

AC 2009-2542: ABET ACCREDITATION: BEST PRACTICES FOR ASSESSMENT

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ABET Accreditation – Best Practices for Assessment

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Abstract

The ABET process and purpose is very often one of the most misinterpreted notions in academia. While many people know the vision of ABET is to provide leadership in assuring quality and in stimulating innovation in the areas of applied science, computing, engineering, and technology education, they occasionally lose sight of the fact that this assurance resides within the quality of your own program. A common dilemma arises in how to properly showcase the quality of a program. Many programs have sailed successfully through previous ABET visits, but they find the newer process of outcomes-based accreditation somewhat overwhelming and do not know how to proceed. In addition, programs are uncertain of the best methods or tools to evaluate the level of achievement of expected outcomes for graduates.

Information available on assessment methods will likely include terminology, such as direct and indirect methods, but the exact definition or implementation of these methods frequently causes great strife. Common questions include, “What is the best assessment method?”, “How many assessment methods does an ABET evaluator want to see?”, or even “How do you incorporate assessment methods?” The most common assessment method utilized by departments to gather data for ABET purposes would probably be the survey mechanism. Although easy to assemble and distribute, it is not always the best means for assessment in every particular case. The purpose of this paper is to assist both established and newer programs with determining methods to successfully navigate through the ABET process. Development and implementation factors will also be discussed. The authors are both from an established ABET department but are in the process of incorporating newer methods for their accreditation process. Both experienced and new personnel working with ABET programs will hopefully learn more about utilizing assessment methods effectively in their individual program.

Background

Founded in 1932 under the name Engineers' Council for Professional Development, ABET (formerly Accreditation Board for Engineering and Technology) accredits post-secondary degree-granting programs. Many people interpret this to mean that ABET accredits departments, colleges, or even courses. In reality, ABET accredits programs, and your accreditation work should reflect the program as a whole.

Some programs treat the six-year time lag between visits with the following timeline:

- Year 1 – Celebrate success of previous ABET visit.
- Years 2-4 – Feel that ABET is a long time away.

- Year 5 – Begin to worry about ABET visit the following year, and survey every class imaginable to be ready for year 6 with the ABET visit.

This process invalidates the entire intent of ABET, which is to ensure continuous improvement within the program. The purpose of ABET is not to compare programs across the nation. It is take a closer look at your own program and see if you are providing and preparing students with the best program you can.

The undergraduate program in the Department of Aerospace Engineering at Texas A&M University has been accredited by ABET since 1942. The department has seen many changes with regard to ABET through the years. The terminology of continuous improvement and outcomes based assessment became linked to ABET accreditation in the most recently adopted Engineering Criteria 2000 (EC2000). The difference with EC2000 is its focus on the continuous improvement and what students learn through the program.¹ This criterion has brought about terminology that programs are not accustomed to utilizing in their day to day business. These terms included *objectives* and *outcomes*. In addition, *continuous improvement* has become so important to ABET that a separate criterion has been devoted to it in the latest update from ABET.²

Defining Objectives and Outcomes

Program objectives are long-range goals of what a program envisions their graduates will achieve. ABET regards objectives as being obtained by graduates a few years after graduation. Program objectives will usually focus on successful careers or being skilled practitioners. They are much longer range attributes a graduate accomplishes. One pitfall programs can face is that their objectives can many times be too closely related to what is expected of students at the time of graduation. Objectives should describe what is attained the first several years after graduation.

On the other hand, program outcomes are specific measurable qualities students must know or be able to do by the time of graduation. While they are normally measured as a student progresses through the program, the program must show they have been achieved by the time the student graduates. Programs will often times confuse the terms of *program outcomes* and *course outcomes* or *objectives*.

Courses within the program have defined course outcomes or objectives. While these need to be traced back to program outcomes, you must remember that ABET is about more than simply showing course outcomes are being met. You must complete the loop from measuring course details to program outcomes.

It can be very helpful for a department to map all of the courses in the curriculum to their ABET program outcomes. A portion of this mapping completed in our department is shown in Table 1. In addition, identifying the level on a scale of 1-5 that each course corresponds to the particular program outcome would be beneficial to your process as it would assist you in focusing your energies.

