evaluated in four different accreditation cycles that experienced shortcomings, that is, either a deficiency (D), a weakness (W), or a concern (C), in the various ABET criteria (Wolfe et al., 2009; Fergus et al., 2020; Bracken et al., 2023; and, Taylor, 2026). The plots in Figures 1a-d are the number of Ds, Ws, and Cs immediately after the accreditation visit in the indicated accreditation cycles, while Figures 2a-d reflect changes made during due process and are the final accreditation statuses at the end of the indicated accreditation cycles. A closer look at the plots in Figures 1a-d and 2a-d reveals some interesting information regarding shortcoming citations in the more than 25 years following the introduction of outcomes-based assessment (formerly known as EC2000) in 1999-2000.

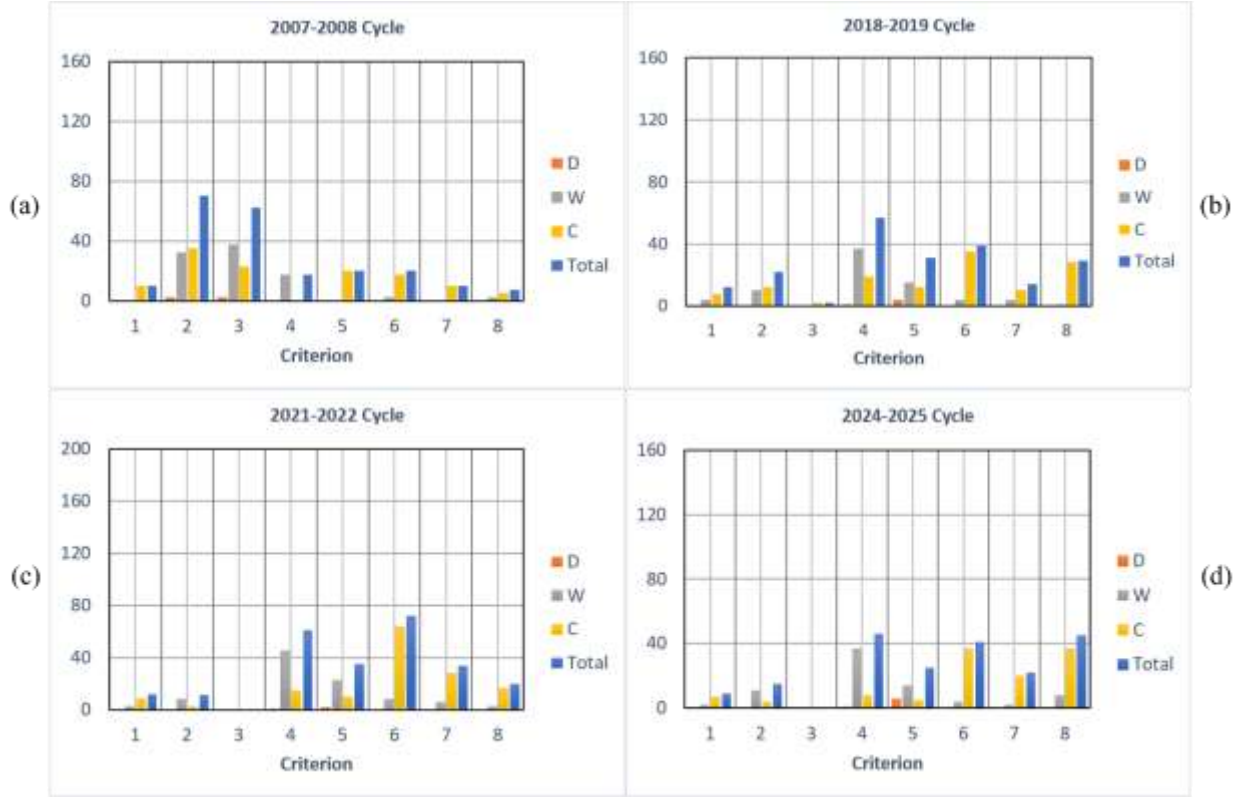


Figures 1a-d. Number of Programs with Shortcomings Immediately Following Accreditation Visits for Four Accreditation Cycles

First, it is evident in Figures 1a and 2a that, even after several accreditation cycles following the implementation of EC2000, Criteria 2 and 3 were the ones cited most often by program evaluators as those criteria with which programs struggled the most. This is likely because programs accredited prior to 1999 experienced significant difficulties coming to grips with the new terminology and processes associated with outcomes-based assessment.

Next, while the numbers of Criterion 2 and Criterion 3 shortcomings were both fairly high for the 2007-2008 cycle, the number of citations of Criterion 3 shortcomings have all but disappeared in more recent accreditation visits. This is seen by comparing the number of Criteria 3 citations in the 2007-2008 accreditation cycle with the number of such citations in the other three accreditation cycles. This dramatic reduction is likely due to ABET specifying the text of the SOs to be used by programs in Criterion 3 beginning with the 2019-2020 evaluation cycle and removing a program's flexibility to edit that text beyond minor tweaking. Whatever handful of programs that were cited has having shortcomings in Criterion 3 were most likely cited as such because they did not, in fact, use the wording prescribed by ABET for their SOs.

