

Use of Indicator Courses in Program Outcomes Assessment

Timothy A. Wilson¹

Abstract – Outcomes assessment processes for computing programs at ERAU Daytona Beach employ indicator courses: A subset of program curriculum reflecting the degree to which specified program outcomes are met. Outcome achievement in each indicator course is reflected by a score on instructor-completed course assessment forms. Collected artifacts to support the assessment are noted and referenced on the form. At an annual assessment meeting, faculty discuss the achievement of program outcomes specific to each indicator course, then the degree to which each outcome was achieved in the whole for each program. The approach requires somewhat limited data collection, supporting a sustainable assessment process. By encouraging a robust discussion regarding course content, delivery, and student performance, the assessment meeting facilitates development of trust by program faculty in assessment processes.

Keywords: Indicator course, sustainable assessment

Introduction

The introduction of Engineering Criteria 2000 (EC 2000) [3] by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) required the practice of outcomes assessment for engineering-program accreditation. This is a report on outcomes assessment developed by faculty in the Department of Computer and Software Engineering at the Daytona Beach campus of Embry-Riddle Aeronautical University (ERAU Daytona Beach). The approach includes two aspects considered here: Implementation of sustainable assessment processes through use of indicator courses and development of an assessment community by means of an annual assessment meeting.

Under current EAC accreditation processes, only slightly modified from the initial EC 2000 implementation, engineering programs develop both Program Educational Objectives and Program Outcomes. Program Educational Objectives (PEOs) are what graduates are expected to do several years after graduating: e.g., what jobs they will have, and what they will be doing in those jobs. PEOs give prospective and current students and their families as well as prospective employers of program graduates clear ideas about the intent of the engineering program and the competencies of program graduates. Program faculty determine PEOs, using input from program-determined constituencies. Constituencies are those with an interest in the performance of program graduates: employers and alumni, for example.

Program Outcomes are the set of knowledge, skills, and values that the graduate has at the time she or he completes the engineering program. Program Outcomes are determined such that PEOs can be achieved. In an ideal world, program curriculum is designed to implement Program Outcomes; in many cases, Program Outcomes achieved by an existing curriculum are determined. EAC identifies a number of Program Outcomes that must be achieved by any accredited engineering program. Those required Program Outcomes, often known by their alphabetic labels “(a)-(k),” are shown in Table I.

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TABLE I
EAC REQUIRED PROGRAM OUTCOMES

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

Programs must have processes in place to assess achievement of Program Outcomes and evaluate achievement of PEOs.² Furthermore, to be accredited, programs must use both Program Outcomes assessment and PEO evaluation to make program improvements. Since Program Outcomes are attributes of program graduates upon completing the program, outcomes assessment has to take place while students are in the program or very shortly after its completion.

The remainder of this paper is organized as follows: Following this introductory section is an overview of computing program assessment at ERAU Daytona Beach. The following section describes the use of indicator courses in outcomes assessment, including the characteristics of indicator courses, criteria for indicator course selection, and a description of how the indicator courses in the computer engineering and software engineering programs contribute to outcomes assessment. That is followed by a section discussing use of an annual assessment meeting to review indicator course results and to incorporate other information in outcomes assessment. The concluding section is a discussion of the indicator course and assessment meeting approaches.

Computing Programs Assessment at ERAU

The Department of Computer and Software Engineering at ERAU Daytona Beach currently offers undergraduate degrees in computer engineering and in software engineering. The computer engineer program began as a bilocated program using distance technology offered jointly by the then Department of Computer Science at ERAU Daytona Beach campus and the Department of Electrical Engineering at Embry-Riddle's Prescott, Arizona, campus. It has since evolved into separate programs, with separate curricula and separate assessment processes, at the two campuses. The computer engineering program at Daytona Beach had its first graduates in April 2001. The software engineering program at the Daytona Beach campus evolved out of the existing computer science degree. It had its first graduates in spring 2004.