Courses/Topics	ABET Criterion 3											ABET Program Criterion				
	a	b	c	d	e	f	g	h	i	j	k	PC.1	PC.2	PC.3	PC.4	PC.5
DEPT Courses																
201	X				X							X		X	X	
301	X	X			X		X				X	X				
302	X	X	X		X		X				X	X				
303	X	X	X	X	X	X	X				X	X				
Required Topics																
Tech Writing							X									
Design Elective	X	X	X	X	X		X				X					
Comp. Methods	X			X							X					
Tech Elective	X				X						X	X	X	X	X	X
ENGR Courses																
Math Courses																
Science Courses																
University Core																

Table 1. Portion of Mapping of Courses to ABET Outcomes.

Stakeholders

As part of an academic institution, a department will have many stakeholders, or constituents. A state funded institution could even include residents of their state as stakeholders. Our department lists its stakeholders for our undergraduate students as follows:

- Current and prospective undergraduate students
- Faculty of the department
- Former students
- Employers of graduates of the undergraduate aerospace engineering program
- Aerospace companies, government agencies, public and private research agencies
- Parents and other relatives of students
- Departmental industry advisory board

At first glance, you might feel the need to involve each of your stakeholders equally in your assessment process. It is helpful to chart how each of your stakeholders affects your program. For example, current students and employers will have a direct interest in the quality of your program and need to provide vital input. Parents, on the other hand, are interested in the results but have no direct input into the program. One of the things we found as we examined our stakeholders was that we had overlooked faculty of the department previously as an employer of our graduates. Many of our undergraduate students continue onto to graduate school in our department. While we had considered faculty as providing input on the undergraduate education through undergraduate courses, we had not considered their input into our long-range objectives. This provided a nice piece to close the loop. In addition, it is important to incorporate your stakeholders to their full potential. While reviewing our ABET objectives and outcomes had been commonly part of our advisory board meeting, we found it helpful to have a separate agenda item relating to ABET. This provided us time to have a discussion with them about our activities and thoughts as opposed to reference to ABET being one of many slides in a departmental presentation.

Assessment and Continuous Improvement

Programs must assess student performance as part of their accreditation process. The assessment process includes collecting and analyzing the data to support a conclusion. It is essential to demonstrate objectives and outcomes for the program are being measured and accomplished. Programs often struggle with deciding what data to collect and ensuring the data is measurable.

In addition, your assessment process needs to show how results are applied to further improve your program. Documentation is vital, and it is important to keep current on the documentation. You will easily forget day-to-day activities regarding accreditation. Examine the suitability of including items you may be doing, such as content revisions, curriculum modifications, and updating labs. Accreditation involves improvement of a program, and your documentation should reflect this.³

Deciding how to evaluate your program outcomes needs to be determined. For example, a holistic approach to assessing your outcomes would be to survey all of your students and ask, on a scale of 1-5, how effectively they work in teams. You can then obtain an average and graph your results. Figure 1 displays an average of 3.2 for this particular outcome example. Having results in this manner makes it very difficult for you to determine where improvements need to be made. Figure 2, on the other hand, shows an analytical approach where specific, measurable statements identifying the performance required to meet the associated outcome were included. The measurable statements can also be referred to as performance criteria. As you can see, you are able to obtain more clearly the areas in which time and resources need to be spent.⁴ Only once you clearly define what you are looking for with regards to your outcomes can you properly assess them. If you are not defining your outcomes, you are only collecting data and not crucial information for your program.⁵

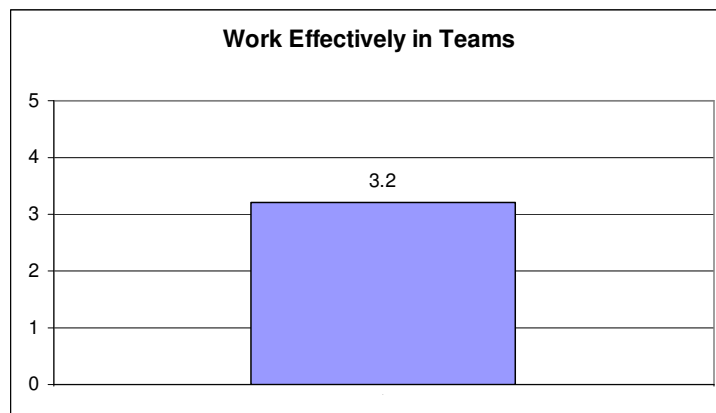


Figure 1. Holistic Approach to Assessment.

