Using the EPSA Rubric to Evaluate Student Work in a Senior Level Professional Issues Course

Dr. Edwin R. Schmeckpeper P.E., Ph.D, Norwich University

Edwin Schmeckpeper, P.E., Ph.D., is the chair of the Department of Civil and Environmental Engineering at Norwich University. Norwich University was the first private school in the United States to offer engineering courses. In addition, Norwich University was the model used by Senator Justin Morrill for the Land-Grant colleges created by the 1862 Morrill Land Grant Act. Prior to joining the faculty at Norwich University, Dr. Schmeckpeper taught at the University of Idaho, the Land-Grant College for the State of Idaho, and worked as an engineer in design offices and at construction sites.

Dr. Ashley Ater Kranov, Washington State University
Dr. Steven W. Beyerlein, University of Idaho, Moscow

Dr. Beyerlein is a professor of Mechanical Engineering at the University of Idaho where he serves as the coordinator for an inter-disciplinary capstone design sequence that draws students from across the College of Engineering. Over the last ten years, he has been part of several NSF grants that have developed assessment instruments focused on professional skills and piloted these with capstone design students.

Prof. Jay Patrick McCormack, Rose-Hulman Institute of Technology

Jay McCormack is an associate professor of mechanical engineering at Rose-Hulman Institute of Technology.

Dr. Patrick D. Pedrow P.E., Washington State University

Patrick D. Pedrow received the B.S. degree in electrical engineering from the University of Idaho, Moscow, in 1975, the Master of Engineering degree in electric power engineering from Rensselaer Polytechnic Institute, Troy, NY, in 1976, the M.S. degree in physics from Marquette University, Milwaukee, WI, in 1981, and the Ph.D. degree in electrical engineering from Cornell University, Ithaca, NY, in 1985. From 1976 to 1981, he was with McGraw-Edison Company, where he conducted research and development on electric power circuit breakers. He is currently an Associate Professor with Washington State University in the School of Electrical Engineering and Computer Science. His research interests are in plasma-assisted materials processing, including the deposition and evaluation of thin plasma-polymerized films deposited at atmospheric pressure using weakly ionized plasma. Dr. Pedrow is a member of the American Physical Society, IEEE, ASEE, Tau Beta Pi and he is a Registered Professional Engineer in the State of Wisconsin.
Using the Engineering Professional Skills Assessment Rubric to Evaluate Student Work in a Senior Level Professional Issues Course

Abstract

This paper describes a customization of the Engineering Professional Skills Assessment (EPSA) method within the ‘ethics’ section of a senior level “Professional Issues” course. The course instructors have found the interdisciplinary EPSA scenarios to generate more enthusiastic and higher level discussion than case studies that focus solely on ethics. The paper describes use of two different EPSA scenarios, the standardized questions which are used to prompt the student discussion, the EPSA rubric, and recommended facilitation plan for adoption by others.

Introduction

Engineering programs often contain a senior level “Professional Issues” course to cover topics, such as ethics, which are related to the professional practice of engineering. These courses commonly utilize case studies focusing on ethics as the basis for student discussions. Measuring the student learning resulting from the case study process is often very subjective, difficult to quantify, inconsistent between evaluators, and costly to administer.

Proficiency in engineering professional skills, such as ethics, as described in ABET criterion 3 - student outcomes, is critical for success in the multidisciplinary, intercultural team interactions that characterize 21st century engineering careers. These professional skills may be readily assessed using a performance assessment that consists of three components: (1) a task that elicits the performance; (2) the performance itself (which is the event or artifact to be assessed); and (3) a criterion-referenced instrument, such as a rubric, to measure the quality of the performance. Funded by the National Science Foundation, investigators at Norwich University, University of Idaho and Washington State University have used this award-winning performance assessment method to develop and rigorously test the Engineering Professional Skills Assessment (EPSA) as a vehicle for directly assessing five learning outcomes simultaneously. The EPSA is a discussion-based performance task designed to elicit students’ knowledge and application of the ABET professional skills.

