EFFECTIVE COURSE-BASED LEARNING OUTCOME ASSESSMENT FOR ABET ACCREDITATION OF COMPUTING PROGRAMS

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ABSTRACT
Recent changes in accreditation criteria of computing programs require effective learning outcome assessment with a vigorous process, well documented results, broad faculty participation, and a complete coverage of the assessment cycle. This paper describes a course-based approach that correlates learning outcome objectives to accreditation standards and courses. Course objectives can then be flexibly assessed by using a mix of most suitable assessment tools. A strong course committee structure is used to ensure the smooth execution of the process. Three specific assessment tools with novel features are also described. This assessment approach has been used for the successful accreditation of a computer information systems program and can easily be adapted to other computer science and information system programs.

1. INTRODUCTION
Since the accreditation of the first computer science program in 1986, computing accreditation has steadily gained widespread acceptance [6]. There are now a total of 421 accredited computing programs with 217, 184 and 20 programs accredited under the curricula of computer science, computer engineering and information systems
respectively [2]. This represents an increase of 28 programs, or 7.1%, from the last year. For many universities, the more relevant computing accreditation question is no longer whether but when.

Computer science and information systems programs are accredited by the Computing Accreditation Commission (CAC) of the Accreditation Board of Engineering and Technology (ABET) [1]. To be accredited, computing programs need to satisfy a set of criteria (7 for computer science and 8 for information systems). ABET provides statements of intent to delineate the general underlying principles of the criteria and standards to describe how programs can minimally satisfy the intent [3].

Among these criteria, Criteria I Objectives and Assessment represents a major shift of accreditation focus from primarily on curricular issues to also include outcome assessments. Because of its relative novelty in computing accreditation, reports have indicated that devising and implementing an effective learning outcome assessment process has caused the most anxiety among faculty members [5, 6, 8]. As a result, there are many recent papers on effective learning assessment practices [5, 6, 8, 9]. ABET and other organizations have also held conferences for best practices in learning assessment.

CAC provides broad flexibility for computing programs to define its own set of program objectives, the assessment tools to measure these objectives, and the mechanisms to evaluate and use the results to improve the programs. Consequently, an institution can adopt the best assessment process and tools most fitting to its special needs. Familiarity with a wide range of best assessment practices facilitates the adoption.

The Computer Science (CS) and Computer Engineering (CENG) programs of University of Houston-Clear Lake have long been accredited by ABET. Recently, the Computer Information Systems (CIS) program is also accredited under the Information Systems (IS) curriculum. There are currently only 20 programs accredited under the IS curriculum. The three computing programs together have more than 200 undergraduate students in their B.S. programs. They have about 220 students in their M.S. programs.

This paper describes a learning assessment approach used in our CIS accreditation. The approach can easily be adapted by other institutions and will be used for the upcoming re-accreditation of the computer science program here. It is based on a strong course committee structure and a detailed learning objective to course correlation mapping. This model allows assessment to be done effectively in the course level so that each course can use the best fitting assessment tools. The approach is vigorous in completing the entire assessment cycle and it enhances faculty participation.

The paper is organized in the following manner. Section 2 discusses the background and related work. The learning outcome assessment model is described in Section 3. Three assessment tools used in this model are elaborated in Section 4 and conclusions are presented in Section 5.
2. BACKGROUND AND RELATED WORK

The intent of the ABET criteria on objectives and assessment is: *The program has documented, measurable objectives, including expected outcomes for graduates. The program regularly assesses its progress against its objectives and uses the results of the assessments to identify program improvements and to modify the program’s objectives* [3]. General recommendations on building an effective assessment program to satisfy this intent include broad participation of faculty members and industry partners [6], clear documentation [6, 7], simplicity (for minimizing faculty and administration time) [4, 8], etc.

More importantly, an effective program should support a complete assessment cycle with the following steps [3, 8]:

- Development of program objectives and goals
- Development of assessment tools to measure these objectives and goals.
- Evaluation of the assessment and using the evaluation results to improve the program. This is sometimes known as ‘closing the loop.’

