AC 2008-2384: A DIRECT METHOD FOR TEACHING AND ASSESSING PROFESSIONAL SKILLS IN ENGINEERING PROGRAMS

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A Direct Method for Teaching and Assessing Professional Skills in Engineering Programs

Abstract

Proficiency in ABET professional skills (the knowledge, attitudes and values described in outcomes 3f-j) are critical for success in the multidisciplinary, intercultural team interactions that characterize engineering careers in the 21st century. While there have been many program-level efforts across the nation to develop these "soft" skills, such as capstone projects that incorporate study abroad and service learning, no direct method of measuring all six skills simultaneously exists in the literature. This project proposes an innovative and direct method of developing and assessing ABET professional skills simultaneously that can be used at the course-level for assessing student performance and at the program-level for assessing efficacy of the curricula.

In 2007, the Center for Teaching, Learning and Technology (CTLT) at Washington State University (WSU) collaborated with the College of Engineering and Architecture's eight engineering programs to develop an authentic performance task called the *curricular debrief,* as well as a scoring tool based on the ABET professional skills and the nationally validated WSU Critical and Integrative Thinking Rubric. Up to eight randomly-selected senior-year students from each program participated in the curricular debrief sessions. Students were presented with an authentic, unresolved engineering problem in their field and asked to discuss implications and propose some approaches to address the multi-faceted problem. Assessment specialists then trained 21 faculty from the eight programs on how to use the rubric to rate transcripts of the curricular debrief discussions. Based on the rating results, faculty then proposed next steps for improving teaching and assessment in their individual programs.

Results from the preliminary round of curricular debriefs showed that students in most programs were fairly unaware of contemporary issues in their engineering field, as well as unaware of related current national or international concerns. Students were also challenged with understanding the impact of engineering solutions in multiple contexts, particularly societal and global. Communication during the discussion was also a common challenge for students, as some seemed unfamiliar with sharing leadership or opposing views while respecting differences. In some sessions, a few students tended to dominate discussion and make decisions for the team without coming to consensus, while other students hung back and rarely contributed.

Introduction: The 21st Century Challenge

One of the primary issues facing American engineering in the 21st century is the global sourcing of complex services. Prior to 2000, outsourcing of routine engineering functions was commonplace. With growing demand and the improvement of off-shore engineering skills, engineering design, research and development, and innovation (once a trademark of American leadership in engineering) are increasingly moving abroad.[1,2] To ensure competitiveness of American educated and trained engineers in the rapidly changing environment of the global economy, engineering education must not only help students develop strong scientific, technical and mathematical foundations, but also an integrated approach to problem solving that moves

beyond traditional engineering parameters. James Duderstadt, President Emeritus and professor of science and engineering at the University of Michigan, asserts that the next generation of engineers will need to be particularly skilled in three areas: the ability to innovate, the integration of knowledge, and global competency. He argues that engineers must become "polymath", or knowledgeable in many fields, in order to effectively address the complex needs of tomorrow's society. In *Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research and Education*, Duderstadt claims that in spite of the positive additions of the six professional skills to the ABET engineering criteria, engineering education in the US today is "falling far short of preparing engineering graduates for practicing—and leading—in a change-driven, knowledge-intensive, global society that will characterize the decades ahead."[3]

In Restructuring Engineering Education: A Focus on Change, the NSF recommends that engineering courses include early and continued exposure to environmental, political and social issues and their international and historical contexts, as well as legal and ethical implications of engineering solutions.[4] Oberst and Jones argue that engineers shape and are shaped by "the emerging realities of a truly global workforce. Engineers as a professional group are thus canaries in the mineshaft of the new world economy. Whether engineers manage the transition from local to international workplace environments will determine if the profession remains attractive."[5] In *The ABET "Professional Skills" – Can They Be Taught? Can They Be Assessed?* Shuman, Besterfield-Sacre, and McGourty raise the call to teach and assess students in the collaborative team environments in which they will operate as engineers. And in today's marketplace, these skills must go beyond communication.[6] "The so-called soft skills are much more than public speaking, management skills, and the ability to work well in teams. What is also needed is an understanding of how the growing social consciousness around the world is making it imperative that engineering students understand the implications of their work."[7]

Although the ABET professional skills are now of critical concern to the assessment of student learning in engineering fields, "there is no universal approach to implementing and assessing the ABET outcomes-based criteria. Each program must interpret the criteria as they fit for them."[8] A variety of innovative and rigorous methods have been developed by programs around the nation to develop and assess these professional skills. Yet, most of the assessment tools evaluate one skill at a time, such as lifelong learning or ethical awareness, or they measure the skill indirectly through focus groups or surveys eliciting student opinion.[9]