Work Effectively in Teams

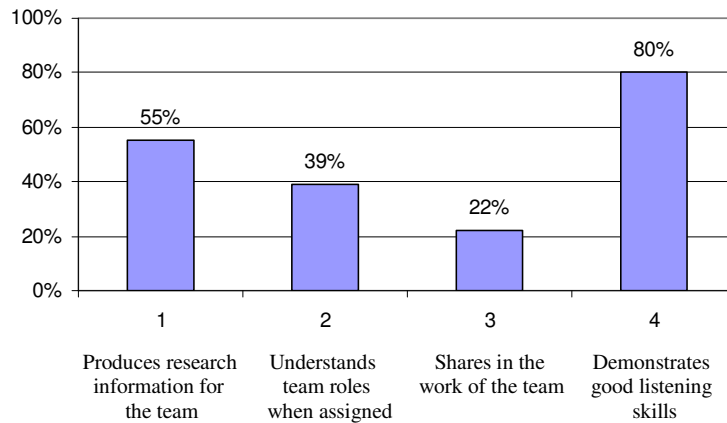


Figure 2. Analytical Approach to Assessment.

Assessment Methods

Assessment methods are divided into two main types, direct and indirect methods. Direct assessment methods provide for the direct examination of student knowledge or skills and are much more difficult to achieve. Direct methods include observing students and examining their work. Indirect methods are much easier to achieve as they involve self-reporting of the extent or value of the learning experience. While indirect methods are valuable, they rely mostly on opinion or self-reporting.⁶ The most effective assessment process involves using both direct and indirect methods and should include a variety of methods. There is not just one perfect method for assessing your program.

For most programs, assessing the long-range objectives is somewhat straight-forward. Former students and supervisors of these former students serve as the best resource for determining how successful students are once they are in the workforce. Input from your advisory board is also vital, especially if they hire graduates from your department. The most common assessment tool for objectives is a survey. While the response rate can sometimes be low when using surveys, it is important to keep them as short and to the point as possible. Surveys are not the time to ask every question you have ever wanted answered, but they can be useful tools to keep in contact with graduates and employers of your graduates for development and relationship purposes.

Assessing program outcomes, as you can imagine, invokes the greatest amount of time and resources. While ABET does not define outcomes for particular courses, the knowledge students gain in the classroom directly affects the outcomes of the program. Some programs feel ‘death by data’ is best and that all courses need to be evaluated regarding all outcomes every time the course is taught. While some programs have been very successful in the past relying on course grades and student self-assessment as achieving outcomes, some reviewers and even people providing ABET training do not feel this is adequate. Questions arise, such as: How many assessment methods are needed for each outcome? How do you adequately measure the soft,

non-quantitative skills, such as knowledge of contemporary issues, life-long learning, and professional responsibility?

While there are many different types of assessment methods available, we will discuss the most often utilized methods and then touch upon other types of methods.

Written Surveys

While surveys are considered indirect measures, they are usually the most popular form of assessment for program outcomes as well as program objectives. Administered to students and faculty, surveys ask individuals to share their perceptions about the program or course attributes. Having properly defined questions is a key to using a survey successfully. For example, we surveyed students in each of our undergraduate courses and asked them at the end of the semester to rate, on a scale of 1-5, how applicable the course was to each of our outcomes. In discussions with students we found high frustrations with this survey. Comments included students disliked seeing the same survey given in each of the classes whether the outcomes were relevant to the course or not. In addition, students felt unsure of what was meant by the particular outcome, which we felt would lead to inconsistencies in the data. For example, we asked students to rate their “Knowledge of aerospace structures”. Each student might have a very different interpretation of what type of knowledge we were looking for in this case. Therefore, having customized surveys for each of the courses, which includes performance criteria necessary to meet the outcome instead of simply stating the outcome, would prove much more beneficial.