Engineering Professional Skill Assessment Method

This assessment method focuses on a group of five to six students discussing a complex, real-world scenario that includes current, multi-faceted, multidisciplinary engineering issues. Before the 30-45 minute long discussion begins, student participants all read a short scenario that presents some technical and non-technical details of the topic.

Table 1 presents a summary of sample scenarios. As part of the EPSA, students are asked to determine the most important problem/s and to discuss stakeholders, impacts, unknowns, and possible solutions. Examples of the scenarios used in the EPSA are presented in Appendix A.
Table 1. Summary of Sample Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Critical Minerals</td>
<td>Hydraulic Fracturing</td>
</tr>
<tr>
<td>Power Grid Vulnerabilities</td>
<td>Fukushima Nuclear Power Plant Disaster</td>
</tr>
<tr>
<td>Offshore Wind Farms</td>
<td>Water Shortages</td>
</tr>
<tr>
<td>Tennessee Valley coal ash spill</td>
<td>BP Oil Spill</td>
</tr>
</tbody>
</table>

After the discussions have completed, the EPSA analytical rubric is used to evaluate the students’ discussion. The EPSA Rubric has one page each for ABET Criterion 3, 3f, 3g, 3h, 3i, and 3j, to measure these directly, and as a whole measures 3d. The complete EPSA Rubric is shown in Appendix B and a one page version of the rubric used for training is shown in Appendix C. Table 2 shows the alignment between the ABET professional skills and the EPSA Rubric. McCormack et al. reviewed current practices for administering and using the EPSA rubric. The EPSA method is flexible, easy to implement, and can be used at the course level for teaching and measuring engineering professional skills and the program level at the end of a curricular sequence for evaluating a program’s efficacy.

Table 2. ABET Professional Skills Addressed in the EPSA Rubric

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Specific Areas Considered</th>
</tr>
</thead>
</table>
| 3f. Understanding of Professional and Ethical Responsibility | • Stakeholder Perspective  
• Problem Identification  
• Ethical Considerations |
| 3g. Ability to Communicate Effectively             | • Group Interaction  
• Group Self-Regulation                                      |
| 3h. Understanding of the Impact of Engineering Solutions in Global, Economic, Environmental, and Cultural/Societal Contexts | • Impact/Context |
| 3i. Recognition of and Ability to Engage in Life-Long Learning | • Scrutinize Information  
• Knowledge Status                                              |
| 3j. Knowledge of Contemporary Issues              | • Non-Technical Issues  
• Technical Issues                                               |

The research team that developed EPSA is currently in the final year of a four-year validity study funded by the National Science Foundation. As part of this validation study, the team of researchers has applied EPSA to test groups of students at Norwich University, the University of Idaho, and Washington State University. A faculty member from Norwich University who is part of the project team introduced other Norwich University faculty to the EPSA method. This paper describes how the EPSA scenarios and the EPSA rubric are being implemented in the “Ethics” section of a senior level “Professional Issues”.

EPSA Customization at Norwich University

In the Fall 2013 semester the EPSA Method was incorporated into two sections of Norwich University’s EG450-Professional Issues. The EPSA method was utilized during two class periods each followed by an all-hands review. In the first class period, which served as a practice session, the students were introduced to the EPSA Method, discussion prompts, and the use of
the analytic rubric. During the second class period, the students were formally evaluated and the results recorded.

There were two sections of the class, one section with 14 students and one section of 31 students. The class time for each group was 75 minutes. This amount of time was found to be helpful in setting-up the groups, the facilitator’s reading of introduction, students reading of the scenario, student discussion, and post discussion analysis.

During the practice session all groups used the Fukushima Nuclear Power Plant disaster scenario, which is shown in Appendix A. Since this was a practice session, the discussion time was reduced, so that the facilitator and instructor could provide comments and guidance on use of the EPSA method and the EPSA Rubric.