ABET Associate Executive Director Gloria Rogers recommends that engineering programs "use a multi-method/multi-source approach to maximize the validity and reduce the bias of any one approach. It is also important to have at least one direct method that provides for the direct examination or observation of student knowledge or skills."[10] Engineering education researchers McMartin, McKenna & Youssefi echo this sentiment, noting that although faculty and administrators have traditionally depended on student surveys or multiple-choice tests as measures of student learning, "these measures…do not demonstrate a student's actual ability to accomplish a particular outcome…Unlike these measures, performance assessments are designed to get at the more difficult aspects of higher learning by solving realistic or authentic problems. Student performance can best be measured by observation."[11]

The Curricular Debrief: An Overview

To respond to this nationwide call to align teaching and assessment with the team environments and global contexts confronted by today's engineers (a concept Shuman et al refer to as "high fidelity"), Washington State University's Center for Teaching, Learning & Technology (CTLT) collaborated with eight engineering programs in the College of Engineering & Architecture (CEA) to develop a direct method of measuring all of the ABET professional skills simultaneously, called the *curricular debrief*. This direct, authentic assessment method engages small groups of students during the timeframe of one class period to discuss a complex problem in their field that has yet be resolved. Faculty raters, assessment specialists, and professionals in the field assess student team performance using a rubric based on the ABET professional skills.

The curricular debrief fits Shuman et al's definition of a performance appraisal: "Performance appraisals are competency based methods (also commonly referred to as authentic assessments) used to measure pre-operationalized abilities in a real-world like setting. Such an appraisal provides a systematic measurement, usually in the form of a rubric, for the demonstration of an acquired skill...Because it goes beyond the typical paper and pencil approach common to other assessment methods, a performance appraisal is suitable for measuring such behaviorally based skills as evaluating an ethical dilemma or working on teams."[12] The ill-structured problems of the curricular debrief are presented as scenarios: "Scenarios are grounded in the theoretical approach of situating learning in an authentic context. The idea is to provide students with the kinds of tasks that they might confront in actual practice in order for them to engage in realistic problem solving and learn how to flexibly apply their knowledge."[13] CTLT then facilitated eight 45-minute curricular debrief sessions spanning the breadth of the university's engineering programs. The sessions included up to eight randomly-selected students from each program. In the case of two programs in which the student body was very small, all seniors in the program participated.

After each curricular debrief session, a CTLT assessment specialist and two or three engineering faculty from each program (twenty-one in all) came to consensus on how the ABET skills were expressed in student team performance using the pilot discussion transcript and rubric. This process is called "norming" and is an important part of establishing inter-rater reliability. Raters must come to consensus as to what constitutes quality in their program as evidenced in the team performance and expressed in the rubric's criteria. It is generally recommended that raters' scores fall within one point of each other. During these sessions, when there was still disagreement of more than one point, continued discussion and rating ensued until consensus had been reached. At times, this discussion resulted in further refinement of the rubric's criteria. These revisions reflect a continuous process to ensure reliability and increase content validity informed by the rubric's use in practice. Faculty and assessment specialist teams then rated team performance on the scenario corresponding with their program using the same process, and results were used to inform program improvements in a collaborative effort.

Assessment specialists analyzed ratings for each program, averaging the scores of all reliable raters for each dimension and reported results confidentially to each department in graphical and written form. An overall average for each student team was not reported, as we felt that

combining scores on different dimensions blurred differences in dimensional performance that may be useful to programs.

Soon after, a CTLT representative met with faculty raters from each department to discuss results and implications. Rubric revisions were also made according to faculty rater suggestions and presented to each program. Recommendations for teaching and program improvements were collaboratively developed by CEA faculty and CTLT staff, giving the engineering programs a sense of agency in the process.

This process helped faculty develop shared understandings of the ABET skills and how they may be expressed in student team performance, set program outcomes or performance benchmarks, apply results to teaching improvements, and track longitudinal growth. It also offers rich opportunities for faculty development and collaboration with industry professionals. The curricular debrief method can also be used as a teaching tool, so that students can practice their ABET professional skills in just one class period, gaining insight from faculty and peer feedback.

