Multiple Assessments and Continuous Improvement of Engineering Technology Programs

Nripendra N Sarker and Mohan A Ketkar

Engineering Technology Department
Prairie View A&M University
Prairie View, TX 77446

Abstract

A program thrives only when there is an effort to continuous improvement. An educational institution has to excel its programs to produce better graduates every year and also to excel over the graduates from other institutions. In the process of accreditation, the ABET stresses on eight criteria of engineering and technology programs. Criterion 3 is the Multiple Assessment and Evaluation of the program outcomes. Assessments are the valuable feedback to improve the program itself. Thus while the faculty, by instinct, are always focused to continuously improve their programs, the ABET accreditation process acts as an additional impetus to continuously boost up the program outcomes. By tradition, semester-wise homework, tests, projects, etc. comprise the major components of assessment of student performance. However, this single assessment is very internal to the institution which leads to the students to graduate after a stipulated period of stay at the educational institution. Assessment of a program should go beyond the institutional boundary spatially and in time dimension several years after graduation. Opinion surveys from student internship supervisors, employers, graduate advisors and the same from the graduates themselves about their career advancements are some of the valuable feedback measures from which an institution can be immensely benefited to improve programs. Thus the assessment and improvement are the two major players of a dynamic system loop. This paper discusses some of these measures to assess a program. The design of some assessment tools is analyzed for their effective use in the process of continuous improvement of programs.

Introduction

Continuous improvement is the key to growth and success. Assessment of the existing method determines the key areas to improve. The success of educational institutions in the USA is due to their continuous effort to excel. A strategic plan helps achieve desired program objectives. A program may lack in following a tightly woven strategy of improvement of its own.
Organizations, like ABET a Southern Association for Colleges and Schools (SACS) have been playing very important roles to drive the programs to continuously improve.

**Strategic Plan**

The strategic plan emanates from the mission statement of an academic institution. An academic program is developed to fulfill some specific mission of the university. It has a set of objectives to accomplish through outcomes of teaching a prescribed set of courses.

Program educational objectives should be tied close to the broad mission of the university but specific to the program. Program outcomes are decided based on abstract statements of program educational objectives. It is the individual courses that are engaged in fulfilling the program outcomes. Course outcomes are very specific to the courses which are to be achieved at the end of each course.

ABET broadly defines program educational objectives as “statements that describe the career and professional accomplishments that the program is preparing graduates to achieve during the first few years following graduation” [1]. This means that the success of a program is directly tied with the professional success of the graduates measured few years after graduation. As in Figure 1, success of a university depends on the fulfillment of the educational objectives of its programs.

![Diagram](attachment:image.png)

**Figure 1. Program elements within the mission of a university**

The set of downward arrows indicates the specific steps needed to develop a successful program while the upward set indicates the contributions of individual elements ultimately to achieve the program objectives and university mission.

Figure 1 is the narrower view of the hierarchy of educational elements from university mission down to individual course outcomes. All universities approve a program when its objectives reflect university mission. Likewise, courses are selected to fulfill the objectives of a program.
Courses outcomes are decided to reflect the program outcomes. This is the implementation side of the hierarchy. On the other side of this implementation is the periodic outcome-assessment to see whether the program meets its objectives.

**Broader View of Educational Program Objectives and Program Outcomes**

Broader view of educational program specifically mentions the contribution of each elements of the hierarchy of a program which should be publicly documented [2]. Figure 2 is one example of a broader view. Program educational objectives should be specific and one or more of them may meet one or more of the missions of a university. Likewise, one program outcome may meet one or more program educational objectives. To be a successful and viable program, all objectives should be met by all the program outcomes. Program outcomes are supported by individual course outcomes.

