

Work-in-Progress: Monitoring the Attainment of ABET Student Outcomes and Projected Achievement of Program Educational Objectives by Cohort

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Abstract

In this study, a systematic methodology is proposed to 1) monitor progress in program-level attainment of ABET Student Outcomes and Program Educational Objectives using the collected assessment data, 2) relate the projected Program Educational Objectives achievement with alumni and senior student surveys for closure and evidence-based revision of Program Educational Objectives and curriculum improvement. The proposed method aggregates the course-level Student Outcome assessment data based on the Student Outcomes - Program Educational Objectives relationship to produce quantitative assessment indicators for the Program Educational Objectives. It addresses the missing connection between before or on graduation Student Outcomes performances and after-graduation Program Educational Objective performance of the groups for better data triangulation. As an innovative approach, the proposed data analyses method tracks the progress/projected achievement of a cohort. The resulting projected Program Educational Objectives achievement can be compared to alumni and employer surveys for the cohort. The findings of these comparisons can be used to review the Program Educational Objectives, Student Outcomes, and Continuous Improvement plan; and make curriculum or course level revisions as well as revisions in the assessment plan.

Introduction

ABET requires the involved engineering programs to assess Student Outcomes (SO) based on a plan developed by the program [1]. Those assessment data are to be used as part of the continuous improvement plan of the program. In addition, ABET requires relating the SOs to the Program Educational Objectives (PEOs). In this hierarchical structure, courses feed into the SOs, and SOs feed into the PEOs. ABET requires SOs to be assessed and improvement actions to be taken at the course and program level if the target is not met. In the statement of Criterion 1 [1]: “*Student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives.*” Most engineering programs assess the SOs in the designated individual courses across the curriculum, and some programs [2], [3] also collect data through standardized tests such as the Fundamentals of Engineering (FE) exam for the SO assessment.

ABET has no requirement for direct assessment of the PEOs since the revision in the 2013-14 cycle after critiques and feedback from various programs [4]. The Criterion 4 description statement is changed from [5] “*The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which both the program educational objectives and the student outcomes are being attained.*” to [6] “*The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained.*” The PEOs are still required to be reviewed every three years or sooner for the alignment with the institutional mission, the program’s constituents’ needs, and these criteria [1].

The assessment and continuous improvement framework required by ABET provide scattered assessment data points at the course level for each SO. Although these course-level assessment data provide direct evidence for course-level improvements, a program-level improvement needs collective evidence via the program-level assessment of the SO. This study proposes to aggregate the course-level assessment data across the curriculum to get the program-level assessment of each SO. The proposed simple analysis allows monitoring the attainment of each SO by a cohort as the cohort progresses through the curriculum.

A good summary of how ABET Criteria 2 and Criteria 3 statements evolved after EC 2000 is provided in [7]. Although in the hierarchical structure, SOs feed into the PEOs, there is no requirement or guidance by ABET on how to use the SO assessment data in monitoring or reviewing the PEOs. Programs frequently use the alumni surveys and inputs from the Industry Board as evidence during the review/revision process of the PEOs. The need for a systematic approach to evaluating the achievement of program educational objectives is discussed by several researchers [7]–[9]. The absence of a quantitative connection between the PEOs and the SOs prevents using the collected assessment data effectively for data triangulation. Therefore, it prevents monitoring the projected success in achieving the PEOs and using these projections together with alumni/employer survey data in the review of PEOs and the continuous improvement process.

Methodology and Application

The proposed methodology is applied to a cohort of the Civil Engineering Program at King’s College for demonstration purposes. The data used in the following analyses are from Civil Self Study Report – Criterion 4: Continuous Improvement Assessment Results [10]. The analyses are conducted for Civil Class 2021 (graduated nine students).

In the first step of the analysis, the percent success scores of the cohort in the attainment of each of the seven SO by graduation is calculated (Table 1).