In preparation for the university's participation in regional accreditation review during the 2000–2001 academic year, in expectation of EAC accreditation review, and to implement internal processes to ensure program quality, the department developed a Computing Assessment Guide (CAG) [2] during the 1999–2000 academic year. The processes described in the CAG include those for determining PEOs and for determining Program Outcomes, as well as processes for evaluating achievement of PEOs and for assessing achievement of Program Outcomes. For both programs, Program Outcomes were chosen to support PEOs and required EAC outcomes. For both programs, the adopted Program Outcomes include the required EAC (a)-(k) outcomes and an additional outcome regarding the programs' emphasis on real-time, embedded, and safety-critical hardware and software, respectively.³

² Both PEO evaluation and Program Outcome assessment fall under the rubric of “outcomes assessment.” ABET has simply identified the process of considering PEO achievement as “evaluation” and that of considering Program Outcome achievement as “assessment.”

³ The two programs have distinct wording and identification of the (a)-(k) derived Program Outcomes. The focus here is not on the particular outcomes of the programs at ERAU Daytona Beach, but on the use of indicator courses in assessing program outcomes.

The department conducted its initial review of computing program outcomes achievement in the spring of 2000. It has conducted assessment according to the CAG processes each spring since. The assessment process has evolved over the following years. The initial process envisioned involved detailed review of student performance in selected indicator courses, surveys of alumni and employers, consultation with the department's Industrial Advisory Board, and analysis of a broad assortment of data concerning student involvement in cooperative education, involvement in professional societies, minor programs, and more. It became obvious that revisions were necessary to ensure that the process was sufficiently simple to be sustainable while sufficiently robust to be useful.

Highlights of the current outcomes assessment process include:

- Recurring collection of specified data;
- An annual assessment meeting by computing faculty to review collected data and to determine if Program Outcomes are being met;
- Revision of the program once every three years, with allowance for extraordinary circumstances; and
- Evaluation of assessment process effectiveness once every three years, followed by possible revision of the assessment process.

Data collected on a recurring basis for outcomes assessment includes degree of Program Outcome achievement in program indicator courses and the results of a survey of graduating seniors. Anecdotal evidence regarding Program Outcome achievement, including letters, e-mail, and public comments from graduates and employers of program alumni, students and parents of current students, etc., is collected as it becomes available.

Use of Indicator Courses in Program Assessment

Outcomes assessment is not unique to EAC accreditation of engineering programs. It is an approach currently in widespread use across educational communities and institutions. There are numerous ways to assess achievement of program outcomes, including standardized testing, portfolio accumulation, exit interviews, and use of existing components of program courses such as homework, projects, quizzes, and tests.

Among the challenges in implementing an outcomes assessment process is achieving sustainability. At some point, the degree of complexity and effort required to implement and sustain the assessment process exceeds the value of the assessment information returned. For example, curricular-based assessment processes in which every test instrument in every course of the curriculum is used as an outcomes-assessment measurement tool likely yields little additional information over more selective curricular approaches.

The approach for Program Outcomes assessment in the computer engineering and software engineering programs at ERAU Daytona Beach involves use of indicator courses to achieve outcomes assessment. Indicator courses are a subset of the curriculum identified specifically for use in outcomes assessment. Indicator courses are courses at specific points in the curriculum, chosen to meet a set of criteria that makes them particularly useful in outcomes assessment. Indicator courses meet one or more informal criteria, including:

- The collection of indicator courses covers the collection of Program Outcomes.
- Each indicator course contributes to achievement of several Program Outcomes.
- Multiple courses assess contribution to the same Program Outcome.
- The course is prerequisite to several other courses.
- The course is the terminal course of a multi-term sequence.
- The course is part of the capstone design experience.

To facilitate their use for internal assessment purposes, department faculty selected indicator courses from the mid-point of the program, providing information regarding achievement of program outcomes in foundation aspects of the program, and from the end of the program, providing information regarding achievement of program outcomes in terminal aspects of the program. Also for purposes of internal program assessment, department faculty members choose to collect the several indicator courses into broad curricular areas such as Computing Fundamentals or Software Design.