Third, it is important to note that, until the 2007-2008 accreditation cycle, Criteria 2 and 3 also covered the assessment of those objectives and outcomes. However, effective with the 2008-2009 cycle, assessment of PEOs and SOs are covered in Criterion 4 - Continuous Improvement. Once assessing a program's attainment of Criteria 2 and 3 was moved to be a part of Criterion 4, the number of shortcomings cited in Criterion 4 increased dramatically, as might be expected, and as is especially evident in Figures 1b-d.



Figures 2a-d. Number of Programs with Shortcomings After Due Process for Four Accreditation Cycles

Fourth, in more recent years, Figures 1b-d show that Criteria 2 (PEOs), 4 (assessment and continuous improvement), and 5 (curriculum), 6 (faculty) and 8 (institutional support) were the ones cited most often by program evaluators in the draft reports as those criteria with which programs struggled the most during those review cycles. However, Figures 2b-d show that while many of the issues with PEOs (Criterion 2) and curriculum (Criterion 5) were resolved during the due process phases of the accreditation cycles, many of the issues with the manner in which programs assessed their SOs (Criterion 4), faculty (Criterion 6) and institutional support (8) still remained, even after those programs were afforded the opportunity to address any initial (i.e., post-visit) shortcomings during the due process cycle.

Finally, a closer look at the plots in Figures 2b-d show that the high number of programs cited with shortcomings in Criteria 6 and 8 were due primarily to unexpectedly high numbers of program concerns, only a very few of which were resolved between the issuance of the draft reports and the final accreditation decisions. Alternatively, the high number of programs cited with shortcomings in Criterion 4 were due primarily to the high number of program weaknesses for this criterion, which is arguably a more serious shortcoming.

In light of available information regarding the frequency of more recent shortcoming citations, we have written this paper to continue the conversation begun by Weisbrook and Schonberg (2011), which was prepared shortly after the, at that time, relatively new ABET Engineering Criteria went into effect. As such, the lens through which that original paper was written was one where continuous improvement methodologies, including the processes used for the development and assessment or review of program objectives and SOs, were not yet fully realized or optimized.

Additionally, according to Taylor et al. (2026), the most common reasons for the shortcomings in Criterion 6 continue to be an inadequate number of faculty to support the program and the lack of faculty professional development opportunities, while for Criterion 8 they are inadequate support for labs and/or personnel and the lack of stable institutional leadership. Since faculty numbers, support for faculty development activities and laboratories,

and stability of institutional leadership are beyond faculty control, in this paper we will primarily focus on Criteria 2 and 4, which ARE within faculty control. We will also discuss Criterion 3 since satisfying that criterion is also an important part of satisfying Criterion 4.

After discussing our methodology and reviewing the major observations and findings from the original Weisbrook and Schonberg (2011) study, we will report on more recent developments at ABET and how those developments have continued to shape the continuous improvement processes adopted by engineering programs accredited by ABET. We also review and comment on the streamlined procedures for developing PEOs and SOs in Weisbrook and Schonberg (2011), as well as the focused and effective methods of review and assessment presented therein. Case studies are presented, as well as lessons learned while employing the procedures, which can serve as examples for programs either going through this process for the first time or revising the core tenets of their continuous improvement processes.

2. Methodology

This study adopts an autoethnographic approach (Reed-Danahay, 2019) to develop optimal processes for writing ABET-compliant PEOs and SOs. According to Eichsteller and Davis (2022), traditional autobiography is basically "the writing of one's own history," whereas autoethnography, seeks to "study, understand, and describe personal experiences relative to a specific setting or activity." As such, autoethnography is understood to be a subjective form of scholarship, as opposed to the more objective ethnographic endeavor, which seeks to remove the researcher or observer as much as possible from the subject being studied.

In this study, we have reflected on our personal, but informed, understanding of ABET requirements and criteria, which is based on our combined 50+ years of experience with ABET accreditation. It is this reflection upon our personal experiences (and professional ones as well) that has allowed us to create thorough yet efficient approaches to writing and assessing PEOs and SOs. We believe that the approaches we have developed are particularly suitable in academic contexts where institutions are struggling either to develop and assess PEOs and SOs for new engineering programs, or to ensure that their engineering programs remain compliant with changing ABET criteria and requirements regarding PEOs, SOs, and continuous improvement.

The experiences that have informed the development of the processes we present in this paper have included service as an ABET program evaluator (PEV) on numerous national and international visits, service as a department chair with responsibility for developing, implementing, and overseeing assessment, evaluation, and continuous improvement processes, and service as departmental and college ABET assessment coordinators. Guided by our commitments to understanding and developing processes within context, we have been able to pool our combined lived institutional experiences and interactions among faculty, alumni, and ABET leadership.

Of course, as is the case with any autoethnography study, we recognize that there are a number of limitations to our work. These include insider bias, subjective interpretation, and findings that reflect our own institutional and evaluator experiences (rather than broadly generalizable statistics-based findings and conclusions). However, we also believe that, through this autoethnographic framework, we have developed easily implementable processes that can be readily embraced by faculty as well as university administrators.

3. Definitions and Constraints

While ABET (2026) presents definitions within its criteria regarding the various terms and phrases that comprise its outcomes-based assessment and continuous improvement processes, these definitions have changed over the past two decades, sometimes subtly, sometimes dramatically. Petersen et al. (2007) trace the evolution of what ABET has meant by "objective" and "outcome", and what would constitute a comprehensive assessment process, at least over the first few years following the implementation of EC2000.

