Minimizing Effort for ABET Student Outcomes Assessment While Maintaining Effective Results

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***Abstract*—In this paper, I provide the Miller Methodology for minimizing the amount of effort necessary for assessing student outcomes through ABET accreditation. A single faculty member is responsible for gathering of the outcome data, and the entire program faculty can then assess the data as it related to the continuous improvement process. This methodology provides for an efficient use of the time of faculty members of a program while still maintaining credibility with respect to the use of student outcome data in the accreditation process. This methodology was used during the 2015-2016 accreditation cycle for the Computer Science (CSCI) and Computer Engineering and Computer Science (CECS) programs in the Viterbi School of Engineering at the University of Southern California. Both programs achieved full accreditation from the ABET Computing Accreditation Commission, and the Computer Engineering and Computer Science (CECS) program achieved full accreditation from the ABET Engineering Accreditation Commission.**

Keywords—ABET; outcomes assessment; student outcomes; Computer Science;

Symposium—CSCI-ISED

Submission Type—Full/Regular Research Paper

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I. Introduction

The process of preparing for an accreditation visit from ABET is quite time-intensive. The self study document is typically a few hundred pages long, with self studies containing more than 500 pages not being atypical. Although many faculty and administrators consider achieving accreditation to be a worth-while venture, the time commitment required discourages faculty from volunteering to take on the task. Criterion 3 (Student Outcomes) and Criterion 4 (Continuous Improvement) are particularly overwhelming and arguably the most important sections since they relate directly to the curriculum. Systems have been developed in an effort of reducing the burden of collecting student outcome data [7-8]. This paper presents the Miller Methodology for minimizing the effort of gathering and analyzing the data related to student outcomes without compromising the effectiveness of the evaluation. Although the paper specifically references the efforts involved in accrediting a Computer Science program through ABET's Computing Accreditation Commission and a Computer Engineering program through ABET's Engineering Accreditation Commission and ABET's Computing Accreditation Commission, the results can be applied to other accreditation commissions as well.

II. Background

ABET is one of the primary accrediting organizations for the fields of engineering and computing [1]. ABET is divided into four different commissions that are responsible for accrediting related programs: Applied Science Accreditation Commission (ASAC), Computing Accreditation Commission (CAC), Engineering Accreditation Commission (EAC), and Engineering Technology Accreditation Commission (ETAC) [2]. All four of the commissions require assessment of eight different criteria related to the program [3-6]:

- Criterion 1: Students
- Criterion 2: Program Educational Objectives
- Criterion 3: Student Outcomes
- Criterion 4: Continuous Improvement
- Criterion 5: Curriculum
- Criterion 6: Faculty
- Criterion 7: Facilities
- Criterion 8: Institutional Support

These eight criteria must be explained in a self study document that is provided to the commission prior to the ABET accreditation visit. After a thorough review of the self study and the site visit, the ABET commission will provide an assessment of the program with a decision of whether to accredit and for how long. Although all eight of the criteria are important, criteria 3 and 4 related to student outcomes and continuous improvement are particularly important and tend to take the most time to prepare and document.

Based on the program being accredited, there is a set of student outcomes defined in the ABET Criteria for Accrediting document [3-6]. All of the commissions include a list of either 10 or 11 recommended student outcomes. There may also be program-specific outcomes that must be met as well. Although these outcomes do not need to be adopted by a program word-for-work, all of the outcomes must be met by the program seeking accreditation. Additional outcomes are allowed as well if the program desires.

978-1-5090-5510-4/16 $31.00 © 2016 IEEE
DOI 10.1109/CSCI.2016.74

The beginning of Criteria 3 in the ABET Criteria for Accrediting Computing Programs states, "The program must enable students to attain, by the time of graduation: …" [4]. The beginning of Criterion 4 states, "The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained" [4]. Although the references provided are specifically from the CAC, the other three commissions have similarly-worded sections [3, 5, 6]. In short, these two sections must provide evidence that the student outcomes are being assessed and used as input to a continuous improvement process during the period since the last accreditation.

Looking specifically at programs accredited by the CAC, Criterion 3 provides nine student outcomes that must be attained by students by the time they graduate (outcomes a-i below). For Computer Science programs, there are two additional student outcomes that must be attained by students by the time of graduation (outcomes j-k below).