During the record session, the professor selected the “Offshore Wind Farm” scenario for all groups due to Norwich University’s proximity to local land-based wind farms. This scenario, which is also shown in Appendix A, includes economic, political, regulatory, ethical, and environmental considerations, including such issues as public use vs. private rights related to land-use, effects of regulations on utility prices, reliability of renewable energy, global warming, and the international markets for energy.

The students were divided into teams, with one part of the team conducting the discussion and the other part of the team using the EPSA Rubric to assess the discussions. Instead of using electronic voice recorders as is typically done by the researchers on the NSF sponsored project, when using the EPSA Method in a class-room setting all data was collected as the discussions took place, with the assessors writing tally marks and notes directly on the relevant portion of the EPSA Rubric. The teams for both the practice scenario and the record scenario were organized as shown in Table 3.

Table 3. Organization of the Discussant and Observer Teams

<table>
<thead>
<tr>
<th>Discussion Sub-Team</th>
<th>Observer Sub-Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4 individuals (ideally 4)</td>
<td>2-3 individuals (ideally 3)</td>
</tr>
<tr>
<td>Actively participate in group discussion</td>
<td>DO NOT participate in group discussion</td>
</tr>
<tr>
<td>Roles</td>
<td>Assignment (done individually)</td>
</tr>
<tr>
<td>Facilitator/moderator</td>
<td>Take notes on assigned EPSA Rubric areas</td>
</tr>
<tr>
<td>Time-keeper</td>
<td>Assign score within each EPSA Rubric area</td>
</tr>
<tr>
<td>Antagonist</td>
<td>Be prepared to explain rationale</td>
</tr>
</tbody>
</table>

Other details about session set-up included the following:

1. Roles are changed from practice day to record day to allow each student (ideally) a different role.
2. Each discussant team and paired observer team was in a separate classroom.
3. The class with 14 students was divided into two teams and the class with 31 students was divided into four total teams.
4. No electronic recorders were used (unlike the formal EPSA method).
5. The facilitator /moderator student was responsible for keeping the discussant team focused as the course instructor moved back and forth between discussion groups. No additional faculty were deployed in this exercise, although they could have been.

The session began with the facilitator/moderator student distributing the following discussion prompts and then reading them aloud:

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Imagine that you are a team of engineers working together for a company or organization on the problem/s raised in the scenario.

1) Identify the primary and secondary problems raised in the scenario.
2) Discuss what your team would need to take into consideration to begin to address the problem.
3) Who are the major stakeholders and what are their perspectives?
4) What are the potential impacts of ways to address the problems raised in the scenario?
5) What would be the team’s course of action to learn more about the primary and secondary problems?
6) What are some important unknowns that seem critical to address this problem?

You do not need to suggest specific technical solutions -- just agree on what factors are most important and identify one or more viable ways to address the problem.

Please begin by reading the scenario individually. You may begin the group discussion when you are ready. You have 45 minutes from this point on to complete your discussion.

---

The students on the Discussant Sub-Team read the scenario and then discussed the scenario. The students on the Observer Sub-Team was also expected to read the scenario, listen carefully to the discussion, note evidence heard about their assigned EPSA rubric areas, and provide a rating for each area at the end of the discussion.

Table 4 summarizes the observer findings. Scores are on the 5 point EPSA scale (1=emerging, 2=developing, 3=practicing, 4=maturing, 5=mastering).