As an illustration of one outcome being assessed in multiple courses, indicator courses used to assess to the computer engineering Program Outcome corresponding to EAC required outcome (g), "an ability to communicate effectively," are Software Engineering (SE 300), Electronic Devices Laboratory (EE 304), and Computer Systems

Design I and II (CEC 420 and CEC 421). The communication component in those indicator courses includes oral presentations, written laboratory and project reports, and requirements, use, and maintenance documents. Copies of the written documents as well as slides and instructor and peer evaluation sheets for presentations are available as artifacts relating to assessment of this outcome.

As an illustration of multiple outcomes being assessed by one course, Software Construction (SE 310), which covers advanced software development practices, is used to assess software engineering Program Outcomes corresponding to EAC required outcomes (a), “an ability to apply knowledge of mathematics, science, and engineering,” (b), “an ability to design and conduct experiments, as well as to analyze and interpret data,” (c), “an ability to design a system, component, or process to meet desired needs,” (e), “an ability to identify, formulate, and solve engineering problems,” and (j), “A knowledge of contemporary issues.” Individual artifacts such as analysis, design, and implementation documents from software development projects may be used to indicate degree of achievement in any or all of those outcomes.

At the end of every academic term in which an indicator course is taught, the instructor for each section of that course completes a Course Assessment Form. The instructor indicates the degree to which the assessed section achieved the associated Program Outcomes during that term. Achievement of each Program Outcome is indicated on a scale of one to five, with five showing the greatest degree of achievement and one showing the least. The instructor separately indicates what artifacts are available to support the assessment, including a listing of those individual assessment instruments used to assess particular Program Outcomes. Confidence in each assessment is bolstered by the instructor’s connecting the assessment to student performance captured in those artifacts.

Assessment Meeting

The department’s annual assessment meeting consists of two parts. The meeting is normally held over the course of one day, with the morning session consisting of a course-by-course review of achievement of the outcomes associated with each indicator course, and with the afternoon session consisting of an outcome-by-outcome review of outcome achievement across indicator courses and senior survey. Prior to the meeting, the department assessment coordinator compiles course assessment forms for the indicator courses. An assessment package consisting of the indicator course syllabi, course assessment forms, senior survey data, exit interview transcriptions, previous assessment meeting results, and anecdotal information is given to each participant. Meeting participants are department faculty as well as invited guests concerned with University, campus, and College of Engineering assessment activities.

During the morning session, the course monitor for each indicator course presents assessment results for that course. Meeting participants frankly and openly discuss the degree to which each outcome was achieved and the artifacts available to support the assessment. The faculty member performing the assessment is required to justify the assessment, e.g. through reference to supporting artifacts, by comparison with achievement of the same outcome by previous cohorts, or by comparison with achievement of the same outcome in other courses by the same cohort.

During the afternoon session, the indicator course and senior survey data are discussed for each individual Program Outcome. Program Outcomes are considered individually for each of the department’s two programs, even when the outcomes are the same for the two. Previous years’ data are reviewed for indication of outcome achievement trends. It is at this time that faculty make an all-or-nothing assessment as to whether the outcome was achieved. It is also at this time that department faculty decide whether immediate changes to the program are required on the basis of outcomes assessment. Assessment criteria state that any outcomes receiving a rating of less than 3 on the scale of 1 to 5 along any axis – indicator course or senior survey – are not considered met. Substantial evidence must be presented to have faculty consider an outcome that received a rating less than 3 in any area as met.

Assessment meeting results are kept in department and college archives for EAC accreditation purposes, and they are filed with university administration for regional accreditation purposes.

Discussion

The indicator-course approach is in contrast to assessment processes that involve generation of information from each course in the program curriculum every time that course is taught. Instead, the indicator-course approach

includes some but not all curricular elements from across the entire program. An immediate problem with approaches that require assessment of each course every time it is offered, regardless of whether that data is the volume of data generated and the need to organize that in a manner useful for decision making. The physical or virtual space required in archiving such data, and the tools necessary to access it once archived, can be problematic: Too much data can be a serious impediment to effective program assessment and improvement [5]. Nicoletti and Orr described a similar approach using a subset of program curriculum, but with less flexibility in the means of outcome assessment for each indicator course [6].

