AC 2007-500: FULFILLING ABET OUTCOMES BY SENDING STUDENTS AWAY

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Fulfilling ABET Outcomes by Sending Students Away

In 2000, the Accreditation Board for Engineering and Technology (ABET) mandated a new process of engineering program accreditation. The old system of counting course credits was largely abandoned and replaced by an outcomes-based process. Institutions must present evidence that graduates possess certain abilities such as communication skills and teamwork, in addition to technical discipline-specific knowledge content. One of the new outcomes is "that graduates understand the impact of engineering solutions in a global and societal context". Many engineering schools struggle with how to achieve this outcome and the problem does not have a simple solution. Although it is possible to devise educational experiences on-campus that might provide opportunities to satisfy this outcome, there is little doubt that education abroad experiences would better achieve it. Typically, traditional engineering curricula are packed with requirements; transfer credit issues exist with foreign universities; most engineering students are not multilingual; and many tend to be risk-averse individuals for whom travel abroad is not a part of their educational "culture". Very often an experience abroad can lengthen time to graduation. Of the 78,227 engineering and engineering technology bachelor's degrees awarded in 2004[1], fewer than 6,000 had an international experience [2]. More than 90% of engineering graduates currently enter a global profession with little or no international experience.

Nationally, progress is being made and one result is an emergence of various study abroad models such as industrial internships, international co-ops, service-oriented models, and traditional exchange programs. A diversity of structures and sojourn lengths means a variety of student experiences and hence different student outcomes. Measuring student outcomes and understanding the learning experience is critical for continuous improvement and satisfying accreditation agencies. In this paper, we will focus on a particular model involving student research projects in international locations, and will describe how the learning outcomes of the program are assessed for purposes of accreditation evidence and program improvement.

At Worcester Polytechnic Institute (WPI), about half of all engineering graduates travel internationally to do academic work through the university's Global Perspective Program, a program that grew from the project-based educational structure implemented at WPI in the early 1970s. WPI sends more engineering students abroad than any other US university[2]. A unique program aspect is that students satisfy WPI general education and engineering academic requirements while abroad; this allows timely progress toward degree completion. WPI has established residential programs in Europe, Africa, Asia, Latin America, Oceana, and the US for undergraduates to complete required academic experiences off-campus in a pre-professional experience under the direct supervision of WPI faculty. The program involves independent research projects for sponsoring agencies and organizations, and is thus quite distinct from traditional study abroad. In 2005-2006, 69% of WPI's graduating class of 561 students completed one at least one academic project off campus on an externally sponsored topic. In the current academic year WPI will send more than 500 students to one of its off-campus residential Project Centers.

WPI's Global Perspective Program was designed upon established learning principles [3 - 10] that support learning by doing, challenging students with open-ended ambiguous problems, overcoming segmented thinking by working outside of the major discipline, and exposing learners to cultural, social, and intellectual diversity. It has its roots in a university-wide curriculum reform that began in 1970 when a new curriculum replaced a traditional, course-based technical curriculum with a project-based program emphasizing teamwork, communication, and the integration of technical and societal concerns. WPI worked to structure a curriculum that graduates socially conscious, globally literate engineers. Architects of the curriculum sought to break the barriers of traditional course boundaries and rigid curriculum requirements by placing students in contexts that provide learning opportunities consistent with the university's mission. Among the program degree requirements are three substantive projects: one in the humanities and arts, one in the student's major area of study (Major Qualifying Project - MQP), and one that explores the interrelationship between society and technology (Interdisciplinary or Interactive Qualifying Project - IQP). WPI students are offered the opportunity to fulfill each of these degree requirements off campus through the Global Perspective Program.

Operationally, WPI's Interdisciplinary and Global Studies Division (IGSD) administers all program aspects of the Global Perspective Program including facilitating student selection, providing advisor training, site and project development, and overseeing risk management, re-entry programs, and overall academic quality. Typically 24 students travel to a site for a 2-month period to work full-time to complete the projects. Two faculty advisors accompany each group. A WPI faculty member serves as project center director, the permanent "program champion" responsible for setting up projects, handling general academic issues, and overseeing center operation. At some sites, a permanent resident assists the center director particularly with housing and logistical concerns. Student preparation for the experience includes formal coursework taught by WPI faculty, and orientation/cultural preparation taught by WPI professional staff. The same staff handles health and travel issues, risk management, and re-entry issues. [11, 12, 13]

To gain an understanding of the social, professional, and cognitive growth demonstrated by students as a result of their global experience, WPI employs a variety of research and assessment tools for program evaluation. The multilevel, multi-temporal assessment process includes a fairly well developed and comprehensive program-level assessment, a new faculty-level assessment, and frequent student-level evaluations. Here we will focus on the assessment of the junior level interdisciplinary project reports. A complete discussion of the various assessment measures for the different levels can be found in other publications.[14]

For purposes of program assessment, the students' formal written reports, both for on and off-campus teams, are read periodically and evaluated by a team of paid faculty reviewers. This practice was established several years ago. Although the assessment probes only the final written product, and not the process by which it is developed, WPI has found this approach quite useful in identifying characteristics of high quality projects.