3.1 Program Educational Objectives

ABET currently defines PEOs as "broad statements that describe what graduates are expected to attain within a few years after graduation. Program educational objectives are based on the needs of the program's constituencies." In Criterion 2 (PEOs), ABET also states that programs seeking accreditation must have: "published educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies", and that " there must be a documented, systematically utilized, and effective process, involving all constituencies identified by the program, for the periodic review and revision of [the] program educational objectives that ensures that they remain consistent with the institutional mission and the needs of the program's constituencies."

In simple terms, PEOs describe what can be said to be the ultimate goal of an engineering program, which is to equip engineering students so that they are able to fulfill their responsibilities to their employers and society. Furthermore, PEOs must include input from the program's constituents, and that they must be reviewed on a regular basis to show that they remain relevant. For completeness, ABET also defines program constituencies to be those "groups, including external groups, identified by the program that have a common interest in the program and can provide meaningful input regarding the program educational objectives."

3.2 Student Outcomes

As currently defined by ABET, SOs "describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that student acquire as they progress through the program." In Criterion 3 (SOs), ABET prescribes that "[t]he program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering." Finally, ABET also explicitly states exactly what are the SOs for each program, but also does allow for an individual program to add any number of additional SOs that it feels are appropriate.

In simple terms, SOs describe the knowledge and abilities that engineering students should have at the time of graduation. Achievement of the SOs is expected to prepare students to be able to achieve the program's PEOs as skilled and knowledgeable engineers.

3.3 Assessment and Evaluation

In Criterion 4 (Continuous Improvement), ABET states that the program being evaluated "must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained." Furthermore, "[t]he results of these evaluations must be systematically utilized as input for the program's continuous improvement actions."

For the purposes of satisfying its criteria, ABET defines assessment as "one or more processes that identify, collect, and prepare data to evaluate the attainment of student outcomes." According to ABET, an effective assessment process "uses relevant direct, indirect, quantitative, and qualitative measures as appropriate to outcome being measured." Furthermore, "[a]ppropriate sampling methods may be used as part of an assessment process." The important implication of this last statement is that it is not necessary to assess the performance of every student every semester as part of a program's outcomes assessment processes.

Alternatively, ABET defines evaluation as "one or more processes for interpreting the data and evidence accumulated through assessment practices." Namely, "[e]valuation determines the extent to which student outcomes are being attained." Of course, then, "[e]valuation results in decisions and actions regarding program improvement."

Thus, the term "assessment" describes the process of acquiring data, while "evaluation" describes the process of interpreting the meaning of the data and to determining what actions to take regarding any concerns that become evident as a result of this process. Another point to note here is that ABET requires only SOs to undergo a regular, well-structured assessment and evaluation process; PEOs, on the other hand, need only be reviewed periodically and revised only if and when necessary.

Table 1 summarizes the most common reasons for shortcoming citations for Criteria 2, 3, and 4. These reasons are directly linked to key elements of the definitions for the concepts noted above. As such, we believe that as we present our approaches for developing and assessing (or simply reviewing, as appropriate) PEOs and SOs, it will be evident that many of these issues in Criteria 2, 3, and 4 can be avoided.

Table 1. Summary of the Most Common Reasons for Shortcomings in Criteria 2, 3, and 4

Review Cycle	Reference Citation	Criterion 2			Criterion 3	Criterion 4	
		PEO review process missing or incomplete	PEOs sound more like SOs	All constituents not included in review processes	All parts of (1) - (7) not used or evaluated	Process missing, not clear, or results not used	Data is not disaggregated
2024-2025	Taylor, etal. (2026)	X	X	X	X	X	X
2023-2024	Chevalier, etal. (2025)	X	X	X	X	X	X
2022-2023	Fleming, etal. (2024)	X	X		X	X	X
2021-2022	Brackin, etal. (2023)	X	X	X	X	X	X
2020-2021	Hosni, etal. (2022)	X	X		X	X	X

4. Development and Review of PEOs

4.1 Requirements for PEOs

A common concern among ABET program evaluators is that PEOs are often written too similarly to SOs, focusing on what students should know and do at graduation rather than their professional achievements after several years of employment (see again, Table 1). This can happen when faculty develop PEOs by simply combining and rewording SOs, which limits the meaningful involvement and expertise of program constituents. A more effective approach begins without predetermined statements and actively engages constituents in creatively developing PEOs that reflect graduates' long-term professional accomplishments.

4.2 Suggested Process for Developing PEOs

A flowchart for the process that begins with a focus on the needs of the program's constituents can be found in Weisbrook and Schonberg (2011). We summarize that approach herein for completeness.

Step 1. Determine your program constituents.

ABET defines program constituencies as "groups, including external groups, identified by the program that have a common interest in the program and can provide meaningful input regarding the PEOs." Note that each constituency must provide input into the periodic review of the PEOs. There may be groups that have an interest in the program from whom it would be difficult to obtain input, e.g., parents. Feel free to consider these groups as "additional stakeholders", but do not list them as constituencies unless they can input into the review of the PEOs. It is up to the program to determine its constituencies, but examples include alumni, industrial advisory board members, non-alumni supporters, employers, faculty, students, etc.