![Diagram of hierarchy of program outcomes](image)

To be accredited by ABET, an engineering technology program, for example, requires to fulfill the entire set of eleven outcome measures as prescribed in ABET Criterion 2 [1] (Figure 3). Collectively this is known as a-k criteria. Each course outcomes are measured using only two or three of the a-k criteria. Eventually all of the a-k criteria are adequately covered by all the courses of a program.
An engineering technology program must demonstrate that graduates have:

- a. an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,
- b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
- c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,
- d. an ability to apply creativity in the design of systems, components or processes appropriate to program objectives,
- e. an ability to function effectively on teams,
- f. an ability to identify, analyze and solve technical problems,
- g. an ability to communicate effectively
- h. a recognition of the need for, and an ability to engage in lifelong learning,
- i. an ability to understand professional, ethical and social responsibilities,
- j. a respect for diversity and a knowledge of contemporary professional, societal and global issues,
- k. a commitment to quality, timeliness, and continuous improvement.

Figure 3. ABET Criterion 2. Program Outcomes [1]

Course Outcomes
Each course should concentrate on measuring only a few of the a-k criteria. Selecting two or three criteria should be an optimum choice for a course. The ABET criteria are abstract in the first place. The course instructor should develop few specific outcome measures for the course to reflect each ABET criterion. Tests, homework, or projects should be designed such that the course outcomes are adequately measured to satisfy the ABET criteria measurements.

Example
For each ABET a-k criteria, instructor needs to identify specific outcome measures to reflect course outcomes within each of the ABET criteria selected. Let us consider ABET criteria [a] and [f] chosen for a course, e.g. Microprocessor Assembly Language.

To meet ABET criterion [a] in this course, the following specific outcome measures may be decided on:

1. binary and hexadecimal number representations and manipulations
2. major elements of Intel processor, such as, registers, ALU, control unit
3. memory organization and working relationships of CPU and memory
4. mnemonics of assembly language
5. construct of assembly language including macros and procedures.
Likewise, to meet ABET criterion [f], the following specific outcome measures may be decided on:
1. analysis and breaking down a problem into components
2. prepare design for writing code
3. writing assembly language code to solve problems

Assessment and Continuous Improvement

Course assessment is primarily used to assign letter grades to students at the end of a semester. However, it is one of the most important feedback information to continuously improve the course and hence to the program. In fact, the other important purpose of all assessments is to improve the running system.

The potential to improve a program improves when assessments are made from various sources related to the program. Course assessment is one such source which is internal to the program. Some external potential sources are the industries who hire the graduates. Supervisors of students on internships and of those pursuing graduate studies are also potential feedback sources to improve a program.

Figure 4 shows some of these sources in a loop for continuous improvement. It includes a list of internal and a list of external sources for assessments. This figure lists nine (9) ways to improve a program. The list is in no way exhaustive.

Figure 4. Multiple assessments and selection of input criteria for improvements
The traditional way of obtaining feedback information from all external sources is by sending out questionnaires. The questionnaires need to be objective and short in size with limited number of questions such that the responder does not keep it aside to respond later or to ignore.

**Survey Instruments**

Individual instructor inputs to a course from his/her subjective intuition. Opinions of external bodies constitute important feedback information for continuous improvement process. A request can be made to employers for their opinions on the graduates who work for them. An employer is not obligated to respond. It is often required to remind the employer repeatedly for a response with no guarantee to get one. Therefore, a survey instrument should be made short to receive a limited number of feedback information. The responder should not be overwhelmed and discouraged with a large number of questions. Any trivial or obvious questions should be dropped off to make the questionnaire short and objective.

Appendix 1 shows one sample survey instrument developed to obtain feedback from the employers. The questionnaire is made keeping the program objectives in the focus. The overall objective is to determine the strength and weakness of graduates using simple statistical analysis. Each weakness should be critically analyzed to focus for improvement.

**Conclusion**

Complying with the ABET requirements brings or keeps the accreditation of the program. However, to keep the program improving continuously, it is necessary to follow the ABET criteria even after accreditation process is over. Directed effort towards continuous improvement should be considered as a part of the job of each instructor. In other words, it requires inherent dedication of the instructor to improve each and every course an instructor teaches and his/her focus on every possible corner to improve.