The Scoring Tool: Guide to Assessing ABET Professional Skills

First, a rubric to be used as the rating tool was developed for the ABET professional skills. "Rubrics are scoring guides that describe the various levels of student performance for a specific learning outcome."[14] CTLT's process for establishing reliability of the rubric was informed by research on tool validation, such as that of McMartin et al: "The primary goals for testing the tool were to establish if it was a reliable tool, i.e., that it yielded the same results over repeated uses and that there was a strong inter-rater reliability. Additional goals were to…establish procedures for administering the tool correctly, to establish the dependability of…evaluators using the rubric, and to determine if the rubric and scoring process could reliably identify differences in student responses."[15]

Because the WSU Critical and Integrative Thinking Rubric (CITR) has been validated nationally and internationally through its successful use at other institutions, CTLT assessment specialists mapped the ABET skills to corresponding dimensions of the CITR. For example, the ABET skill 3f "understanding of professional and ethical responsibility" was defined using language from Shuman et al: "Students clearly frame the problem or issue and begin the process of resolution."[16] This skill was then mapped to corresponding dimensions on the CITR, such as "identifies the problem, question or issue" and "identifies conclusions, implications, and consequences." The resulting Guide to Assessing ABET Professional Skills is the product of a collaborative effort between CTLT assessment specialists and each WSU engineering program and includes five dimensions representing ABET Skills 3f-j, with accompanying descriptive criteria for six levels of team performance from emerging to mastery. CEA assessment committee members determined that a score of four on the six-point scale represents WSU's standard for graduating seniors. This will allow students to exceed expectations (with scores between 4.0 and 6.0) in future years as the ABET skills are more directly addressed within the curriculum. Figure 1 illustrates the criteria for ABET skill 3f, understanding of professional and ethical responsibility. See Appendix A for the entire rubric.

ABET Skill 3f. Understanding of professional and ethical responsibility
Students clearly frame the problem and begin the process of resolution. Students consider related ethical issues related, such as health and safety, fair use of funds, and doing "what is right" for all involved.

Struggling	Developing	Mastering
0 1	2 3	4 5 6
*Students do not identify or summarize the problem.	*Students start to frame the problem, although some key details are glossed over. *Students discuss one or more approaches to resolve the problem.	*Students clearly frame the professional challenge and issues related to the problem. *Students develop appropriate, concrete approaches to resolve the problem.
*Students do not consider ethical issues related to the problem.	*Students show some recognition of relevant ethical issues, but don't adequately address them in proposed approaches to resolve the problem.	*Students clearly identify relevant ethical issues and address them in proposed approaches to resolve the problem.
Comments		

Figure 1: ABET skill 3f, Guide to Assessing ABET Professional Skills

The Scenario and Student Instructions

CTLT developed authentic scenarios for each of the eight engineering programs, adapted from current news stories on global engineering issues. Reputable news sources such as the New York Times, the British Broadcasting Corporation, and National Public Radio, as well as specialized engineering sources such as Engineers without Borders, were consulted. All scenarios were approved by each CEA program, and an effort was made to balance the level of difficulty and applicability for each program.

The scenarios were intended to mimic the typically ill-structured and multi-faceted problems faced by engineering teams in the workplace. They were prefaced with instructions that encouraged students to discuss the implications of the problem and develop approaches to address it, rather than immediately develop solutions. After all, practicing engineers must approach problems holistically, working as a team to assess data sources, address contextual issues, and communicate with stakeholders before deciding on solutions. "The scenario assignment is not intended to measure a student's scientific knowledge. Rather, it is a realistic open-ended task that draws on a student's critical thinking skills as well as problem formulation and management expertise."[17] See Appendix B for instructions and sample scenarios.

The Student Discussion

Before each of the 45-minute curricular debriefs, a CTLT facilitator informed students that results would be confidential and that comments would not be connected with names. Students

signed informed consent forms to participate. They were also told that the purpose of this exercise was to assess how well each program was doing with their curriculum and not an assessment of individual student's abilities. Next, students were given a copy of the written scenario and instructions, and the instructions were also read aloud. Because the curricular debrief was designed to obtain a baseline measure of how well the ABET professional skills were already embedded and being applied by the students, student teams were not prompted if they were off-track until 15 minutes had passed in which they did not seem to be addressing specific skill areas on their own. This also allowed time for the natural flow of discussion to evolve so that students could build on each others' ideas and exhibit the professional skills on their own.

When teams seemed stuck for more than 15 minutes or did not seem to be addressing the elements of the issue indicated in the rubric, a facilitator prompted them with one or more open-ended questions. These prompts included, "What do you already know from the scenario? What can you safely infer from the information provided? What additional information do you need and why? What sources would you consult to find out what you need? What strategies will your team use to communicate with stakeholders?" For most student teams, it was not necessary to use all of the prompts, and for some, no prompting was needed.

For accurate record-keeping, a second CTLT staff member kept track of speakers during the session with labels such as "Student 1, Student 2," etc. This person also noted the first sentence of each utterance to ensure that later transcriptions followed the flow of speakers correctly. Sessions were audio-taped and later transcribed in entirety to form the final transcript used for ratings.