Step 2. Convene Team of Constituents

Gather 15–20 participants representing all constituencies in a spacious, preferably off-campus location where they can work in four smaller groups. Provide four easels or wall spaces for Post-it notes, along with restrooms, snacks, and lunch, and plan for a full 6–8-hour workday.

Step 3. Introduction

Begin the meeting by explaining its purpose, briefly reviewing ABET accreditation and assessment requirements, defining PEOs, and emphasizing that the goal is to develop PEO statements for the program. Do NOT provide previous PEO statements or SO statement so participants can develop their PEO statements without preconceived ideas about their content or format.

Step 4. Individual Session: Brainstorming

Give each group member a pad of Post-it notes, and ask the question, "What do you expect graduates of our program to achieve within a few years after graduation?" Alternatively, "What professional skills, competencies, and accomplishments do you expect of graduates of our program to have 3 to 5 years after graduation?" Then ask each participant to record each of their ideas on a separate Post-it note. This should take about 15-20 minutes. For key constituents unable to attend the workshop, solicit their input by email beforehand using the same introduction and questions provided in Step 2. Transfer their responses to Post-it notes and incorporate them into the ideas generated by workshop participants in this step.

Step 5. Small Group Session I: Determine Themes

Divide participants into diverse teams of three or four to share ideas, one team at a time, by posting their notes on a flipchart or wall. Have the full group discuss and organize the notes by common themes, removing any ideas considered inappropriate.

Step 6. Large Group Session: Review and Refine Themes

Reconvene the full team to review each group's findings, discuss commonalities and differences, and combine, modify, and refine the themes into a final list. The final four to eight overarching themes should represent the distinct professional skills, competencies, and accomplishments expected of graduates after three to five years of employment.

Step 7. Small Group Session II: Draft Objectives Statements

Divide the team into three to five groups, assigning each group one to three themes and the related Post-it notes. Each group should review the notes, identify the major components, and draft a broad PEO statement for each theme; each theme should be supported by bullet-point descriptors that provide specific details, which will facilitate the review of PEOs and inform any needed modifications.

Step 8. Review Statements

Present the draft statements to the entire team for comment and input. At the end of the day, your program will have a set of draft PEO statements - the majority of your work is now finished! Weisbrook and Schonberg (2011) provide an example of expanded PEOs for an engineering management program based on this process, along with statements for evaluating their appropriateness and achievement. The ABET-compliant PEOs are the opening phrases of these expanded statements – they describe what graduates are expected to achieve several years after graduation, unlike SOs, which describe what students are prepared to achieve.

Step 9. Finalize, Confirm, and Publish Statements

After the workshop, have program faculty review the PEO statements for alignment with the institution's mission and ABET criteria, using the previous PEOs to identify any essential elements that may have been omitted. Share the revised PEOs with additional constituents, department faculty, and the advisory board for feedback, make any necessary changes, and present the finalized statements to the department faculty for approval.

ABET requires programs to publish their PEOs. This can be done by posting them on the department's website and printing them in the university catalog. Save all notes and related materials from the workshop that document the process of developing the PEOs for future reference. The ABET visit team will need to see evidence that the PEOs were developed and/or reviewed by ALL constituency groups to show compliance with Criterion 2.

4.3 Periodic Review of PEO Statements

Program educational objectives should be reviewed every two or three years by all program constituencies to ensure they remain relevant and current. Programs do not need to repeat the extensive process used to develop the objectives initially. Instead, the program's industrial advisory board can review the objectives during a regular meeting. Programs can also gather input from employers at career fairs and from alumni by asking them to rate the importance of each objective component in the alumni survey. If students are a constituency, programs can gather their input through graduating-senior surveys or student focus groups.

4.4 Periodic Review of PEOs Attainment

ABET only requires that the PEOs be periodically reviewed; assessment of the attainment of the objectives is not required. However, assessment of objectives attainment can be a rewarding exercise for those who might wish to use the ABET process to further enhance their programs.

Self-reflection on abilities or achievements provides indirect assessment data, while observing or measuring performance provides direct data. Although direct assessment offers a more objective evaluation, observing alumni performance can be difficult. As a result, alumni surveys can provide an effective way to assess graduates' attainment of the PEOs.

When designing objective survey instruments, focus on collecting information that supports program improvement. Alumni surveys should provide enough detail to identify and address shortcomings. For example, if graduates report that the program did not adequately prepare them to be effective leaders, the program needs to determine which leadership skills require improvement, such as presentations, motivation, meetings, conflict resolution, or project management. Therefore, when developing PEOs using the brainstorming process in Section 4.3, be sure to itemize their key components to guide the creation of specific and useful survey questions.

If an alumni survey is developed, for example, it should be linked directly to PEOs written as broad statements followed by related components that had previously led to the formation of the PEOs; see Weisbrook and Schonberg (2011) for an example of such an alumni survey. The alumni survey should ask respondents to rate how well the program prepared them to achieve each PEO component. Send the survey to alumni about five years after graduation, and establish a schedule to avoid duplicate responses. For example, it should be sufficient to survey graduates four and five years after graduation every two years.