Each year that this effort is undertaken a team of 11-12 reviewers is identified and recruited in the spring and meets for two half-day workshops for training and calibration. The assessment is

based on an extensive evaluation form for assessment of each report. Prior to each review cycle the form is reviewed, discussed, and updated as appropriate. To standardize the evaluation, rubrics have been developed to provide guidance for rating various aspects of the reports.. In order to calibrate the reviewers, each reviewer is given the same three project reports to read and evaluate using the form. The group convenes for a second half-day to debrief everyone's evaluation, attempt to calibrate each other against the rubrics, and minimize variance in application of the rubrics. Very often rubrics are rewritten on the basis of the discussion. The evaluation form covers such aspects as project objectives, quality of the literature review, application of appropriate methodologies, findings and analysis of data, achievement of educational goals, and quality of the writing and presentation.

To address ABET EC 2000, the following outcomes are included in the assessment: [15, 16]

- an ability to function on multi-disciplinary teams;
- a recognition of the need for, and an ability to engage in life-long learning;
- a knowledge of contemporary issues;
- an understanding of professional and ethical responsibility;
- the broad education necessary to understand the impact of engineering solutions in a global and societal context.

Figure 1 presents example rubrics for the final outcome on the preceding list. The evaluation contains two parts intended to allow an objective assessment of both on-campus and off-campus project reports.

Figure 1. Rubrics for Evaluation of Accreditation Outcome for "Impact of Engineering Solutions in a Global and Societal Context"

Exposure to Global Issues and/or Foreign Cultures

Rating 5: excellent
The project was conducted at a foreign off-campus site and dealt, in a substantive fashion, with topics that were clearly global in nature or international in scope. If conducted on campus the project focused on and effectively analyzed topics that were clearly identified as global or international.

Rating 3: acceptable
The project was conducted at a foreign off-campus site or dealt, in a substantive fashion, with topics that were clearly global in nature or international in scope.

Rating 1: poor
The project was conducted on campus and contained only oblique indications that the students were aware that some of the problems being addressed were global or international in character.

Impact of Engineering Solutions on Society

Rating 5: excellent
The project is focused heavily, if not entirely, on such an impact and evaluates it effectively using the most appropriate methodologies. (Implies a rating of 4 or higher on methodology and overall quality.)

Rating 3: acceptable
Evaluation of such an impact is a significant component of the project and was conducted using sensible methods (if not state of the art). (Implies a rating of 3 or higher on methodology and overall quality.)

Rating 1: poor
Evaluation of such an impact is a relatively peripheral or incidental component of the project and appropriate methodologies either were not employed or shed little light on this issue.

Each reviewer is randomly assigned 15-20 reports to read and evaluate. Data from each form is entered into a database for analysis. Most student reports approach 100 pages in length. The evaluation form has 35 questions and sub-questions, including comment entries. Hence, the reviewer's task is substantial.

Within the IGSD, an Assessment Coordinator analyzes the results and prepares a summary report to the WPI community. Separate reports are prepared for each engineering department summarizing results for its own students. The faculty and staff involved in administering the Global Perspective Program work collaboratively on continuous improvement issues as informed by assessment measures such as the one described. These may involve changes in the student preparation, advisor training, sponsor consultation, resource allocation, or any other issues identified as problematic from the review process.

One striking result of this program assessment has been a persistent and significant quality gap between on-campus and off-campus projects. This gap became apparent once a significant number of students were completing projects off-campus, and it has grown steadily since 1997. Assessment results show that projects conducted by student teams at off-campus sites consistently outrank those done on campus in nearly aspect. This is illustrated in the following tables. Note that although GPP participants are selected through an application process, significant GPA differences do not exist between them and on-campus students. A possible explanation is that factors such as learning preferences, motivation, willingness to take intellectual risks, teaming skills and other attributes separate the off-campus cohort from its peers who stay on campus. Work probing this issue and its correlation to self-directed learning motivation has yielded some interesting results discussed elsewhere. [17]

In the following tables average ratings for key ABET outcomes are shown for on-campus projects and off-campus projects. With one exception, the off-campus project reports revealed acceptable evidence that students meet these outcomes. The on-campus cohort was 244 students representing 119 teams, and the off-campus cohort was 242 students representing 77 teams.

Table 1: Average Scores for On-Campus and Off-Campus Cohorts Relative to Some Accreditation Outcomes (The rating scale is 1=poor, 3=acceptable, to 5=excellent)

Desired Accreditation Outcome	On-Campus	Off-Campus
Multidisciplinary team and topic	2.91	4.14
Evidence of ability to engage in life-long learning	2.99	4.14
Understand impact of engineering on society	2.45	3.33
Knowledge of contemporary issues	3.06	3.68
Understanding of professional and ethical	2.17	2.79

responsibility		

Overall, these assessment results strongly suggest that the off-campus project experience results in uniformly better learning outcomes than the on-campus experience. As a result, WPI has launched a number of initiatives intended to enhance on-campus project work, including more resources and workshops for faculty advisors, opportunities for advisor mentoring, and a well-advertised annual Project Fair at which students can search for projects that interest them. The assessment has also indicated areas for improvement across all projects and has provided us a base from which to design that improvement. Since the assessment is directly related to the educational objectives of the projects, curricular improvements designed to address program deficiencies can be made with some confidence.

An area for future work is to incorporate student opinion into the programmatic assessment of the projects. A student evaluation form for the junior year project has been developed and is under faculty review; if approved, it will be implemented starting in the fall of 2007. Data gathered from this tool will further inform WPI as to what improvements need to be made to the program. Efforts are underway to explore with faculty advisors ways to further probe the academic experience for students beyond the product and perhaps provide some insight into the process as well. The analysis from these two sources of data along with a sustained assessment of the final project product will continue to guide how WPI delivers its education and in turn will be used to illustrate to ABET how the institution's engineering programs satisfy ABET EC 2000.

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