In summary, surveys can be developed and administered quickly, and results are easily accessible and relatively inexpensive. They can be as short and simple or as in depth as you would like. Changes can be implemented quickly as the result of information received from survey. In addition, you are able to acquire information from various stakeholder groups as surveys can be web-based or even mailed to groups other than your current students. A difficulty with survey tools is that wording must be clear enough to be equally understood by all parties, and improperly worded surveys can cause a bias with your results. By adding open-ended questions to the survey, this can sometimes diminish these problems.⁴

Direct Interviews and/or Input

Interviews can be regarded as both indirect and direct methods of assessment, depending on the implementation. Interviews held between the department head and graduating seniors where the discussion focuses on their favorite class, favorite professor, etc. would be considered an indirect method since opinions or self-reporting is expressed. However, bringing industry members to observe student performance during a senior capstone course design review would be considered a direct method. We have found this particular use to be an excellent way to achieve non-bias input from one of our constituent groups who have a vested interest in seeing our students enter the workforce as prepared engineers. Industry members are able to evaluate our students on numerous areas, such as ability to communicate effectively, ability to design a system to meet desired needs, understanding of impact of engineering solutions, etc. While some may counter this type of input is simply a survey, it is truly a focused, direct, objective observation of student performance and is regarded as a direct assessment method.

Another mechanism for direct feedback of our program is through our industry review panel. The role of this panel is to: help the department determine how well it is achieving its program and curriculum goals and objectives; assess whether students are achieving the desired educational outcomes and to what extent the outcomes are being achieved; recommend changes in the curriculum, pedagogy, and procedures, to improve areas where outcomes are falling short; and recommend other changes, as appropriate, that may improve the educational process and overall quality of the graduating engineering student. Industry members interview graduating seniors and determine how well the department is meeting its desired outcomes. Once the interviews are complete, the interviewers generate a report and brief the department head. The report summarizes strengths and weaknesses of the academic preparation students receive and the extent to which the outcomes are being achieved, on a scale of 1-5, along with any corrective actions needed to achieve the desired outcomes. By having this review panel occur during the same visit as our senior capstone course design review, we maximize our participation from industry personnel.

Work experience opportunities for your students, such as co-op or summer internships also provide occasions to obtain direct feedback on performance of students. While we do not have a formal internship program where students are required to be registered for an internship course, we are able to obtain direct feedback from supervisors on the educational preparation of our students that participate in the co-op program.

In summary, direct interviews and/or input provides face-to-face interaction and further probing or explanation can occur if necessary. If you are located a long distance from your industry personnel, you might even consider having faculty from another department on campus interview your students. As long as they are cognizant of the department goals and desired outcomes of the educational process, faculty outside of your department can provide objective, direct feedback. Disadvantages to this process include the extensive time involved and the intimidation factor that outside individuals can often have on students.

Embedded Indicators

Direct assessment of student performance in a course directly tied to a specific program outcome is referred to as an embedded indicator. This type of information reflects a direct assessment method and can provide quite useful information. To be clear, embedded indicators do not refer to course grades, and we will discuss those separately. Embedded indicators relate to student performance on a particular activity, such as an exam question, project, or report, and correlate to a particular outcome. Courses that are more relevant to a particular outcome, such as shown in Table 1, are better choices for utilizing embedded indicators. It is important for the score of the activity to directly correlate to a specific outcome. This may take a little time on the part of the faculty member to directly associate test questions or weekly activities to a particular outcome. In addition, the management and statistical summary of results can be overwhelming for faculty and/or staff members but can be automated with a spreadsheet program to provide ease in obtaining results over time once developed.^{7,8}

In summary, embedded indicators provide beneficial, direct evidence in support of program outcomes. While time-consuming to identify and record, they provide strong evidence of student

learning. A senior capstone design course may be an ideal place to capture information on numerous program outcomes at the senior, near graduation, level.⁵

Portfolios

A collection of work samples from students is a portfolio. This method provides a direct method of assessment and allows multiple outcomes to be assessed at one time. Usually, portfolios will include work samples for a student beginning as a freshman. This allows learning and development over time to be showcased. In summary, portfolios are beneficial as multiple outcomes can be analyzed with one portfolio; however, developing and managing useful portfolios can be costly in terms of time and effort.

