STREAMLINING CONTINUOUS IMPROVEMENT: Efficiently Creating Value While Satisfying ABET Criterion 4

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** Stop Wasting Your Time Assessing Student Outcomes **

The focus of student outcomes-based assessment should be on finding <u>where</u> to best improve student learning, not on <u>whether</u> to improve student learning.

Abstract

This paper asserts that programs should shift emphasis from just assessment data collection and embrace a culture that uses assessment and evaluation to guide continuous improvement. Programs often spend time and effort collecting data to satisfy the requirements of ABET's harmonized Criterion 4, Continuous Improvement [1], but do not realize the benefits of doing this work. Unfortunately, many programs either collect more data than necessary or collect data that provide little insight on weak points of their students' learning as related to student outcomes. Other programs, for a variety of reasons, miss opportunities to improve student learning after assessing and evaluating the attainment of student outcomes. Thus, faculty and their programs often see the work of assessment for continuous improvement as useless labor done only to satisfy ABET criteria. This paper outlines an assessment and evaluation process minimizing extra work for faculty yet yielding actionable information for continuous improvement decisions and actions. A simple process for maximizing the value of assessment and evaluation of student outcomes as input for positive changes in student learning is described.

Background

Twenty years ago, ABET moved to outcomes-based assessment criteria; yet some programs continue to struggle with satisfying accreditation criteria associated with assessment of student outcomes. Initially, the relevant criterion was titled "Assessment" [2] and thus programs focused on development and assessment of student outcomes. When accreditation criteria were harmonized among the four ABET commissions, the focus changed from assessment to continuous improvement, and the criterion title changed to "Continuous Improvement" [3]. However, the culture of focusing on "assessment" has often remained unchanged. A recent ETAC newsletter [4] urges programs to adopt a culture of "continuous improvement," and this paper attempts to provide the authors' views of what this means and approaches to its implementation.

The opinions in this paper are those of the authors and are based on many years' accumulated experience while serving as program evaluators and team chairs, including writing and editing many draft and final statements of accreditation. The authors are also active or retired educators and have had their own programs evaluated and accredited by ABET. The opinions expressed

are based on the personal experiences of the authors and are not intended to represent any official position of an accreditation commission or ABET, Inc.

Criterion 4 Requirements

Criterion 4, Continuous Improvement, in the 2020-2021 ABET criteria documents, states:

> The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the program's continuous improvement actions. Other available information may also be used to assist in the continuous improvement of the program. [1]

We believe this criterion can be parsed into four requirements. The first requirement is to have appropriate and documented processes for continuous improvement. Having, documenting, and executing processes for continuous improvement is important. However, the key to a successful continuous improvement process is the appropriateness and use of these processes while executing the other three requirements—assessment of student outcome attainment, i.e., student learning, evaluation of data, and using evaluation results to guide continuous improvement actions. [Programs should note that the word "actions" has been added to Criterion 4, beginning in this accreditation cycle (2020-2021) to recognize that continuous improvement has both input (results of assessment and evaluation) and output (actions).] For the remainder of this paper, we will discuss each of the last three requirements of Criterion 4 by reviewing common problems and suggesting simple processes for maximizing value of the effort spent.

Assessment – Data Collection and Preparation Failures

In a culture of assessment only, programs can spend inordinate time in data collection leading to no action plans for program improvement. As a result, considerable time is consumed in assessment with no improvement in student learning, that is, no added value. In this environment, faculty consider assessment a chore with no reward. In extreme cases, faculty are admonished for failing to collect data rather than rewarded with improvements that could enhance their classes, courses, or programs when they do participate in assessment and evaluation. Some mechanisms contributing to this situation follow.

Frequently, programs collect far more data than needed for compliance, for measuring the extent to which student outcomes are being attained, and for appropriate processes that produce improvement actions. These mountains of data are difficult to process and evaluate; and, when combined with other issues, can lead to erroneous conclusions. In addition, the more data collected, the more faculty time is required for collection and preparation. While collecting extensive data is not counter to requirements of Criterion 4, extensive data sets are not necessary, demand more faculty time than needed, and make the continuous improvement process difficult to sustain.