The Rating Process

During the norming session, faculty raters and an assessment specialist discussed the range of student comments in the pilot transcript and related them to rubric criteria. For example, a low score on the context dimension was given when the student team failed to articulate the global, societal, and environmental contexts but did address the economic context of the problem. A high score was given when several or all contexts were addressed. In cases of discrepant ratings (more than one point apart), faculty members discussed their rationale, and one or more changed their scores if they considered the rationale convincing. Then the same faculty raters used the same procedures to rate their own students' transcript. Two assessment specialists also rated this transcript using the same process.

This process was informed by research in the field. McMartin et al note that "during the practice scoring sessions (held for each scenario), the readers discussed their rationale for assigning each score. Differences between scores were discussed until a common understanding of the scoring criteria was reached and applied."[18] They suggest that discrepancies of more than one point between raters can be handled in two ways. "First, if a reader is not a consistent scorer, he or she should not continue in the process. Second, should a scenario receive a set of scores that has a larger than one point discrepancy…a third reading can be undertaken to confirm the correct score."
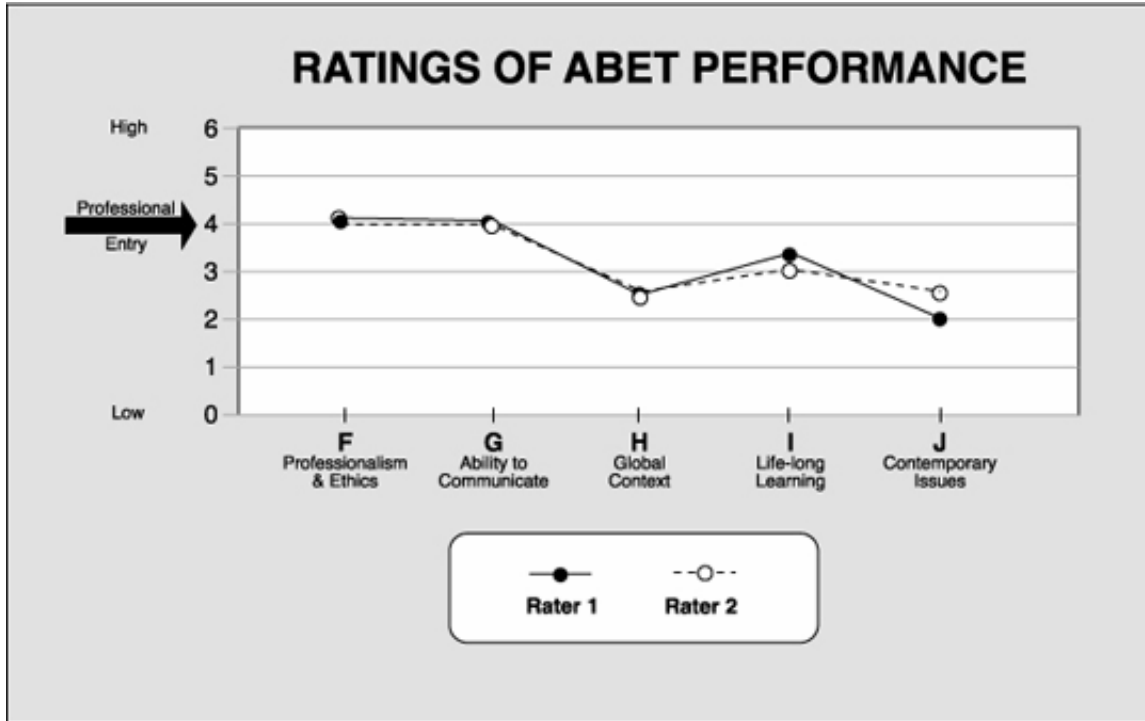
Results
Overview

Results from the preliminary round of curricular debriefs showed that students in most programs were fairly unaware of contemporary issues in their engineering field or current national or international concerns. Students were also challenged with understanding the impact of engineering solutions in multiple contexts, particularly societal and global. Communication during the discussion was also a common challenge for students, as some seemed unfamiliar with sharing leadership or opposing views while respecting differences. In some sessions, a few students tended to dominate discussion and make decisions for the team without coming to consensus, while other students hung back and rarely contributed.

Because the two assessment specialist raters had extensive experience rating student performance using rubrics and worked together throughout all rating sessions, they reached inter-rater reliability quickly. This consistency held throughout all sessions, so that CTLT raters usually scored within 0.5 points of each other on most dimensions, and never differed by more than one point. The assessment specialists' scores were also aligned within one point of faculty raters in all programs (except for faculty "outliers" who had not yet reached reliability with other faculty raters). Therefore, the ratings and figures reported below reflect average dimensional scores between the two assessment specialist raters.