Standardized Exams

Typically purchased from a private vendor, standardized exams can provide direct feedback or comparisons based on a reference or norm group. While they can usually be quick and easy to employ, you must evaluate how well aligned the exam is to your outcomes. Many departments will find the Fundamentals of Engineering Exam results very beneficial; however, it provides less information for departments that do not have subject-specific examination parts, such as Aerospace Engineering. If only a small number of your students take the exam, the credibility of the results is considerably lessened, but they should be included. Be aware it is not a strong assessment piece in this case. In summary, standardized exams are available with no additional time involved in the development phase. In addition, national data can assist you with comparing to your students. Disadvantages include being limited in options for questions.^{4,5}

Course Grades

Course grades represent how successfully the student was able to meet the faculty member's requirements for the course. Many factors contribute to a particular grade in a course, so it is difficult to show demonstration of knowledge of a particular outcome based on an overall course grade.⁵ In addition, numerous program outcomes will be associated with each course, and it would be nearly impossible to single out the impact on one particular outcome. Scoring of assignments and exams and even evaluating final grades can vary from faculty member to faculty member, which increases the inconsistencies of using course grades as an informative assessment method. In some instances, course grades might provide useful information. If you are assessing *Knowledge of Propulsion*, a course grade might be used to exhibit accomplishment of this outcome. Course grades might even be the only information you are able to obtain from courses taught outside of your department that contribute to your program outcomes. Faculty from other departments will many times not assist you with the assessment process in other ways. In either case, the grades must be obtained consistently by faculty and directly reflect the specific performance criteria for an outcome. In summary, course grades can provide some useful information in certain situations, but they should not be solely relied upon to demonstrate achievement of a particular program outcome.⁹

Rubric Tools for Assessment Methods

Rubrics are helpful scoring tools for use in many assessment methods as they assist you with listing your criteria and describing the components you are evaluating. By specifically detailing how you would like a particular performance criteria appraised, consistent data will be easier to

obtain. Figure 3 shows a portion of a rubric used in the analytical approach showcased earlier in the teaming example in Figure 2. Rubrics contain statements, which define the achievement levels, such as unsatisfactory, developing, satisfactory, and exemplary, for each performance criteria. This assists the user in determining the correct category for evaluation and provides more consistency across multiple users. Rubrics also provide clear direction of where your students are performing, as shown in Figure 4. They can be useful in conjunction with embedded indicators and direct interviews for example.⁴

Performance Criteria	Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4	Score
<i>Produces research information for the team</i>	Does not collect any information that relates to the topic	Collects very little information with some relating to the topic	Collects some basic information with most relating to the topic	Collects a great deal of information with all of it relating to the topic	

Figure 3. Portion of an Example Rubric.

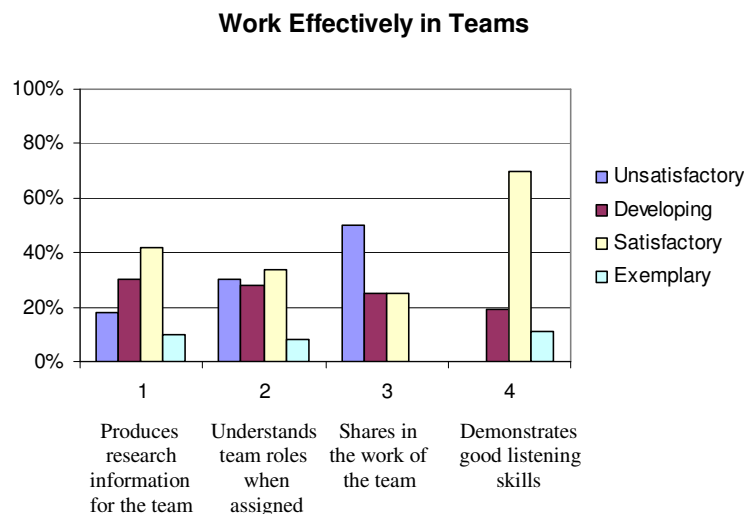


Figure 4. Analytical Approach to Assessment Through Using a Rubric.

Summary

As you develop your assessment process, remember there is not simply one magic assessment method for your program. All assessment methods contain some bias and have their limitations. A comprehensive assessment program contains both direct and indirect assessment methods using a multi-source approach with regards to your stakeholder groups to maximize validity and reduce bias of any one approach. By incorporating multiple methods for each outcome, you will be able to obtain converging evidence that supports achievement of knowledge is acquired. You

should strive for at least two assessment methods for each outcome, and three methods would be preferable with one of them being a direct method. A solid direct method in combination with surveys or other indirect methods for support would be ideal.

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