An associated problem is collecting course-level assessment data, e.g., related to course-learning outcomes (CLOs), that are not linked to student outcomes. These course-level data often lead to

course-level improvements—which is a good thing by itself. Nevertheless, programs often fail to link either the data or course level improvement actions to attainment of student outcomes and perhaps miss the most appropriate improvement action opportunities. For instance, course assessment data may lead to course changes but mask opportunities for improvement actions being taken in another course—where the root cause of the poor student learning may reside. It is important to note that ABET evaluates programs, not courses, and is looking for improvements at the student outcome or program level.

Further, some programs spend too much time collecting indirect evidence such as advisory members' feedback or student surveys and collect little direct evidence of the extent of attainment of student outcomes. While indirect evidence may be helpful in corroborating findings or determining program improvements, using only opinions does not fully meet the requirement for "appropriate" processes for assessment (see the definition of "assessment" provided in the criteria [1]). Opinion surveys do not provide direct evidence of student learning that many find most important in guiding continuous improvement actions.

Aside from collecting too much data, programs often fail to link course-level assessment of CLOs to the program's student outcomes, making it difficult or impossible to determine the extent to which student outcomes are attained. In other instances, it becomes difficult to determine if students in the program have attained the desired knowledge or skill. Assessment instruments that are simultaneously used to measure attainment of more than one student outcome or performance indicator[1] confound the data. For example, grades on a laboratory report are used as data for assessing written communication. If the same grade covers both technical aspects of the laboratory and written communications, it is difficult to determine which skill (technical aspects or written communication) may be lacking. In such cases, the data collected cannot be directly related to each outcome being measured. Data can also be confounded when assessing student outcomes in courses with students from multiple programs and not parsing the data by program. One program's students may be doing well and the other's poorly, but the data do not reveal which.

Once raw data are collected, they are usually prepared or processed to yield information that can be evaluated to determine the extent to which student outcomes are being attained. Some of these processes fail to provide useful information, or they muddle data that may have otherwise been useful. Perhaps the most common of these problems is averaging averages. When doing this, the resulting data tend to obscure shortfalls in student learning by masking outliers or by giving small samples the same weight as larger samples. In one extreme case, a program collected data for each student, averaged the individual's points for the section, further averaged the section data by all students in the section, and finally averaged these across several semesters. Amazingly, all the processed data points came to about 62.5%. Yet, viewing the raw data revealed several opportunities to improve student learning. If programs were to compare averages against the raw data to identify statistically significant outliers rather than using the average to declare success, averaging could be useful. Nevertheless, given the lack of homogeneity of the data, averaging averages is almost never a valid mathematical operation.

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[1] A specific, *measurable* statement identifying a student activity related to the student outcome being assessed.

It is worth mentioning that Criterion 4 requires regular use of processes for continuous improvement. While "regular" is not specifically defined, once every six years is usually not viewed as "appropriate" for the task. During evaluations, programs occasionally are found that have not assessed or evaluated attainment of all their student outcomes since the previous evaluation visit.

A Simple Assessment Process

The new ETAC Criterion 3 [1] lists five elements that a program's student outcomes must include. Whether a program adopts these five elements as their student outcomes or has a more extensive list, the next decision is how many of these student outcomes will be assessed and evaluated per academic term or year. As noted above, the criterion only specifies "regular" so a program might choose to assess and evaluate all student outcomes on a one-year or two-year cycle, for example. The number of student outcomes being assessed is not really the key issue; rather, it is how much assessment is done for each student outcome.