Scales et al. described several approaches to outcomes assessment, including use of alumni surveys, the capstone design experience, employer surveys, and exit interviews [7]. The outcomes assessment process for computing programs at ERAU Daytona Beach includes a survey of graduating seniors. Responses to the senior survey are considered important, but are considered somewhat unreliable on a short-term basis because of small sample sizes. The similar 1-to-5 rating of responses across course assessment forms and senior survey provides an opportunity to test the consistency of the assessment process and serves as a reality check for the indicator course approach. The two-semester capstone design sequence is an important component of what is assessed, but it is supplemented by considering courses at the end of the lower division and other courses in the upper division. Employer survey and alumni survey data are available, but are more appropriately used in evaluation of PEO achievement.

The approach here leaves open the possibility of subjective assessment of outcomes such as preparation for life-long learning for which objective assessment may be difficult. Brawner et al. [1] described the use of qualitative assessment and its relationship to total quality management, its utility in the check phase of the “Plan, Do, Check, Act” cycle, and its appropriateness for ABET-related assessment activities. Advantages of qualitative assessment over quantitative assessment include the utilization of expert information regarding outcome achievement (faculty), simplicity, and sustainability. Disadvantages of subjective qualitative assessment techniques when compared to quantitative ones include inconsistency between assessment performed by different individuals at the same time, and inconsistency between assessments performed by the same individual at different times. A possible objection to the use of subjective qualitative approaches would be a perception that they are less rigorous than quantitative approaches that are supposedly more objective; however, quantitative approaches can have substantial built-in and hidden biases. Another possible objection is that participants in the qualitative assessment process might be less than forthcoming about assessment of outcomes associated with their own classes, and that the collected faculty might be less than interested in hearing that Program Outcomes are not being achieved across a number of classes. However, the process itself, from determination of the PEOs to the assessment meeting, encourages faculty buy-in at all levels. Such buy-in acts as a deterrent to less-than-open participation in the assessment process, although it cannot guarantee that every participant in the process does so totally motivated by program improvement. Finally, the degree to which outcomes assessment is supported by artifacts takes subjective measures from “gut feelings” into the strongly-supported range.

There is a built-in check of Program Outcomes assessment by evaluation of PEO achievement. PEO evaluation of computing programs at ERAU Daytona Beach employs input from program graduates several years after graduation and from employers of program graduates. Achievement of Program Outcomes should facilitate achievement of PEOs, and any inconsistency between Program Outcomes achievement and PEO achievement serves to indicate that one of the outcomes assessment process, the objectives evaluation process, or both require attention.

An important and sometimes overlooked aspect of the approach discussed here is the development of faculty understanding and commitment to the program assessment. Besides its stated use in determining degree of achievement of Program Outcomes, the annual assessment meeting provides an opportunity for program faculty to see the state of the program and of its students beyond the perspective of each faculty member’s individual instructional efforts. A substantial degree of information sharing among faculty members takes place at the assessment meeting, from the overarching framework of the curriculum and its relationship to Program Outcomes to minute detail regarding topic coverage within one or more courses. The assessment meeting can also be seen as one aspect of building an assessment-focused community within the department, college, campus, and university as a whole. The assessment meeting serves as a confidence- and trust-building exercise for participating faculty (and administrators) not only in their own assessments of student performance, but in the assessment structures and processes adopted by themselves and their peers. Since the assessment meeting is part of an ongoing, sustainable, recurring assessment process, the degree of trust generated by faculty participation likely exceeds that developed through individual assessment workshops and training sessions [4].

Summary

Computing programs at ERAU–DB employ two assessment methods that support recurring assessment activities: indicator courses and an annual assessment meeting. Use of indicator courses provides assessment coverage across the breadth of Program Outcomes and through the depth of the curriculum. The annual assessment meeting serves both for information exchange among faculty as well as to develop and continue faculty involvement in the assessment process. While they cannot be applicable in all institutions, they are instances that faculty and administrators responsible for assessment may find useful as examples of alternative assessment approaches.

References

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