Figure 2: Program A Student Team Performance in ABET Skills

Program A Results

Program A's student team consisted of seven randomly selected students, including four women and three men, with four minority students. The student team did especially well on ABET skill 3f, *the understanding of professional and ethical responsibility*, and 3g, *the ability to communicate effectively*, with average scores of 4.0. The students appeared to need the most improvement on ABET Skill 3j, *the knowledge of contemporary issues*, with an average score of 2.3, and 3h, *the understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts*, with a score of 2.5. See Figure 2 for ratings of team performance.
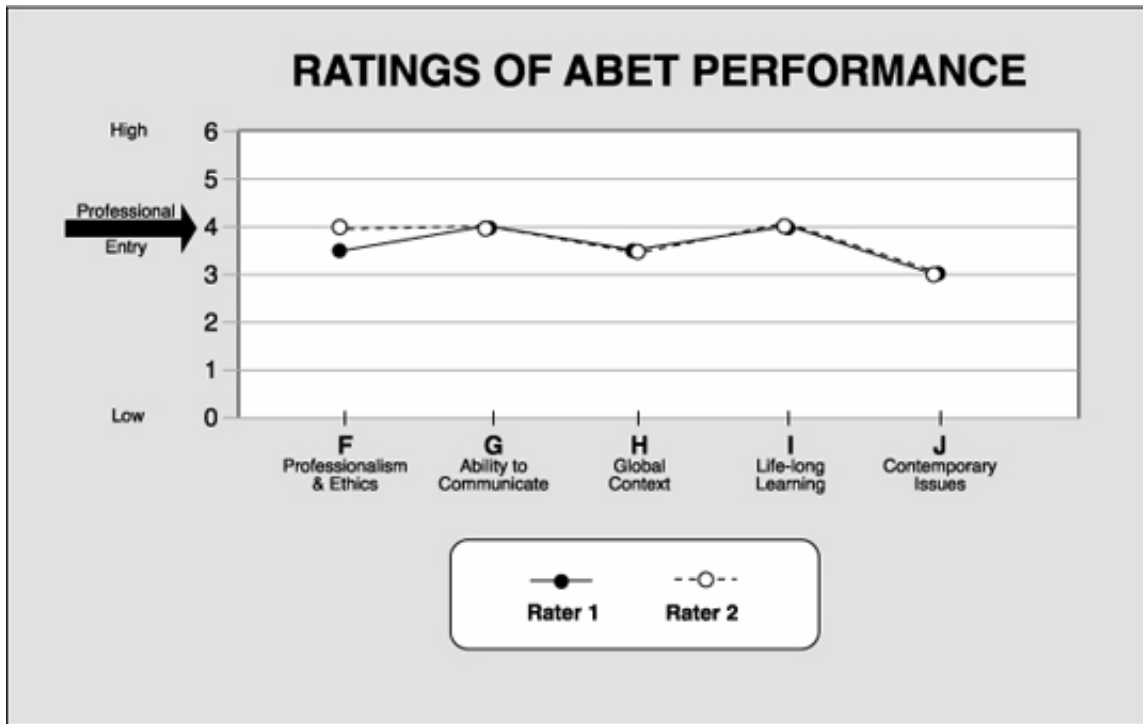
Figure 3: Program B Student Team Performance in ABET Skills

Program B Results

Program B's student team was comprised of six randomly-selected students, all male, with one minority student. The student team performed best on ABET Skill 3g, *the ability to communicate effectively*, and 3i, *recognition of the need for and ability to engage in lifelong learning*, with average scores of 4.0. They appeared to need the most improvement on ABET Skill 3j, *knowledge of contemporary issues*, with an average score of 3.0. See Figure 3 for ratings of team performance.

Recommendations

It will be critical to integrate the development and assessment of the ABET professional skills into the classroom in strategic courses, not only to optimize student learning of the skills, but also to make the curriculum more rigorous and the curricular debrief assessment at the end of senior year to have wider and deeper impact. Comprehensive recommendations that apply to all programs assessed are listed below, and are to be incorporated as each program chooses.

- Incorporate activities that teach and assess professional skills into each program's core curriculum, such as in one required course for each year in the program (freshman to senior).
- Have faculty members integrate ABET skill-building into their teaching by using a scenario activity in one course each semester or year. These activities may be informal student discussions during one class period, with time for reflection on the value of the activity or of the skills themselves. Or, they may be assignments asking for written responses to scenarios or hands-on group work.