To keep the process simple, each student outcome can be assessed using performance indicators (PIs). For example, a student outcome requiring students to apply written, oral, and graphical communications in technical and non-technical environments could have three PIs—written communications, oral communications, and graphical communications. While it may be difficult to assess all three simultaneously, separately assessing them is more straightforward. Measurement rubrics and instruments can be developed for each PI. The program can easily see the extent to which each of these PIs is being attained. If through evaluation it is determined that student learning could be improved in one area (or more), those areas could become the focus of continuous improvement actions. Ideally, the assessment process is combined with grading student work—something the faculty member is already doing. A laboratory report can be graded for technical content at the same time it is assessed for written communications using separate rubrics. If the PIs are assessed in two or three junior or senior-level courses (in a four-year program), there should be adequate data to evaluate the extent to which each PI is being met and, therefore, the extent to which the student outcome is being met. Ideally, PIs for student outcomes are also used as course-level assessments of course-learning outcomes.

Data sets collected from the performance indicators of a student outcome ideally are aggregated to determine the overall extent to which the student outcome is being attained. As mentioned above, such aggregation should not be done by averaging assessment data/results within a PI or across the various PIs for a student outcome. An easy and efficient way to avoid averaging is to simply track the number of students attaining the desired performance level and the number of students who failed to attain the desired performance level for that specific PI. More sophisticated methods, including weighting of specific PIs, can be used. However, the value of the additional effort should be considered. A PI is, after all, just an indicator!

Evaluation – Evaluation Failures

Within a culture of "assessment," a phenomenon has arisen over the years. Rather than looking for ways to improve student learning through student outcomes-focused assessment, programs appear to avoid continuous improvement actions by attempting to show that improvements are

unnecessary. They cite assessment data that meet or exceed arbitrary performance targets. It is this culture that should change if assessment and evaluation are to add value to programs. Assessment is not done to demonstrate that continuous improvement is unnecessary. Rather, assessment and evaluation of student outcomes informs actions that improve student learning.

Much discussion has centered on the use of targets or thresholds in the evaluation of assessment data when determining the extent to which student outcomes are attained. Using targets or thresholds is often recommended during various assessment training sessions. While there is no requirement in Criterion 4 to employ thresholds, ABET program evaluators sometimes incorrectly demand their use. While not required, thresholds can be helpful if used appropriately. Using thresholds to determine if students have met a desired attainment level for a student outcome can help prioritize or focus continuous improvement actions so that programs can select those that will provide the maximum benefit.

Too often, programs use thresholds improperly to claim that a student outcome has been met. Rather than being "met," Criterion 4 asks that programs assess the ***extent to which*** student outcomes are ***attained***. Thresholds should not be used as an excuse to avoid continuous improvement actions. Rather, when programs look across all outcomes assessed during the cycle, emphasis should be on where improvements in student learning would be most effective. Improvement actions should be decided based on the best place to act while considering benefits and costs. Some potential improvements may be unaffordable in the near term, while others may require only small changes to course material or coverage and yet have a significant impact on learning. It is certainly unnecessary to attempt improvement for every student outcome every time.

An Effective Evaluation Process Leading to Improvement Actions

Once assessment data have been collected and prepared for use, the program should evaluate those data to determine the priorities for improvement as discussed above. A process to aggregate (or roll-up), but not average, these assessment data sets across student outcome performance indicators provides an overview of student attainment of the student outcomes. An effective evaluation process should highlight the student outcomes most needing improvement in student learning. The aggregated data may be compared against a predetermined threshold, if one is used; but the focus is on the attainment levels. Using aggregated data allow determination of ***where*** continuous improvement actions may be most effective.

If a program chooses to assess and evaluate its student outcomes across a two-year cycle, it is logical that student outcomes assessed in each academic year should be evaluated and considered for improvement actions that year. Alternatively, a program may have five student outcomes and a process to assess those outcomes over a three-year period (e. g., outcome A in year one, outcomes B and C in year two, and outcomes D and E in year three). The program's first year of the cycle will focus on any improvements that may be needed for student outcome A; and then it would consider the best opportunities for improvement in the second and third years. Again, improvements should be based on where to take action—not just in the course where the assessment data were obtained or the performance indicator was measured.