Although alumni surveys provide effective indirect assessment of PEO attainment, programs should supplement them with direct measures when possible. Employers can provide direct input through focus groups, teleconferences, or meetings at career fairs, using alumni survey questions to guide discussions. However, these methods require that programs maintain strong employer relationships and may not suit programs whose graduates work across many industries. Thus, while useful information can be obtained in this fashion (especially for programs with access to supervisors), these approaches may not work for all programs.

4.5 Special Case: New Programs

This raises an important question: How should new programs develop and review their program educational objectives? Because these programs typically undergo their first ABET review only 3–6 months after their first students graduate, they lack alumni who graduated 3–5 years earlier and employers who can directly assess the job performance and skills of that alumni cohort. New programs can address this challenge as follows.

Step 1: Convene a group of constituents as described in Step 1 in Section 4.2, but except that there are no actual alumni or actual current employers present. Include industrial advisory board members, other stakeholders, faculty, and 3–4 potential employers identified through career fairs or the advisory board.

Step 2: Follow the nine-step process outlined in Section 4.2 to develop the Program Educational Objectives (PEOs).

Step 3: Develop the alumni survey described in Section 4.3, but now send it to another group of potential employers. Ask them to assess whether the PEOs represent reasonable skills and accomplishments for graduates with 3–5 years of workforce experience.

In this way, the review serves as a validation exercise. Use the results to confirm the initial PEOs or adjust them based on feedback from an independent group of reviewers.

5. Developing and Assessing SOs

5.1 Requirements for SOs

ABET defines student outcomes (SOs) as the union of the ABET Criteria 3 Outcomes (1) through (7) and any additional outcomes that the program articulates. The SOs must support the attainment of the PEOs, and the program must periodically assess and evaluate the SOs to demonstrate the degree to which students attain them. This section presents a process for developing outcomes that satisfies these requirements, followed by an appropriate process for assessing and evaluating the outcomes. Weisbrook and Schonberg (2011) present a flowchart for the development and assessment processes being discussed in this section.

5.2 Process for Developing SOs

Step 1: Begin With ABET Criteria 3 Outcomes (1) Through (7)

In the early years of EC2000, programs had to define "program outcomes," now called "student outcomes," that encompassed the ABET-prescribed outcomes (a) through (k) without using the ABET statements verbatim. Many programs spent considerable effort combining and rewording these outcomes and then mapping them back to the original (a) through (k) statements, as required by the ABET Self-Study Questionnaire. Faculty found this exercise

frustrating and confusing, and they saw little benefit in adding this step to the assessment process.

Beginning with the 2019-2020 accreditation cycle, ABET changed its practice and now defines the common portion of the SOs as the prescribed (1) through (7), which can (or rather, should) now be used verbatim. These more highly-defined outcomes were intended to provide an additional focus to the assessment process. Pfluger et al., (2022) describes the link between the former ABET (a) through (k) and the current (1) through (7). Similarly, Alhashemi, et al. (2021) describe and provide a mapping for the transition from SOs (a) through (k) to SOs (1) through (7), but also provide a statistics-based tool that can be used for their assessment.

While the ABET-prescribed SOs (1) through (7) should form the foundation for your SOs, they can still be tweaked to better suit your program if you find that your program's assessment processes would be enhanced by modifying the wording. Any editing should focus on the particular outcome and more clearly articulate the expectations for students in the program; edited versions of the outcomes should explicitly encompass every component of Criterion 3, that is, SOs (1) through (7).

Step 2: Address Other SOs of the Program and/or Program Criteria

ABET currently restricts Program Criteria to Faculty and Curriculum sections, permitting curriculum compliance through content coverage rather than outcome assessment. While programs may choose to establish supplemental student outcomes based on program criteria, doing so requires formal assessment and evaluation under Criterion 4. Alternatively, programs can satisfy Program Criteria compliance using the assessment data already collected for ABET Criteria 1 through 7.

Step 3: Document How SOs Prepare Graduates to Attain the PEOs

Review your PEOs and identify areas not covered by ABET SOs (1) through (7) or the program criteria. For example, if your PEOs emphasize leadership or cross-cultural work, add SOs that develop the skills and knowledge needed to achieve those objectives.

5.3 Assessment of SOs

5.3.1 Requirements for Assessment of SOs

As stated previously, ABET requires that programs develop and systematically use "appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained" and that "[t]he results of these evaluations must be systematically utilized as input for the program's continuous improvement actions." ABET evaluators expect evidence that students achieve the SOs through direct assessment. As such, programs should collect enough meaningful data to guide improvement. A strategic assessment plan can use as few as three or four direct measures per outcome, provided they cover every part of the SO statement.

5.3.2 Suggested Procedure for Developing Direct Assessment Process for Outcomes

Step 1: Determine Performance Criteria for Each Outcome

For each SO, identify the skills or competencies students should demonstrate at graduation. Be sure to cover the entire SO and use action verbs to define clear performance criteria, e.g., "Communicates effectively in team-based written reports" or "Incorporates information from charts and graphs into decision-making process."