- Continue to strengthen the alignment between ABET professional skills and class activities by discussing current events related to the field when the opportunity arises in class.
- Use the rubric more overtly in instruction and as a guide for grading. Give students the rubric before an assignment to help them learn what is expected, and how to evaluate themselves and each other on ABET professional skills.
- Ask students to create a team product during curricular debrief sessions, such as a summary of approaches and issues. This can be assessed along with the discussion transcript.
- Conduct department-wide rating sessions each year (preceded by practice rating sessions) and include a wider range of participants (faculty, students, assessment specialists, and professionals in the field).
- Meet regularly to identify and implement changes. Solicit faculty reflections on strategies for augmenting class activities to improve student's ABET skills and level of engagement.

CTLT staff will continue to collaborate with CEA in the long-term implementation of the curricular debrief assessment process.

Next Steps

In spring 2008, the CEA assessment committee will take the following steps to further establish reliability and validity of the curricular debrief:
- Faculty will examine all 8 scenarios to determine that they are solid representations of current, authentic engineering problems and that they equally elicit students to demonstrate the ABET professional skills.
- Faculty will re-examine the criteria of the rubric to make sure they are aligned with the ABET professional skills.
- Larger samples of students will be selected from each department for the curricular debrief and form two groups to see if they demonstrate similar levels of performance.
- Comparisons between the senior-year performance in the curricular debrief will be made with student performances in other classes and grade-levels.
- EE 416: all students are required to write, as part of their project write up responsibilities, an essay locating their project in a broader contemporary issue and addressing the impact that the team's engineering solution will have in global, economic, environmental, and cultural/societal contexts. All are required to participate in the curricular debrief as part of the course requirements.
- Engineering 120 is integrating all 8 scenarios and a version of the process (including the rubric) into this course to develop the ABET professional skills and to peak student interest in the major. Formative feedback will be highlighted.
- Each of the other programs is working individually with the assessment specialists to address areas of concern.
- The associate dean would like to see each program identify a core 300-level course where the ABET professional skills can be overtly developed.
- The curricular debrief will continue each spring semester. Each year, new faculty will join the original faculty raters to assess the curricular debrief performance as part of on-

going faculty development. In the future, professional sponsors and/or advisory board members or other external stakeholders will be invited to participate.

Conclusions

Findings from the curricular debrief and focus group sessions may be combined with other assessment measures to give engineering programs a more complete picture of student mastery of the ABET professional skills. The curricular debrief sessions and rubric tool can be employed longitudinally to help faculty gauge student and program strengths and weaknesses. Faculty can then embed practice lessons on particular skills more deeply into the curriculum (with core courses, group activities, discussions and assignments). Future assessment teams may include professionals in the field, undergraduates and graduate students, as well as advisory board members.

The curricular debrief method can be used as both an assessment and teaching tool. This addresses a related issue raised by Brumm et al.[19] Their survey of over 200 engineering faculty, alumni and industry professionals found that the vast majority "believe that the classroom is the least likely place to develop competencies necessary for the successful practice of engineering at the professional level. We must reexamine how we use the classroom in educating future engineers, broadening our focus to include competency development."

This college-wide, program-specific project has increased faculty involvement as well as collaboration between departments. Anecdotal student comments made to various professors showed that many students became very engaged and motivated by the curricular debrief sessions. They enjoyed addressing current problems in engineering and learning about the kinds of teamwork that professional engineering positions require. They also said that the activity helped them feel valued by their programs, as this effort showed that the College of Engineering and Architecture cares about student learning and improving the student experience.

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Appendix A

Guide to Rating ABET Professional Skills
DRAFT, May 18, 2007

Name:_____ Date: _____

Check one: Faculty ___   Assessment Specialist ___   Professional in Field ___

Instructions:

a) Read and discuss the ABET skills and rubric criteria below until your committee has a shared understanding of how these skills are exhibited in team performance.

b) Skim the transcript without making written comments to get a sense for how the team addressed the ABET skill(s).

c) Review the transcript again, marking passages where the team exhibited the skill(s), for example, "3f."

d) Circle descriptors in the criteria below that express how well the team as a whole performed a given skill, such as ABET Skill 3f, "Students clearly identify the professional challenge and related issues."

e) In the comment boxes, note the rationale for your ratings. For example, "S7 did well on identifying professional challenges (score of 4), but the team did not build on her ideas," or "The team did very well (score of 5) at summarizing the problem, but did not relate the problem to ethical issues (score of 1), so I averaged these to a score of 3 on Skill 3f."

f) Total the dimensional scores and average them (see Scoring Instructions, page 4). *Note: A score of 4 represents competency for students graduating from WSU.*

ABET Skill 3f. Understanding of professional and ethical responsibility
Students clearly frame the problem and begin the process of resolution. Students consider related ethical issues related, such as health and safety, fair use of funds, and doing "what is right" for all involved.