Although computing programs have great latitude in defining its own program objectives, these objectives must include learning outcome objectives for graduates, which in turn must satisfy the curriculum criteria of CAC. For example, the curriculum criteria intent for computer science has 17 standards, such as: *IV-1. The curriculum must include at least 40 semester hours of up-to-date study in computer science topics.* It is important for programs to clearly document that the learning outcome objectives cover all curriculum standards.

Different assessment tools can be mixed and used for measuring learning outcomes. Sanders and McCartney reported a survey on twelve assessment tools used in computer science accreditation [9]. These tools include senior exit surveys, alumni survey, written and oral exit examinations, portfolio, external advisory panel, etc. By itself, each tool has its own set of limitations and none of them is course-based [9]. By contrast, course-based assessment has the advantages of broad faculty involvement and easy incorporation into existing course logistics. Many other assessment tools have also been reported. For example, Blanford and Hwang suggested five assessment methods, including personal class assessment, faculty interview, and student focus group [4]. Among them, personal class assessment is a course-based assessment tool in which instructor writes an assessment of the course being taught.

Assessment can be time consuming and minimizing faculty time is of key importance. For closing the loop, Crouch recommended to form a *departmental steering committee* of senior faculty members to consolidate all course outcomes into a final set of outcomes [5]. As a result, not all faculty members will then need to participate in this step. Blanford and Hwang suggested an assessment day as an effective way for faculty to meet, evaluate assessment results, and provide improvement recommendations [4].
3. AN ASSESSMENT PROCESS

When our department decided to revamp the assessment process to prepare for the accreditation of the CIS program, the faculty members focused on several design criteria:

- The assessment process should not only be used to satisfy ABET accreditation, but also as a major internal driver for program improvement.
- It should have broad faculty participation.
- The process should be incorporated into existing program logistics as much as possible.
- The process should allow easy combination of appropriate assessment tools for a given objective.
- The process should include a vigorous infrastructure to ensure its execution.

Figure 1 shows our assessment model in the notational style of UML class diagrams. Six learning outcome objectives were reconstructed from existing ones using ABET curriculum guidelines as input. Each objective was then correlated to the ABET curriculum standards. Each objective was also further broken down into goals. Goals were then correlated to courses offered by the university. For each course, a committee then developed a complete set of course objectives.

For example, Figure 2 shows the learning outcome objective #1, its goals and its correlated ABET curriculum standards. Figure 3 shows how goal #1.3 is correlated with university courses and the assessment tools used. Figure 4 shows the course objectives for CSCI 3134 Programming with Java, which is correlated with goal #1.3.
Objective #1 CIS students will be competent in core foundation of Information Systems, Computing and Mathematics.

Upon graduation, CIS students should:
1.2. Understand the architectures of software and hardware systems.
1.3. Be proficient in at least two programming languages.
1.4. Be able to construct data structures and develop algorithms to solve computing problems.
1.5. Be able to apply data structures and algorithms to solve computing and IS problems.
1.6. Be able to use discrete structures for design of algorithms and data structures.
1.7. Be able to apply the relevant areas of Mathematics, including Statistics and Calculus, to computing.

Correlated ABET CAC IS Curriculum Criteria:
IV-1, IV-4, IV-5, IV-6, IV-7, IV-8, IV-11, IV-12, IV-13, IV-15

Goal 1.3 Be proficient in at least two programming languages

Correlated courses: (1) CSCI 3133 Programming with C, (2) CSCI 3134 Programming with Java.
Assessment Tools: (1) Per course exit survey of CSCI 3133, (2) Per course exit survey of CSCI 3134, (2) Related component of portfolio analysis of CINF 4838 Senior Project.

Course objectives of CSCI 3134 Programming with Java
1. Understand the fundamental concepts of object-oriented design, including information hiding, inheritance and polymorphism.
2. Understand the fundamentals of object-oriented programming in Java.
3. Write applets and applications
4. Compare and contrast procedural and object-oriented programming.
5. Design and implement object-oriented solutions to simple and moderately complex problems.
6. Understand UML notation and its importance in program design.
7. Write programs that use File I/O in Java.