Table 4. Summary of Observer Notes and Scores

<table>
<thead>
<tr>
<th>ABET Criterion</th>
<th># of Notes</th>
<th>Mean</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABET Skill 3f – Understanding of professional and ethical responsibility</td>
<td>15</td>
<td>3.74</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>ABET Skill 3g – Ability to communicate effectively</td>
<td>18</td>
<td>3.77</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>ABET Skill 3h – Broad understanding of the impact of engineering solutions in multiple contexts</td>
<td>13</td>
<td>3.95</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>ABET Skill 3i – Recognition of the need for life-long learning</td>
<td>12</td>
<td>3.62</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>ABET Skill 3j – Knowledge of contemporary issues</td>
<td>13</td>
<td>3.5</td>
<td>2.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Student Evaluation of the EPSA Implementation

In the Norwich University’s course evaluation system, thirty-six of forty-five students numerically rated the experience in their assessment of the course. The mean of their observations was 5.92 / 7.00. Of the 36 students who provided a numerical rating only six provided a rating of 4 (neutral) or below when assessing the value of this experience. Of the 36 students who provided a numerical rating, only six ranked the experience in the lower half of the experiences in the course. By and large the students thought it was a valuable experience and should be retained in future courses.

Faculty Evaluation of the EPSA Implementation

The following favorable outcomes were observed across the student discussion sessions.

1. Roles - “extra duties” are important to assist the facilitator and give everyone a specific responsibility.
2. Initial feedback from some students indicated that 45 minutes is too long a discussion period. (The EPSA team has experimented with shorter time periods, and found that 30-35 minutes is often adequate.)
3. Students anecdotally stated that they desired more information in the off shore wind power scenario.
4. Students seemed more comfortable with the scenario information they received in the Japan Nuclear scenario and the time they had to discuss the issue. Since it was a practice session 30 minutes was allotted.
5. Several students wrote about the process and exercise in their course journals. Overall those who discussed it were very positive about the experience.

The following instructor concerns surfaced in reflecting on the exercise. A recommendation for address each concern is also proposed.

Q: Do we need two practice sessions and two recording sessions or is that overkill?
A: Do only one practice session and two record sections. Allocate some general class time after the session to exchange general feedback on the process, the outcomes, and the lessons learned.

Q: The instructor assigned teams and additional duties. Should the process be done randomly?
A: Yes, students should be mentally prepared to fulfill any role and should learn which role they will be asked to fill on the day of the session.

Q. Should the process allow the students to receive the scenarios and rubrics in advance to do some research on their own to better understand the dilemma and to examine the EPSA rubric in more detail?
A. Yes, this would add richness to the discussion and the observer notes.

Q. How should one calibrate the observations of the observer sub teams?
A. A “you tube like” training scenario along with a rated EPSA rubric would allow the students...
to develop proficiency in using the rubric and may help to make their scoring more reliable. Peer assessment is a valuable part of the exercise, and should be retained.

**EPSA Facilitation Plan**

The facilitation plan for implementing the EPSA Method in a course is shown in table 5. The implementation generally takes a portion of one class period to introduce the EPSA Method, one class period to conduct the EPSA Method, followed by a portion of one class period to review and discuss the results.

*Table 5. Facilitation Plan for Implementing the EPSA Method*

| PRIOR CLASS | - introduce the one page rubric and the scenario, letting students know that they will receive specific discussion prompts at the start of the EPSA session and that they may be assigned to either a participant or an observer group but they won't know which until the next class period. |
| EPSA CLASS SESSION | 1. Review scenario and discussion prompts - 5 min  
2. Review/assign roles - 5 min  
   a. Discussion Sub-Teams (3-4 students) use separate roles of Moderator, Timekeeper, Antagonist, and possible Assessor who does a self-scoring of the rubric from inside the team  
   b. Observer Sub-Teams (2-3 students) work with full page versions of the one of the following rubric pairs (3f-3g), (3f-3h), (3i-3j)  
3. Discussion period - 30 to 35 min  
   a. Discussants strive for their best effort engaging all group members  
   b. Observers record individually without talking or intervening  
4. Debriefing - 10 to 15 min  
   a. Observers individually report out by skill area 3f, 3g, 3h, 3i, 3j (i.e. all 3f reports followed by others) - 1 min summary each  
      give area score(s), describe greatest strength within in this skill area (and why it's valuable), and greatest area for improvement (and how it could be implemented)  
   b. Discussant Assessor identifies skill areas in which internal perspective may differ from observers - 1 min  
   c. Discussion Sub-Team asks questions of observers - 5 min  
   d. Instructor or TA provides summary from his her perspective - 3 min |
| NEXT CLASS PERIOD | - class wide report on EPSA performance is given, with advice on taking this forward to professional practice |