Struggling		Developing			Mastering	
0 **1**		**2** **3** **4**			**5** **6**	
*Students do not identify or summarize the problem.		*Students start to frame the problem, although some key details are glossed over. *Students discuss one or more approaches to resolve the problem.			*Students clearly frame the professional challenge and issues related to the problem. *Students develop appropriate, concrete approaches to resolve the problem.	
*Students do not consider ethical issues related to the problem.		*Students show some recognition of relevant ethical issues, but don't adequately address them in proposed approaches to resolve the problem.			*Students clearly identify relevant ethical issues and address them in proposed approaches to resolve the problem.	
Comments						

ABET Skill 3g. Ability to communicate effectively
Students work as a team to address the problem by acknowledging and building on each other's ideas. Students invite and encourage participation of all team members. Students collaboratively build an understanding of the issues involved and possible approaches to the problem. Students discuss how they will communicate with stakeholders (e.g., residents, workers, administrators, the public, etc.).
Note: The ABET communication outcome includes several forms of communication such as written and oral presentation. However, the CEA Assessment Committee determined that written and formal oral communication were assessed sufficiently throughout the engineering program curriculum. Therefore, this definition focuses on external and internal communication.

Struggling		Developing		Mastering	
0 1	2	3	4	5	6
*Students pose only individual opinions and do not build on other student's ideas. *Students do not consider the assumptions or biases underlying the problem, *Some students may monopolize or become argumentative.		*Students occasionally build on each other's ideas. *Students briefly discuss the assumptions or biases underlying the problem. *Students attempt to share the floor, although this may not always be successful.		*Students collaboratively build on other students' ideas to form a team approach. *Students deeply examine the biases and assumptions underlying the problem. *Students share the floor and encourage participation of all team members.	
*Students do not consider stakeholder positions on the issue, focusing only on their own perspectives.		*Students may consider perspectives of one or more stakeholders, but do not discuss how they will communicate with these parties.		*Students consider diverse perspectives of outside stakeholders. *Students discuss how they will communicate with these parties.	
Comments					

ABET Skill 3h. Understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts
Students consider the project's impact on global, economic, environmental, and cultural/societal contexts.

Struggling		Developing		Mastering	
0 1	2	3	4	5	6
*Students do not relate the problem or their approaches to relevant contexts (global, economic, environmental, or cultural/social).		*Students discuss the impact of their approaches on one or two relevant contexts (global, economic, environmental, cultural/societal).		*Students deeply examine the impact of their approaches on relevant global, economic, environmental, and cultural/societal contexts.	
Comments *(See context definitions at end of rubric)*					

ABET Skill 3i. Recognition of the need for and ability to engage in life-long learning
Students consider what needs to be learned (what they know and don't know), create a plan to retrieve and organize data and evidence, and reflect on their own understanding. Students address biases and assumptions related to this data.

Struggling	Developing	Mastering
0　　　　　　　　1	2　　　　　　　　3	4　　　　　　　　5　　　　　　　6
*Students do not consider outside sources of data/evidence, or these sources are seen as irrelevant to the topic. *Students do not identify what they still need to know. *Students do not recognize inherent biases or assumptions in sources.	*Students acknowledge outside sources, and some ability to discern fact from opinion. *Students identify what they don't know as well as what they do know. *Students briefly address inherent biases or assumptions in one or two sources.	*Students seek and evaluate outside sources (possibly including personal experience). *Students identify what they still need to know. *Students discuss inherent biases or assumptions in several sources.
Comments		

ABET Skill 3j. Knowledge of contemporary issues
Students consider how the problem relates to contemporary issues.

Struggling	Developing	Mastering
0　　　　　　　　1	2　　　　　　　　3	4　　　　　　　　5　　　　　　　6
*Students do not relate the problem to other contemporary issues. *Students do not consider the impact of global, economic, environmental, or cultural/societal contexts on the problem.	*Students show some recognition of contemporary issues and how they relate to the problem. *Students briefly consider the impact of global, economic, environmental, and/or cultural/societal contexts on the problem.	*Students clearly identify how the problem and proposed approaches relate to contemporary issues. *Students deeply examine the impact of global, economic, environmental, and/or cultural/societal contexts on the problem.
Comments		

CONTEXTS (The team should address all relevant contexts below to receive a high score)

Ethical: Students frame the problem or proposed approaches in terms of values such as health, safety, or doing "what is right" for all involved.

Global: Students relate the problem or proposed approaches to larger global issues (such as globalization, world politics, etc.).

Economic: Students relate the problem or solution to trade and business concerns (such as project costs).

Cultural/Societal: Students relate the problem or proposed approaches to the needs of local, national, or ethnic groups affected by the issue.