Table 1: Percent Achievement of Student Outcomes by Class 2021

	Semester		Student Outcome						
	#	Year	SO1	SO2	SO3	SO4	SO5	SO6	SO7
Course 1	1	FL17				15			
Course 2	3	FL18	95	35	45				
Course 3	5	FL19	80						
Course 4	5	FL19	83						
Course 5	6	SP20						88	
Course 6	6	SP20						66	
Course 7	6	SP20				50			
Course 8	7	FL20		86			100		
Course 9	7	FL20	89	100	100		89		78
Course 10	8	SP21	86	80	100	66	100	86	90
Course 11	8	SP21			70	90			
	Average		87	75	79	55	96	80	84

The percent success scores of the cohort in each course are defined as the percentage of students that are considered successful by achieving the benchmark score in the assessment rubric of the relevant SO. Table 1 summarizes which SO is assessed in which course(s) and semester. For example, in Course 5, 88% of the students scored equal or higher than the benchmark score of 3 out of 4 in SO6. This assessment analysis is already part of Criterion 4. The average SO percent scores in Table 1 are calculated by arithmetic averaging the percent scores of courses that are used to assess that particular SO. These average values are the percent success scores of the cohort in the attainment of each of the seven SO by graduation (Figure 1).

Depending on how the assessment courses mapped to SOs, these averages can also be calculated earlier than the graduation date for early monitoring of the SO attainment success. For example, in this case, the attainment of SO4 can be measured as early as the first semester of the curriculum, whereas attainment of SO7 can only be measured starting the seventh semester. Programs that wish to start monitoring the attainment of the SOs of a cohort early in the curriculum should design the course – SO mapping more deliberately.

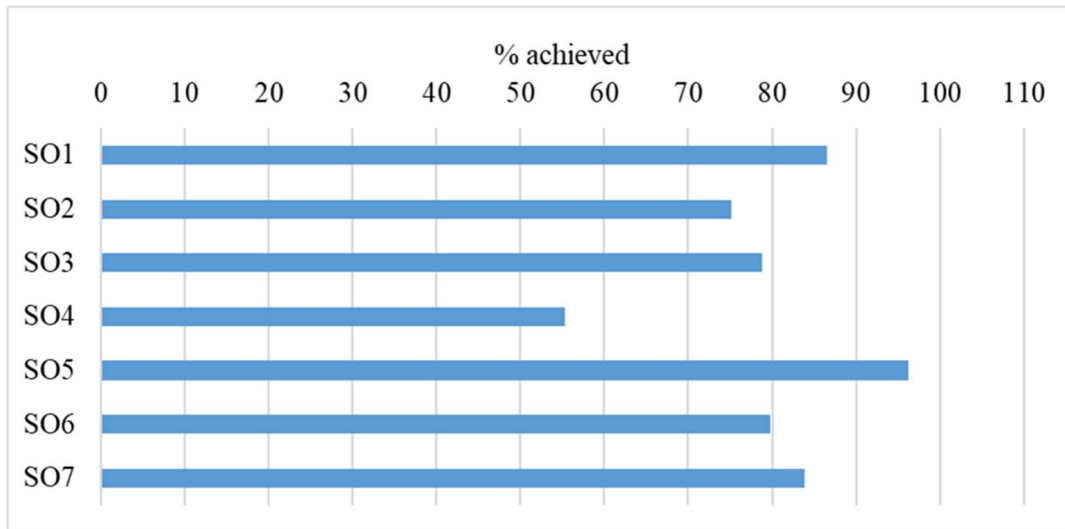


Figure 1: Average Percent Achievement of Student Outcomes by Class 2021

In the second step of the analysis, the projected achievement scores of the cohort for each of the four PEO are calculated by graduation (Table 2).

Table 2: Program Educational Objectives Aligned with Student Outcomes and percent achievement scores by Class 2021

Student Outcomes	Program Educational Objectives			
	PEO1	PEO2	PEO3	PEO4
SO1	87			
SO2	75			75
SO3	79	79	79	
SO4	55		55	55
SO5	96	96	96	
SO6	80			
SO7	84	84		
Average	79	86	77	65

They are named “projected” instead of calculated since ABET defines PEO as “...*broad statements that describe what graduates are expected to attain within a few years after graduation.*”[1]. The assessment data collected by the graduation can only allow projecting the future achievement. In calculating the projected PEO achievements, the alignment matrix of PEOs with SOs and the average percent achievement of SOs are used (Table 2). A simple arithmetic averaging is used to calculate the projected PEO achievement for each PEO. These calculated averages are the final quantitative indicators for assessing PEO based on the data collected before graduation. Although the averages calculated in Table 2 are projected achievements by the graduation, similar to SO monitoring, this method allows calculating the projected PEO achievements at the end of each semester depending on how courses mapped to SOs and SOs are aligned with PEOs.