Step 2: Determine Courses Where Performance Criteria Can Be Assessed

Assess SOs in required courses whenever possible to ensure every student has an opportunity to achieve them. You may use electives if all options assess the same performance criteria, but managing assessment becomes more complex as the number of options increases. Once you determine the performance criteria, identify the course or courses in which you will assess each criterion. Some criteria may fit multiple courses, so consider faculty workload when selecting courses. Choose courses that provide the most effective assessment of each competency. For outcomes with fewer criteria, consider using multiple assessment tools, such as assignments, projects, or test questions. For example, if an outcome has three performance criteria, assess them with three different tools.

Step 3: Determine Assessment Tool for Each Performance Criterion

Programs can assess some skills and competencies with numerical scales, but rubrics often provide a better approach. For example, a computation quiz can assess "Applies knowledge of statistics," while a rubric can better assess "Communicates effectively in oral presentations." A rubric divides a performance criterion into categories and defines achievement levels for each. For example, an oral presentation rubric might assess organization, visual presentation, vocal delivery, and audience connection. Weisbrook and Schonberg (2011) provide a sample rubric for this criterion. Using such a rubric, an instructor can rate each student's performance and then record the results to

show how many students reach each performance level within each category.

After selecting an assessment method for each performance criterion, set an acceptable performance level (performance metric). For numerical assessments, a metric might state, “80% of students will score at least 70%.” For rubrics, it might state, “75% of students will meet or exceed expectations in each category.” Also, for an outcome with multiple assessment methods, set a threshold by defining how many performance criteria students must meet for the outcome to be considered achieved. For example, an outcome may be considered achieved when students meet the metrics for at least two of the three (or four) performance criteria.

Step 4: Establish Metrics for Performance Criteria and Outcomes

Performance metrics should align with your program and the level at which you assess students. For example, a program may set higher metrics for performance criteria that support objectives its constituents consider more important. Similarly, a program may set a higher metric for a performance criterion assessed at the senior level than for the same criterion assessed at the sophomore level.

However, we note that exceedingly high participation rate requirements and similarly high attainment level metrics should be avoided. Considering the vagaries of student attendance and assignment completion, such requirements could cast doubt on the ability of assessments in the future to provide meaningful information to the program that can be used in a continuous improvement process.

Likewise, exceedingly low attainment level metrics should also be avoided. While in such cases a program might proudly present attainment of every outcome, since the thresholds for achieving the outcomes are pitifully low, the whole purpose of the exercise (i.e., continuous program improvement) might be compromised. In the end, even so-called “very good programs” should use the assessment process to make it even better.

5.4 Indirect Assessment of Outcomes

If you want to add a second type of assessment, senior exit surveys provide an efficient way to collect indirect assessment data. Design survey questions around the student outcomes and performance criteria. Alternatively, conduct senior exit interviews using similar questions.

5.5 Assessment Schedule

Programs do not need to assess every performance criterion each semester. A practical approach is to assess each criterion once a year as long as the program meets the established metric. If the program does not meet the metric for an outcome, make changes and reassess the criterion the next time the course is offered. Programs should also require faculty to submit assessment results when they submit course grades. This practice makes assessment data collection a routine part of teaching each course.

6. Evaluation and Continuous Improvement

Once assessment data have been collected and analyzed, the results should be evaluated to determine the extent to which the student outcomes (SOs), and optionally the program educational objectives (PEOs), are being achieved. The findings then provide a basis for determining appropriate actions to support continuous improvement of the program. As seen previously in Table 1, one of the most common issues cited by many evaluators regarding program assessment process or results are that they are either not used for continuous program improvement or not connected to SOs, or (in the case of students from multiple department or programs enrolled in a course or engaged in an exercise) that they are not disaggregated between programs. Many of these issues, as well as the other issues noted in Table 1 that are known to result in shortcomings in Criteria 2 and 3, can be avoided by following the processes outlined in this paper. Here we revisit the major points made by Weisbrook and Schonberg (2011) for the closing phase of an outcomes-based assessment process cycle – evaluation and continuous improvement.

6.1 Program Educational Objectives

PEO review results are used to help identify whether changes are needed in the curriculum, individual courses, student outcomes (SOs), or other aspects of the program and review processes. Of course, program modifications may also be influenced by external input, such as recommendations from an industrial advisory board to update the curriculum in response to emerging technologies.

6.2 Student Outcomes

Assessment data for Student Outcomes (SOs) should be evaluated to determine whether changes are needed at the course or curriculum level. These changes can include modifications to course content, teaching methods, assignments, or prerequisite requirements. The results of all performance criteria for each outcome, including direct and indirect assessments, should be consolidated and reviewed by the program's ABET committee to identify opportunities for improvement and adjust performance criteria or metrics when necessary. Of course, it is also important to remember that the primary goal here is continuous program improvement by identifying areas that need attention, rather than striving for perfect attainment of the SOs.

6.3 Closing the Loop

After changes are implemented in the program, their effectiveness must be evaluated, a process that ABET refers to as "closing the loop." The impact of changes made in response to assessment of SOs can typically be evaluated within a year. However, the effects of curriculum and course changes on graduates' career and professional accomplishments, as reflected in PEOs, must be monitored over several years.

7. Case Studies

In this section we discuss a number of case studies to illustrate the processes we have described previously. These case studies (i.e., these autoethnographic experiences) were selected because they were on-going at the time of the writing of this paper and we were actively involved in them. In the end, our analysis of the end products (and their *de facto* endorsements by ABET by way of reaccrediting our programs in the ensuing review cycle) indicates that the processes employed can lead to successful accreditation visits.