Evaluation of student outcome attainment data includes not just determining the extent of attainment but also brainstorming ideas of *where* improvements could be made. Answers may run the gamut, for example, content of the course where the assessment was made, content in another course (such as a prerequisite or other course), or facilities and equipment. The possibilities are only limited by the imagination. In brainstorming, consideration of budget, time, and other limitations is withheld until after the brainstorming.

Failures in Continuous Improvement

Continuous is defined as "happening or existing without a break or interruption" [5]. Continuous improvement is ongoing. Failures in continuous improvement are often closely connected with failures in evaluation. For example, extensive use of averages obscures the need for improvement, and thresholds that are too low or used to avoid continuous improvement have been discussed previously. Similarly, failing to use the results of assessment and evaluation of student outcomes as input to continuous improvement actions results in a situation where the requirements of Criterion 4 are not satisfied. Worse, valuable faculty time is wasted by failing to convert the time and effort applied to data collection and evaluation into improvements in student learning. The purpose of using outcomes-based assessment for continuous improvement is lost.

Criterion 4 acknowledges that continuous improvement actions are often made based on "other available information," such as input from industrial advisors, faculty knowledge, or other sources. No one discourages continuous improvement based on other information sources. However, these actions do not relieve the program of using the results of assessment and evaluation of student outcomes as input for continuous improvement actions. Frequently, during an evaluation, programs will present the mountain of data they have collected, processed, and evaluated along with a list of improvements they have made. They hope that evaluators will accept this as evidence that they have used the results of assessment and evaluation as input to continuous improvement. Unfortunately, on careful review, there is no connection between the assessment and evaluation of student outcomes and the list of improvements. Requirements in Criterion 4 are not satisfied when all improvement actions are based solely on "other available information" and the results of assessment and evaluation of the extent of attainment of student outcomes have not been used as input to continuous improvement actions.

Maximizing the Value of Assessment and Evaluation Through Positive Continuous Improvement Actions

The value of assessment and evaluation comes from focusing on student outcomes where students struggle and by brainstorming ideas about *how best* to implement continuous improvement actions to improve student learning. Remember, actions may be best suited in a place NOT where the assessment data were gathered. For example, students may not be gaining the prerequisite knowledge needed from an earlier course. To realize value from assessment and evaluation, select improvement actions (e.g., by comparing expected benefits and costs) and then implement them. Continuous improvement need not be onerous nor expensive nor involve major program changes. For example, one electrical engineering technology program found during assessment that many students were not grasping a key concept on integration and

differentiation, which was a performance indicator for a student outcome. The proposed improvement was to spend more time on the subject during the course and make minor changes in the presentation. On subsequent assessments, the program found significant improvements in student learning.

Repeat the continuous improvement process each year for the student outcomes being assessed and evaluated that year. In short, minimize the *quantity* of data and focus on the *quality* of those data towards effective evaluation of assessment data. Develop a culture of continuous improvement. Stop wasting time on merely assessing student outcomes and move toward creating value out of assessment processes. In the authors' experience, there is a positive correlation between programs that have embraced a culture of continuous improvement and programs that are high performing.

References

[1] *Criteria for Accrediting Engineering Technology Programs, 2020-2021*, Nov 2, 2019. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-technology-programs-2020-2021/. [Accessed Jan 06, 2020]

[2] *Criteria for Accrediting Engineering Technology Programs, 2002-2003*, ABET, Inc., Nov 3, 2001.

[3] *Criteria for Accrediting Engineering Technology Programs, 2008-2009*, ABET, Inc., Nov 3, 2007.

[4] *ETAC Newsletter*, Vol 1, No. 1, Engineering Technology Accreditation Commission, ABET, Sep 4, 2019.

[5] *Mariam-Webster's Dictionary of English Usage, 2020*. [Online]. Available: https://www.merriam-webster.com/dictionary/continuous. [Accessed Jan 31, 2020]