Figure 5 shows a never ending loop to stay tuned in. A program should remain engaged in assessment for finding newer ways for continuous improvement. The ABET or SACS assess the effect of continuous improvement effort at certain time interval. Department, College or the University should may have special committee to look over the activities of continuous improvement effort on a regular basis. Faculty retreats are good places to sort out the next steps for actions.

![Figure 5. Group assessment in a faculty retreat](image-url)
References


NRIPENDRA N. SARKER
Dr. Sarker is currently Lecturer in the Department of Engineering Technology of the Prairie View A&M University, TX. He also worked at universities in Bangladesh, Japan and UT - San Antonio. He received his Master’s and PhD degrees from the Texas A&M University at College Station. His research interests include simulation, algorithm development, and computer networking. He is the Chair of departmental ABET committee and a member of the College Committee for ABET at PVAMU.

MOHAN A. KETKAR
Dr. Ketkar is an Assistant Professor and Co-coordinator of Electrical Engineering Technology program at the Prairie View A&M University, TX. He received his M.S. and PhD in Electrical Engineering from the University of Wisconsin-Madison. He has served as faculty member at Lake Superior State University, MI, University of Houston and Prairie View A&M University. He is a member of the College Committee for ABET at PVAMU.
**APPENDIX 1**

PRIAIRE VIEW A&M UNIVERSITY
DEPARTMENT OF ENGINEERING TECHNOLOGY

**Employer Survey: Educational Program Based Questionnaire**

<table>
<thead>
<tr>
<th>Supervisor Name</th>
<th>Organization Name</th>
</tr>
</thead>
</table>

Date Answered _______

**Response scale:** 1 – Poor. 10 – Excellent.

*Instruction: Respond for those employees who graduated from PVAMU*

**Program Objective 1:** Produce graduates who will have successful careers in Computer Engineering Technology and related fields, thereby, fulfilling the purpose mission of the university in serving a diverse ethnic and socioeconomic population

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answer: 1 to 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 How do you rate the technical skills of the employee</td>
<td></td>
</tr>
<tr>
<td>1.2 How comfortable you are in hiring our graduates in the future?</td>
<td></td>
</tr>
<tr>
<td>1.3 The employee deserves special recognition</td>
<td></td>
</tr>
<tr>
<td>1.4 The employee is enthusiastic about taking challenging tasks</td>
<td></td>
</tr>
<tr>
<td>1.5 The employee’s communication skills</td>
<td></td>
</tr>
<tr>
<td>1.6 The employee’s skill to work on teams</td>
<td></td>
</tr>
</tbody>
</table>

**Program Objective 2:** Produce graduates who will be capable of advancing their careers by obtaining professional certificates, registrations, moving into other lucrative professions, and leadership positions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 The leadership skill of the employee</td>
<td></td>
</tr>
<tr>
<td>2.2 The employee has the potential to advance career by obtaining certifications, etc.</td>
<td></td>
</tr>
</tbody>
</table>

**Program Objective 3:** Produce graduates who can successfully obtain admissions to obtain admissions to pursue graduate degrees

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 The employee has higher degrees (MS or PhD) or attending for (Answer YES or NO)</td>
<td></td>
</tr>
<tr>
<td>3.2 Else the employee has the potential to pursue for advanced degrees</td>
<td></td>
</tr>
<tr>
<td>3.3 The employee has intuition to do research and has analytical skills to solve problems</td>
<td></td>
</tr>
</tbody>
</table>

**Program Objective 4:** Produce graduates who will understand and maintain professional ethics and the need to safeguard the public environment and the natural resources of the nation

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 How do you rate the employee in maintaining the professional code of conduct</td>
<td></td>
</tr>
<tr>
<td>4.2 The employee maintains high ethical standard in his/her career</td>
<td></td>
</tr>
<tr>
<td>4.3 The employee is aware of the importance of public safety in his/her career</td>
<td></td>
</tr>
<tr>
<td>4.4 The employee is aware of protecting the environment and the natural resources of the nation</td>
<td></td>
</tr>
</tbody>
</table>