7.1 Development and Assessment of PEOs for an Engineering Management Program

As an example of the process presented in Section 4.2, we consider the procedure employed by the engineering management program at our home university to develop a new set of PEOs as part of that program's preparations for its upcoming ABET / EAC (re)accreditation visit. In the Spring of the year preceding the accreditation cycle, constituents of the engineering management program met in St. Louis to develop PEOs. The group represented all program constituencies—alumni, faculty, employers, and students. It included four members of the Engineering Management Academy, all program alumni; one alumnus who had graduated within the past five years; the department chair; four faculty members; and two students. An additional Academy member participated by teleconference, while four employer representatives provided input by email. The group developed the PEOs as described below.

After reviewing ABET assessment process and the definition of PEOs, group members generated more than 150 ideas describing the professional skills, competencies, and accomplishments expected of graduates three to five years after graduation (this took approx. 20 minutes). Participants organized these ideas into themes and identified six distinct areas: technology and analytical problem solving, financial skills, people, communication, professionalism, and integration of the previous five areas into a broader perspective.

The group then formed teams to develop draft PEO statements for each theme and reconvened to review and refine the statements. The discussion also prompted a broader evaluation of the program, identifying gaps such as risk analysis and project management and generating ideas for addressing those shortcomings.

The group drafted two versions of the PEO statements, with the extended version providing additional detail and serving as the basis for the alumni survey used to assess the objectives. Following the session, the core group refined the objectives through email discussions and presented them to the department faculty for further review. The faculty shared revisions and comments with the original constituent group and approved the final statements during the following fall semester.

Following approval of the new PEOs, the survey developed from the extended version of the PEO statements was sent to 260 graduates of the program who had graduated 3 to 6 years prior; 44 surveys were returned. The target metric for all components of the survey was that "85% of respondents would 'agree' or 'strongly agree' that the program prepared them to achieve the specific objective in their career." Ultimately, the survey results showed that three specific objectives—modeling tools and statistics, conducting meetings, and marketing strategies—received agreement rates in the 70% range, while two—conflict resolution and empowering teams—received agreement rates of 84%, just below the acceptable threshold. Because the department was already undertaking a major curriculum revision in response to other alumni feedback, the department faculty also took advantage of this opportunity to address the issues identified through this survey.

Finally, we note that while a 17% response rate for the survey was admittedly not great, there was a fairly high level of consistency in the responses received. Future efforts will likely need to include some encouragement from the department chair or the department's ABET coordinator to boost the response rate and help ensure that any changes made to the PEOs are not made in response to what may be viewed as a vocal minority.

7.2 Development and Assessment of SOs for Engineering Management Program

At the same time, SOs for the engineering management program were adopted based on the ABET-prescribed wording with a few minor edits to better reflect the personality of the program; no outcomes were added based on program criteria or the new set of PEOs. After developing the SOs, the department's ABET coordinators met with faculty teaching the seven required engineering management courses to identify where to assess each outcome. Faculty then developed performance criteria from activities already embedded in the courses. Although developing the criteria first and then identifying assessment activities would have better aligned the criteria with desired outcomes, the initial criteria reasonably captured the essential components of the program's SOs.

7.3 Additional SOs for a Civil Engineering Program Based on Program Criteria

A review of the civil engineering program criteria following a successful accreditation review provided opportunities for updating the program's current SOs and for adding additional ones. While some aspects of the civil engineering program criteria were already incorporated into the ABET-prescribed SOs, other components were thought to be sufficiently different from the ABET SOs (1) to (7). After some discussion, the civil engineering program committee decided that the addition of one or more separate outcome statements addressing those components was warranted (see also Khan et al., 2009). As a result, the civil engineering program established two additional SOs for the program, each with its own assessment tool and performance metric. One of those SOs focused on project management, business, public policy, leadership, professional ethics, and professional licensure, while the other addressed the ability of students to design a system, component, or process in at least two civil engineering contexts. These additions to the civil engineering program continuous improvement activities were viewed favorably by the next ABET review team, and continues to be in place at the present time.

8. Lessons Learned and Pitfalls to Avoid

In their original paper, Weisbrook and Schonberg (2011) highlighted three important lessons learned from their service as ABET program evaluators as well as faculty members in a program being visited by an ABET accreditation team. These lessons are summarized below, and are followed by insights in four new lessons based on recent experiences that programs seeking ABET accreditation would do well to learn.

8.1 Developing PEOs

The team charged with creating PEOs should understand the PEO development process, definitions, and be willing to participate openly and constructively. A skilled, organized, and objective facilitator should guide the session, keeping participants focused and addressing distractions or lack of engagement. The group should prioritize meaningful constituent input over perfect wording, since the program can refine and resolve problematic objectives afterward. Finally, when writing the PEO statements, it is important to remember that they should be worded with regard to what program graduates are expected to do a few years following graduation, not what current program students are expected to know at graduation. As noted previously, a common shortcoming for Criterion 2 is that the PEOs sound too much like SOs. Basically, then, if there are words in your PEOs that are also used in your SOs, consider removing them from your PEOs and rewriting the PEOs to be more compliant with ABET expectations.