Environmental: Students relate the problem or solution to local, national or global environmental issues (e.g., ozone depletion).

Scoring Instructions:

<u>Scoring</u>: Estimate a score for team performance on each dimension using the evidence that you gathered from the transcript. Then add all scores and divide by 5, rounding up to the nearest tenth (for example, 3.5), for the team's overall score.

<u>Comments</u>: Record your rationale for your final scores. (For example, "The team addressed ABET skill 3i. but did this superficially, so I gave them a 3 overall on this," or, "Student 7 addressed ABET skill 3j thoroughly, but the team didn't acknowledge his ideas or integrate them into their approaches, so I gave the team a 2 on this,")

ABET Skills	Score
3f. Understanding of professional and ethical responsibility	
3g. Ability to communicate effectively	
3h. Understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts	
3i. Recognition of the need for and ability to engage in life-long learning	
3j. Knowledge of contemporary issues	
TOTAL	
AVERAGE **(Total divided by 5)**	
Comments:	

<div align="center">**Appendix B**</div>

Student Instructions:
Imagine that you are a team of engineers working together on the issue described in the scenario below. Discuss what your team would need to take into consideration to address the issue. You do not need to find solutions, but try to come to a consensus on what is most important, and agree on one or more approaches. You will have 45 minutes.

Materials Science and Engineering Scenario: Angola has one of the highest rates of landmine injuries per capita in the world. Estimates for the number of landmines in Angola range from 6 to 20 million. The higher figure represents a number of mines that is nearly twice the population. These landmines cause death and debilitating injury, preventing economic and social progress.

Millions of landmines were placed in the 20-year conflict following independence from Portugal in 1975. These landmines still exist throughout the country in farmland, under roads, and in confining belts that surround towns and cities. A survey conducted by the Mine Advisory Group (MAG) found that in certain provinces of Angola, up to 98% of landmine victims are civilians. The same survey found that these people were engaged in "survival" activities, such as gathering food or firewood when they fall victim to a landmine; many were children who had run into a field to play. Caring for amputees places a huge economic and social burden on Angola and agencies committed to aid.

Landmines are designed to maim, not kill; victims often require extensive medical care including amputations and subsequent prosthetics. According to Physicians Against Land Mines (PALM), one out of every 334 Angolans has lost an arm or a leg to landmine injury. Financial constraints limit the rate of advancement in prosthetic rehabilitation, and it is a challenge to find a way to fund widespread application of prosthetic innovations.

Common Materials Used to Make Prosthetics
- Silicone elastomers used as barriers between the human socket and the prosthetic
- Carbon fiber composites used in artificial limbs
- Titanium implants to the bone
- Polypropylene
- Aluminum alloys

Facts about Landmines in Angola
- Children represent 50% of mine casualties.
- The amputee population is 70,000 (and 8,000 are children under 15).
- There are between 150 and 200 new landmine victims every week.
- Less than 7% of landmine victims die, and 37% require amputation.
- A child's prosthesis must be replaced every 6 months, an adult's every 3 to 5 years.

Sources: Mines Awareness Project 1997, UNICEF ANGOLA and Advocacy Project Proposal, Angolan Campaign to Ban Landmines. Science, Medicine and the Future: Artificial Limbs, British Medical Journal 2001 September 29; 323(7315): 732–735.

Computer Engineering Scenario

Recently, police swept through dozens of homes and businesses in Brazil, tagging $30 million worth of evidence including cash, PCs, and piles of stolen merchandise. Suspects were involved in an organized criminal ring supported by "phishing." Emails asked users to update bank information with an attachment that was actually a Trojan. This modified the PC's host file to point the machine to a malicious website.

Phishing, which often involves sending out fake email messages to get private information such as bank account numbers and passwords, has become the "international electronic crime of choice." Most phishing attacks take less than a week, with the fake sites online for only a few days and most of the important information gathered within 24 hours. Because the rewards are great for little risk of being caught, the problem has become widespread.

Many phishing schemes are run through a hierarchy similar to the Mafia. Some groups hire bank employees who move money between accounts to avoid tracing. Some set up "sweatshops" where people do grunt work such as coding for tiny cuts of the profits. Congress has introduced bills targeting online identity theft and phishing. Some say that these laws are not adequate because phishing scams are difficult to track and depend on someone being defrauded first. Enforcement varies in other countries, which complicates the problem. The U.S. government works with private organizations to respond more quickly to new attacks, blocking traffic to machines hosting phishing sites, but finding and prosecuting those responsible is difficult.

Adapted from "Phishing is Big Business." EWeek.com, March 7, 2005, by Dennis Fisher.