"The program must enable students to attain, by the time of graduation:

(a) An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline

(b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution

(c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs

(d) An ability to function effectively on teams to accomplish a common goal

(e) An understanding of professional, ethical, legal, security and social issues and responsibilities

(f) An ability to communicate effectively with a range of audiences

(g) An ability to analyze the local and global impact of computing on individuals, organizations, and society

(h) Recognition of the need for and an ability to engage in continuing professional development

(i) An ability to use current techniques, skills, and tools necessary for computing practice

(j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

(k) An ability to apply design and development principles in the construction of software systems of varying complexity" [4].

The above 11 outcomes need to be assessed a minimum of two times during the current accreditation cycle, and the results of the assessment need to be used in a process that provides continuous improvement to the program. Although the manner by which programs assess the outcomes and feed the results into the continuous improvement process are not defined by ABET, one method for performing these tasks is provided in the following sections.

III. Miller Methodology

The main purpose of assessing the student outcomes is to determine whether the program is helping students to attain the knowledge specified in the outcomes by the time they graduate (provided in Criterion 3). During the process of assessing the outcomes, improvements to the program can be made (provided in Criterion 4).

The Miller Methodology explained in this section was used by the Computer Science department within the Viterbi School of Engineering at the University of Southern California during the ABET accreditation cycle in 2015-2016. The Computer Science (CSCI) program was fully-accredited by the CAC and the Computer Engineering and Computer Science (CECS) program was fully-accredited by both the CAC and EAC.

For each of the a-k outcomes, two different metrics should be used. Although these metrics could come from the same class, assessing them in different classes will help with identifying locations of possible improvement in Criterion 4.

In addition to two metrics for each outcome, each outcome should also be assessed twice during the accreditation cycle, hopefully during different academic years. Although it is not necessary to assess all of the outcomes in the same academic year, we found that it was easier to perform all of the assessments at one time so as to not burden faculty over a longer period of time. For example, if the program is on a six-year accreditation cycle, perform the first assessment of outcomes in year two or three and the second assessment of outcomes in year four or five. By the start of the writing of the self study, there will then be two metrics assessed in two different years, providing four data points.

Although all faculty should be involved in the process of assessing the data with regards to continuous improvement, it is not necessary for all faculty to be involved in the collection of assessment data. With this in mind, the Miller Methodology assesses all of the outcomes in two classes – a required sophomore-level course and a required senior capstone course. The specific courses we used are the third programming course in our introductory sequence (CSCI 201: Principles of Software Development) and our capstone course (CSCI 401: Capstone: Design and Construction of Large Software Systems). The benefits of assessing the outcomes in these classes are:

- Data points at varying levels in the curriculum – This allows the faculty to see how students have hopefully improved in their skills from earlier in the curriculum to later in the curriculum.
- Reducing effort of gathering assessment data – Since we are only gathering assessment data in two classes, the number of faculty involved in the collection process is minimized. Note that all of the faculty should be involved in the analysis of this data though.
- Similar class structure – In a sophomore-level course, students have learned enough material to work on a

group project, similar to what typically happens in a capstone course. This allows the assessment of the outcomes to be very similar in both classes, further reducing the work required.

- Consistency in outcomes gathering – Although the required classes in a program may change over time, a required sophomore-level class (i.e. the third programming class in the introductory sequence) and a capstone course will probably not be drastically changed or eliminated.
- No additional assignments necessary – Since both classes already have group projects, there is no need to assign anything to the students that is not already required in the class. In addition, no additional grading is necessary by the professor since the evaluation is already being used as a basis for the students' grades.

In our specific case, both of these classes are taught by the same professor, which happens to be the author of this paper. This was not a coincidence but instead was done intentionally for the purposes of accreditation. The collection of all of the assessment data was done in two classes that I teach, and the results were then taken to the faculty of the program to assess. The process by which I was collecting the data also had to be reviewed and approved by the faculty.

IV. Miller Methodology Assessment Metrics

In both classes where student outcomes are gathered (CSCI 201 and CSCI 401), students are required to complete a group project. They have to complete all aspects of a project starting with conception through to deployment. In CSCI 201 students choose their own projects, and in CSCI 401 students are assigned a project that is led by an outside stakeholder. There are three different items that are graded with respect to the group projects:

- Peer Reviews - Students must provide two peer reviews throughout the semester where they give an honest evaluation of the other members of their teams. They rank each person on their team with a score of 1 to 5 with respect to responsiveness to communication, willingness to work, amount of work completed, professionalism, on-time completion, and quality of work.
- Project Documentation – At the end of the project, each team must submit a final project document that includes the concept, high level requirements, technical specifications, detailed design, test cases, and deployment instructions.
- Project Presentation – At the end of the project, each team must present and demonstrate the project in front of the class.