8.2 Creating a Sustainable Assessment Schedule

Faculty may worry that assessing student outcomes (SOs) will be too time-consuming and difficult. This is not an unreasonable fear if the data collection is excessive or unfocussed. However, a focused assessment plan can make the process sustainable and engender faculty broad faculty support for the process. PEOs can be reviewed every 2–3 years using alumni and stakeholder feedback, while outcomes attainment can be assessed annually using representative student samples. Collecting assessment data at the time grades are submitted and reviewing results at the end of a spring semester allows faculty to implement improvements in the following fall semester.

8.3 ABET Requirements are in Flux

ABET assessment requirements have changed significantly over the past 25 years and are expected to continue evolving. Examples include changes in how student outcomes may be stated and increased expectations for using multiple direct assessment measures. Programs should stay current regarding criteria and assessment expectations by regularly checking the ABET website and participating in ABET conferences and workshops.

8.4 New Programs

Two new BS engineering programs were established a few years ago at our university. In both cases, the initial set of PEOs were drafted by the programs' curriculum committees, and then brought before the department faculty as a whole for review and comment (and ultimately approval). We learned quickly from the soon-following initial ABET visits that this was not entirely appropriate since, other than faculty, many of the programs' constituents were not involved in the PEO development process. We, of course, remedied this situation during the due process phase of the accreditation cycle by convening a group of constituents for each program and following the PEO development and review process outlined in Section 4.5. This was found to be acceptable to ABET, and the programs' shortcomings were removed. As a result, we believe that the process we have outlined in Section 4.5 regarding the development and subsequent review of PEOs for new programs will be viewed favorably by an ABET program evaluator.

8.5 Keeping Notes

It is one thing to say that you have a continuous improvement plan and that you have used it to make changes in your curriculum to enhance student learning. However, ABET program evaluators will request evidence of those changes and the subsequent improvements in student learning. As a result, it is imperative that you keep logs or minutes of each meeting where assessment results are evaluated, program changes are suggested (and subsequently approved), and whether attainment levels of student outcomes have increased when curricular changes were made as evidence of your having "closed the loop".

8.6 Data Consistency

It is possible that a course whose student work is used as part of an outcomes-based assessment process can be taught by different instructors either during an assessment cycle or over several assessment cycles. Faculty are, of course, free to choose the student work they assign as well as the level of rigor they use in evaluating whether or not student work exceeds, meets, or is below their expectations. However, this could jeopardize the consistency of the data collected in a program's continuous improvement processes if data from a specific problem or exam or laboratory exercise in a course is required for that process and one or more instructors do not give that assignment when they teach the course. This, then, might call into question the appropriateness of those processes for assessing and evaluating the extent to which student outcomes are being attained. As such, whoever is coordinating assessment data collection must ensure that whoever teaches a course from which such data is required to be aware of the need to require certain specific exercises as part of their instructional and evaluation activities.

8.7 Disaggregation of Assessment Data

It is entirely reasonable to expect that students from other disciplines will be enrolled in courses used to provide assessment data (e.g., laboratory exercise scores, homework problem scores, or exam scores). This includes regular courses as well as capstone courses such as senior design. In such cases, it is imperative that instructors who are asked to provide assessment data in the form or a homework problem score or a lab exercise score separate out student performance data for all students outside of the program for which the data is being requested. This also includes the removal of performance data for graduate students, even if the graduate students are in the same discipline as the program being assessed.

9. Conclusions

In this paper, we have presented methods for developing and assessing PEOs and SOs that we believe to be straightforward, coherent, efficient, and effective. Over the past few accreditation cycles, we have successfully used them within our own departments, and also to mentor faculty in other departments at our home institution. The case studies and the lessons learned we presented provide practical information that departments and programs can use as they engage in their outcomes-based continuous improvement activities.

It is also important to remember that continuous improvement processes do not have to be tangled and burdensome. In fact, as PEVs ourselves we have appreciated the efforts put forth by programs we visited to render those processes easy to understand and evaluate. Draft statements for PEOS can be prepared during a regular working day. Initial versions of SOs can be accepted as provided by ABET. Developing and finalizing performance criteria can take just a few hours; this time can be reduced by taking advantage of any number of examples that can be found online. Likewise, identifying courses and assessment tools to be used to gather assessment data can be completed in a short meeting of the program faculty.

Once the foundational elements are in place, faculty can prepare rubrics fairly quickly; again, there are excellent examples online that can be used for guidance. Once a system has been completed, the on-going data collection and evaluation tasks require only a minimal effort, and the program coordinator should need to spend only about a day's worth of effort each year to compile the data for review. While it requires some thoughtful effort to develop and implement an effective continuous improvement process, once the process is in place the effort required to sustain it need not be onerous.

Finally, although our discussions in this paper were aimed at assessment processes for engineering programs, we believe that the methodologies we have presented can be adapted for non-engineering programs as well. These methodologies can also support outcomes assessments that may be required by other accrediting organizations, including regional accrediting organizations such as the Higher Learning Commission and the Southern Association of Colleges and Schools. Of course, local conditions (e.g., a program's relationship with its alumni, the existence of an Industrial Advisory Board, etc.) and intended use (e.g., for a top-level review as opposed to an in-depth assessment) will ultimately dictate the extent to which they will need to be modified to suit their intended purpose.

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