Assessment Rubric for Global Competency in Engineering Education

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Abstract

Educating engineering students for global competence is increasingly required to keep up with the contemporary global environment. As more engineering programs are incorporating global competency into their curriculum, more attention needs to be paid to how you assess that competency. Implementation and assessment of international experiences for engineers has been studied in the last ten years. Largely absent, however, are studies featuring rigorous methods for assessing competencies specifically related to professional practice within the academic discipline. Discipline specific measures for assessing international engagement in engineering need wider implementation.

Only one of the ABET EC2000 Criteria 3 student outcomes mentions the word 'global" explicitly, criteria h. However, the three others that are compatible with assessing global competency are c, j and k. Of these four criteria, two of these are hard, technical skills, and two are competencies related to professional practice within the academic discipline. A number of studies have produced assessment rubrics for measuring global competence in general, but not as they relate to ABET student outcomes. A rubric is proposed that encompasses both the technical and the professional skills needed to assess global competency as related to four Criteria 3 outcomes. The rubric includes a spectrum for attitudes, knowledge and skills, an examination of an internal frame of reference and behavioral observation. Skills related to global competence are categorized in terms of awareness, perspectives and participation for each of the four student outcomes with an expanding scale of capability.

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Introduction

Change is happening worldwide at a pace so fast that it can be considered revolutionary. Seven of these areas are defined as the 7 Revolutions. The issues that are most global include population, resources, technology, communication, economics, conflict and governance[1]. It is difficult to keep up with these interconnected challenges. Charles Darwin is credited with once having said "It is not the strongest of the species that survives, nor the most intelligent, but rather the most responsive to change".

In 2008, the NSF funded a National Summit Meeting on the Globalization of Engineering Education. The outcome of the meeting was a report that describes how technical and geopolitical developments in the past 20 years have impacted the way engineering is conducted. The report includes a discussion of the rationale, urgency, the obstacles and hurdles, and the impact of the current economic downturn, and culminates in the Newport Declaration to Globalize U.S. Engineering Education[2]. The declaration presents a compelling case that it is imperative that all engineering students in the U.S. develop the skills and attitudes necessary to interact successfully with people from other cultural and national environments. As more U.S. engineering programs are now incorporating global competency into engineering it becomes more important to have choices of assessment methods for those outcomes.

Given the imperative stated by the Newport Declaration and the global environment that engineers are operating in, more definition is needed concerning assessment of the global component within engineering disciplines. The best way to promote assessment methods is to reference specific criteria as outlined by ABET (Accreditation Board for Engineering and Technology). Although EC2000 ABET Criterion 3, Student Outcomes (a-k) only mention the word 'global' one time, a global theme can be implemented in a number of other student outcomes. For example, j is knowledge of contemporary issues. The measureable abilities should include a component of being knowledgeable about how global issues affect our engineering. A contemporary issue that is global in nature and affects how we do engineering is the case of how terrorism affects airline safety.

The engineering community is adding a global component to their programs in individual ways. For example, Lohmann[3] talks about Georgia Tech and defines the general requirements for their international plan as having three components. The components of global competence education are

1) Course requirements
2) Second language requirements
3) International experience requirement

Amadei[4] at the University of Colorado Boulder describes a program in engineering for developing communities to educate globally responsible students. Their vision calls on engineers to not just solve problems of the one billion rich people on the planet, but also for the five billion poor people. Johnson[5] describes an engineering program as a collaboration between engineering and language departments that includes an extended study and work abroad component. The program's success is inspiring given that the university is small and has limited resources for implementing new programs. Shuman[6] summarizes the contributions of many different schools in incorporating this component into their engineering program as it relates to the assessment of professional skills in particular, which are more difficult.

Morell[7] describes the impact on engineering education of a knowledge based economy from an industry perspective. The key foundation for this work is to develop national/regional economic development strategies worldwide. Recommendations on education reform include students being active participants in their education process, faculty actively improving education, active learning approaches including laboratories and internships, and an engineering curriculum that is broad and flexible.

Global Competency Outcomes

Only one ABET Student Outcome of Criterion 3 specifically mentions the word 'global'. Criterion 3h is defined as 'the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context'. The economic, environmental and societal contexts are all components of a contemporary global perspective.

Three other outcomes lend themselves easily to an interpretation involving global issues. The first is c, defined as 'an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability'. Realistic constraints include constraints imposed by other cultures, natural resources and governments.

Another outcome is j, defined as 'knowledge of contemporary issues' and the last is k, which is 'an ability to use techniques, skills and modern engineering tools necessary for engineering practice'. Contemporary issues in engineering encompass the need for solutions on a planet wide scale, as detailed in the 14 Engineering Grand Challenges. Modern engineering tools necessary for engineering practice include developments in capability by other countries that can't be ignored in any industry that sells products to an international market.

Shuman describes assessment in terms of skills that are highly technical in nature, calling those hard skills. Student Outcomes as 3a, b, c, e and k are listed as hard skills with the remainder of the a-k outcomes falling under the heading of professional skills. These skills include 3d, f, g, h, i and j. Shuman says that these professional skills are not assessed the same as the hard skills with 3h, i and j being defined as "awareness" outcomes. Those outcomes hope to capture the students' ability to know how to be aware of the importance of each and incorporate them into their problem-solving activities[6].

These three outcomes (h, i, j) focus on influencing engineering students' aims, attitudes and values as they practice their engineering "hard" skills. These awareness skills center on the students attitudes and values, therefore it makes sense to use behavioral observation as an assessment technique for measuring frequency, duration, topology of student actions, usually in a natural setting with non-invasive methods[6].

At the start of EC2000, Prus and Johnson[8] proposed six types of assessment methods for all of (a-k) Student Outcomes. Although multiple methods should be used for measuring each outcome, not all methods will work for the "awareness" oriented outcomes. The six assessment methods are:

1) Tests and examinations
2) Measures of attitudes and perceptions
3) Portfolios
4) Performance appraisals and simulation
5) Behavioral observation
6) External examiner

Student Outcome h explicitly incorporates and c, j and k implicitly incorporate elements that can be globalized. Two of these outcomes are hard skills (c and k), two are professional skills (h and j). You can assess the global component of hard skills c and k. You can do that through an assignment that has a global perspective. It becomes an adjustment to the scope of the program. The professional skills are somewhat more energy intensive to assess. You have professional skills, best understood as "attitudes", and you assess attitudes using behavioral observation.

Three outcomes (h, i, j) focus on influencing engineering students' aims, attitudes and values as they practice their engineering "hard" skills. How do you assess attitudes and values? Attitudes are distinct from, but related to, behavior. You can see that in the results of an implicit association test. Your attitudes influence but don't guarantee a certain behavior. It has been shown that work sampling in some cases as a substitute for 100% behavior observation[9]. Sampling theories have been extended to the observation of intervals that can capture, accurately, the cognitive, behavioral and affective domains for processes that engineers normally engage in, including working in teams, conducting design work and addressing ethical issues. Levels of awareness in terms of testable skills allow for an assessment of the overall global awareness, perspective and participation.