A description of the grading criteria used with a mapping to each of the a-k ABET student outcomes is provided in Appendix A. The same grading rubric is used in both classes and is provided to the students in each class prior to the start of the project.

Although the classes used to evaluate the student outcomes are taught every semester, and the same grading rubric is used each semester, we only assess the data twice during the six-year accreditation cycle. Specifically, we gather the outcome data in both classes in year two and again from both classes in year five, giving two metrics in each of the two years. This data is then presented to the faculty of the program as part of the continuous improvement process as one measure to determine if any changes to the program are necessary.

V. Conclusion

Preparing for an ABET accreditation visit is an arduous task that is not typically desired by many faculty members. Even if the benefits of accreditation are realized, the amount of work it entails is more than many people want to undertake. In an effort to maintain credibility while minimizing effort, I have presented the Miller Methodology that was successfully implemented during the accreditation of the Computer Science (CSCI) and Computer Engineering and Computer Science (CECS) programs in the Viterbi School of Engineering at the University of Southern California during the 2015-2016 accreditation cycle. By assessing student outcomes in only one required sophomore-level class and one required senior-level capstone course, we were able to minimize the amount of effort required for gathering student outcome data while still providing sufficient feedback for the continuous improvement process. The outcomes were assessed twice in two different semesters of the six-year accreditation cycle, providing measures at different points in the curriculum over different years. The outcome data was collected by a single faculty member and provided back to all of the program faculty to assess for continuous improvement. The process by which the single faculty member gathered the data was also reviewed and approved by the program's faculty. Without jeopardizing the credibility of the assessment process, the Miller Methodology minimizes the amount of work required for gathering student outcome data by affecting only a single faculty member.

References

[1] ABET Web Site. http://www.abet.org.

[2] ABET Accreditation Commissions Web Site. http://www.abet.org/about-abet/governance/accreditation-commissions/.

[3] ABET Criteria for Accrediting Applied Science Programs, 2016-2017. http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-applied-science-programs-2016-2017/

[4] ABET Criteria for Accrediting Computing Programs, 2016-2017. http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2016-2017/

[5] ABET Criteria for Accrediting Engineering Programs, 2016-2017. www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2016-2017/

[6] ABET Criteria for Accrediting Engineering Technology Programs, 2016-2017. http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-technology-programs-2016-2017/

[7] Sun, Chengyu, Raj Pamula, Russ Abbott. "Combining Program Assessment with Learning Management for Efficient and Sustainable Accreditation Process." *American Society for Engineering Education 2016 Pacific Southwest Conference*, April 2016.

[8] AEFIS Web Site. http://www.aefis.com.