This course-based assessment model is supported by a strong course committee structure. Each course has a course committee with a course coordinator and at least two other committee members. All committee members are full time faculty members. The committee is responsible for all facets of the course’s learning assessment including development and update of course objectives and assessment tools, assessment execution, evaluation, and providing recommended actions based on the evaluation results. The committee is also responsible for other activities not related to assessment such as selection of textbook, liaison with adjunct faculty members, ensuring instruction quality, etc.

Recommendations made by course committees are collected and discussed in full faculty meetings to determine appropriate follow-up actions, which include the update of learning outcome objectives and course objectives.
This approach has several advantages:

- Learning assessment is more decentralized and not restricted to few champions of assessment. It encourages and actually requires broad faculty participation.
- Integration of assessment recommendations is centralized for a broad perspective.
- It allows the integration of assessment activities in the regular work flow of teaching courses.
- Since each course objective is fine-grained and specific, it allows the course committee to flexibly select the most suitable assessment tools.

4. ASSESSMENT TOOLS

This section briefly describes three major learning assessment tools we have used. As indicated earlier, our approach allows the course committees to select the most fitting assessment tools, including those suggested elsewhere. In fact, the faculty is continuously experimenting with new assessment approaches.

Per course exit survey

In this assessment tool, students taking a course complete a survey at the end of the semester to reflect their perception on how well the course objectives are satisfied. The general evaluation criterion is for 70% or more of the students to agree or strongly agree that the learning objectives have been satisfied. If a learning objective fails this criterion, the course committee must provide remedial recommendations. In the past, this tool has revealed many weaknesses in various courses and many categories of recommendations have been dispensed. These recommendations include increasing lecture and laboratory time, adding assignments, changing course objectives, changing instructors, arranging extra tutorial sessions, etc.

One main advantage of this tool is its ease of integration into existing course’s workflow. The exit survey is distributed and collected together with the regular student evaluations. The results are tabulated by administration staff and posted in the department’s Intranet. The course committees only need to study the survey results and provide remedial recommendations. The major disadvantage is that course exit survey is considered to be an indirect assessment method. Student perception of how well a course objective is satisfied may not be accurate. Thus, it cannot be used as the sole tool in an effective assessment program.

Senior Project Day

The senior project course is the capstone course in our computing programs and is crucial in our learning outcome assessment. The course should be taken in the last semester of study. Near the end of every semester, faculty members and representatives from the surrounding companies are invited to attend a senior project day as evaluators. They listen to the presentations of senior project teams, review their portfolios, evaluate their learning outcomes according to a set of predefined criteria,
and provide feedback to the students. The senior project day not only provides a focal point for the assessment efforts, it has many other benefits:

- Allow students to experience a presentation setting similar to a technical conference.
- Improve the ties between the department and the surrounding companies.
- Provide students with practical feedback from the industry that may be immediately useful for their career search.

**Per course examination evaluation**

In this assessment tool, questions in examinations are correlated with course objectives. Effort is made to identify a set of questions that completely covers all course objectives. The instructor then analyzes the score results of these questions to determine how well the course objectives are satisfied. This tool is considered as a direct method with better accuracy. However, it requires significant more work from the instructors than per course exit surveys. As a result, it has only been used in two core required courses and the faculty is currently reconsidering its effectiveness and possible extension to other courses.

**5. CONCLUSIONS**

The assessment approach described in this paper can easily be adapted to other computer science and information system programs. It has successfully been used for the accreditation of our computer information system program under the ABET information systems curriculum. In fact, the ABET CAC accreditation statement has indicated that “The program has done a very good job in assessment. All faculty members are participating in the assessment process with appropriate feedback to improve their courses.” All standards have been satisfied with no concern. The only observation is that there may be an “over emphasis of student self-evaluation of mastery of material.” As a result, the faculty is working on expanding other assessment tools to de-emphasize per course exit surveys.

**REFERENCES**