In the third step of the analysis, the calculated indicators (averages in Table 2) are compared and correlated to any data collected for the purpose of PEO achievement assessment after graduation. Typically alumni [11] and employer [12] surveys are used for such after-graduation assessments. In this work in progress, no alumni or employer survey is conducted yet to measure the after-graduation PEO achievement assessment. Nevertheless, for the sake of demonstration, mock survey data will be used for this step. Table 3 lists the Projected percent achievement of PEO by Class 2021 as well as the (mock) survey assessment for the same cohort. These assessment indicators are also plotted (Figure 2) for visual comparison.

Table 3: Comparison Projected and Surveyed % Achievement of Program Educational Objectives by Class 2021.

Program Educational Objectives	Achievement	
	Projected	Surveyed
PEO 1	79	85
PEO 2	86	75
PEO 3	77	60
PEO 4	65	85

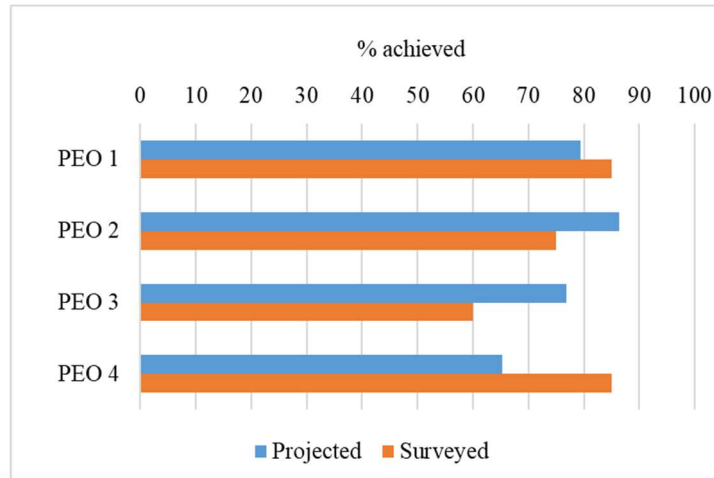


Figure 2: Projected and Surveyed Average Percent Achievement of Program Educational Objectives by Class 2021

The analysis results given in Table 3 and Figure 2 can be interpreted as evidence to evaluate the overall assessment plan outlined in Criterion 4: Continuous Improvement and in the review of the PEOs outlined in Criterion 2: Program Educational Objectives [1].

Discussions and Conclusion

The current continuous improvement directions by ABET focus on the assessment of the SO at selected courses throughout the curriculum. Yet this scattered assessment data does not provide any direct input for assessing the success of the program (and their graduates) in achieving their Program Educational Objectives. The PEOs are required to be reviewed systematically for ensuring alignment with the institutional mission, the program’s constituents’ needs, as well as the SOs but the only instrument for this review is the performance of the graduates, which can be measured via after-graduation surveys. The method proposed in this paper addresses the missing connection between SO performances and after-graduation performance of a cohort by focusing on the progress of a cohort rather than SO at the course level. This approach is similar to using the “Lagrangian” rather than the “Eulerian” approach in the description of the flow. This methodology does not require any additional “before graduation” assessment data to be collected; therefore, the workload to conduct such analysis is minimal. In this paper, course-level data is aggregated to PEO level indicators using simple arithmetic averaging. More sophisticated aggregation methods such as weighted averaging can also be used in the analysis. As future work, an alumni survey will be developed with questions measuring PEO achievements by breaking down the broadly defined PEOs into measurable performance indicators. The rubric of the survey will be designed to be comparable with the assessment data rubric for direct comparison of the results.

Disclaimer

Part of the data used in this study is altered from the original data to protect the confidentiality of the data. Also, mock data is used to demonstrate some of the steps of the proposed method, as noted in the relevant section of the paper.

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