APPENDIX A – MILLER METHODOLOGY STUDENT OUTCOMES ASSESSMENT RUBRIC

ABET Outcome	Assignment	Description	Grading Criteria						# Points to Meet Expectation
A	Project Presentation	What math and CS classes were used in the project?	**0 points** No classes were discussed as being used in the project	**1 point** 1 class was discussed as being used in the project	**2 points** 2 classes were discussed as being used in the project	**3 points** 3 classes were discussed as being used in the project	**4 points** 4-5 classes were discussed as being used in the project	**5 points** More than 5 classes were discussed as being used in the project	4
B	Project Documentation	How well did each of the project documents meet the requirements?	**0 points** No documentation submitted.	**1 point** Minimal documentation submitted.	**2 points** Documentation did not have different sections for different documents.	**3 points** Documentation was separated properly but did not include at least 50% of the details of project.	**4 points** Documentation was separated properly and did not include at least 75% of the details of project.	**5 points** Documentation was separated properly and included nearly all of the details of the project.	4
C	Project Presentation	Were all of the features originally discussed implemented?	**0 points** 0-15% of the features were implemented.	**1 point** 16-30% of the features were implemented.	**2 points** 31-45% of the features were implemented.	**3 points** 46-60% of the features were implemented.	**4 points** 61-79% of the features were implemented.	**5 points** 80-100% of the features were implemented.	4
D	Peer Review	Provide a peer review of all members of your team.	On scale of 1 to 5, evaluate each member of your team on responsiveness to communication, willingness to work, amount of work completed, professionalism, on-time completion, and quality of work. Sum all values to get a score out of 30.						24
E	Project Presentation	What legal, professional, ethical, security, and/or social issues needed to be addressed?	**0 points** No discussion of legal, professional, ethical, security, or social issues.	**1 point** One of legal, professional, ethical, security, or social issues was discussed briefly	**2 points** One of legal, professional, ethical, security, or social issues was discussed sufficiently	**3 points** More than one of legal, professional, ethical, security, or social issues were discussed briefly	**4 points** More than one of legal, professional, ethical, security, or social issues were discussed sufficiently	**5 points** More than one of legal, professional, ethical, security, or social issues were discussed in depth	4
F	Project Presentation	Was the presentation easy to follow? Was there a logical progression of topics? Was there good oral communication?	**0 points** Demonstration AND presentation were unable to be followed, speakers were not loud enough AND did not speak clearly	**1 point** Demonstration AND presentation were difficult to follow, speakers were not loud enough AND did not speak clearly	**2 points** Demonstration OR presentation were easy to follow but not both, speakers were not loud enough OR did not speak clearly	**3 points** Demonstration OR presentation were easy to follow but not both, speakers were loud enough OR spoke clearly but not both	**4 points** Demonstration and presentation were both easy to follow, speakers were not quite loud enough for audience or did not speak very clearly	**5 points** Demonstration and presentation were both easy to follow, speakers spoke loud enough for audience and clearly	4

ABET Outcome	Assignment	Description	Grading Criteria						# Points to Meet Expectation
G	Project Presentation	How will the project affect the organization, society, or others?	**0 points** No discussion of how the project will affect the organization, society, or others.	**1 point** Very little discussion of any effect the project will have on anyone.	**2 points** Discussion of how project will affect someone was briefly provided.	**3 points** Discussion of how project will affect more than one group of people was briefly provided.	**4 points** Discussion of how project will affect more than one group of people was sufficiently provided.	**5 points** Discussion of how project will affect more than one group of people was provided in depth.	4
H	Project Presentation	What topics outside of the curriculum did you need to complete the project?	**0 points** No discussion of topics outside the curriculum.	**1 point** Topics outside the curriculum were mentioned in the rest of the presentation but not explicitly stated	**2 points** 1-2 topics outside of the curriculum were discussed	**3 points** 3-4 topics outside of the curriculum were discussed	**4 points** 5-6 topics outside of the curriculum were discussed	**5 points** More than 6 topics outside of the curriculum were discussed	4
I	Project Presentation	What software or other tools did you need to complete the project?	**0 points** No discussion of software or other tools.	**1 point** Software or other tools were mentioned in the the presentation but not explicitly stated	**2 points** 1-2 pieces of software or outside tools were discussed	**3 points** 3-4 pieces of software or outside tools were discussed	**4 points** 5-6 pieces of software or outside tools were discussed	**5 points** More than 6 pieces of software or outside tools were discussed	4
J	Project Presentation	What architecture and design patterns did you use and why?	**0 points** No discussion of architecture or design patterns.	**1 point** Architecture OR design patterns (but not both) were mentioned but decisions were not justified.	**2 points** Architecture OR design patterns (but not both) were mentioned with weak justifications for decisions.	**3 points** Architecture OR design patterns (but not both) were mentioned with justifications for decisions.	**4 points** Architecture AND design patterns were mentioned with weak justification for decisions.	**5 points** Architecture AND design patterns were mentioned with strong justification for decisions.	4
K	Project Presentation	What worked and what didn't with respect to development methodology and teamwork?	**0 points** No discussion about methodologies and teamwork.	**1 point** Methodology and/or teamwork was mentioned but not with respect to what worked and what did not.	**2 points** Methodology OR teamwork was mentioned (but not both) with respect to what worked OR what did not.	**3 points** Methodology OR teamwork was mentioned (but not both) with respect to what worked AND what did not.	**4 points** Methodology AND teamwork were mentioned with respect to what worked OR what did not.	**5 points** Methodology AND teamwork were discussed with respect to what worked AND what did not.	4