**Conclusions**

The interdisciplinary EPSA scenarios generated more enthusiastic and higher level discussion than case studies that focus solely on ethics. Since the scenarios are situated in contemporary contexts and show the interdisciplinary and complexity of real-world engineering problems, the
EPSA affords students to practice holistic engineering problem solving thinking with fellow students.

The EPSA Rubric provides a standardized means for faculty to evaluate the quality of student discussions and to make evaluation of students’ work more consistent between the multiple sections of the course. In addition, through the evaluation process, faculty gain insights into the strengths and weaknesses of students’ abilities to pinpoint primary and secondary problems, identify stakeholders, work well in group discussion and consider the impact of potential solutions on different contexts, they then can determine where and when in the curriculum to improve teaching and learning of the outcomes.

The flexibility of the EPSA Method allows it to be readily adapted for use in courses at all levels in the curriculum. The course instructor plans on using the EPSA method in subsequent years as a means to assess the ABET Professional skills at the program level.

Acknowledgements

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References


1) The Fukushima Daiichi Disaster and the Future of Nuclear Power

Following the 2002 Kyoto Protocol, the Ministry of Economic Trade and Industry in Japan made a multi-year commitment to reduce greenhouse gas emissions by expanding electrical generation by nuclear power. In this environment, nuclear power in Japan grew steadily, reaching 30% of total Japanese electricity production in 2011 with further plans to boost production to 50% by 2030. On March 11, 2011, the most powerful earthquake on record to strike Japan devastated the region, particularly the Sendai area. The earthquake triggered a powerful tsunami with waves that exceeded 130 feet in height and traveled 6 miles inland. The earthquake was so powerful that the main island of Japan was shifted 8 feet to the east.

The Fukushima nuclear power plant featured six boiling water reactors, designed and constructed by General Electric. The reactors were designed to withstand approximately .2g ground accelerations and the plant had massive seawalls to prevent inundation by tsunami waves as large as 6 meters. Both of these limits were exceeded by the March 11, 2011 earthquake and tsunami. The earthquake damaged four of the six reactors at this location and the 14 meter tall tsunami that arrived 45 minutes later severed connection with the electrical grid, rendered auxiliary generators inoperative, damaged external cooling water pumps, and flooded basement areas in the turbine buildings. Only three of the reactors were operating at the time, and while these successfully executed immediate shutdown, some of the pipes leading in and out of the reactors were severed, causing steam to escape and water levels to drop.

Without cooling and ventilation to remove heat generated by natural decay of fission products created before shutdown, reactor temperatures could not be contained even after deployment of fire-fighting equipment to pump seawater directly into the reactors and spent fuel pools. Interaction between fuel elements and high temperature steam produced explosive quantities of hydrogen gas that accumulated in roof areas in three of reactor buildings. This led to a series of violent explosions that ultimately ripped through the roof and side of these reactor buildings in the week following the earthquake.

Over 3500 workers participated in plant decontamination. Two workers died from blood loss associated with the hydrogen explosions; two others have exceeded their annual dosage allowed for nuclear workers. A parliamentary panel concluded that TEPCO (plant operator), government, and regulators were negligent in establishing and maintaining safety protocol at Fukushima. The panel points out that the government, regulators, and TEPCO failed to prevent the accident and subsequently “betrayed the nation’s right to be safe from nuclear accidents”. They concluded that the natural disasters could not be anticipated or necessarily designed for.
This accident once again brought the safety of nuclear power into the forefront of public discussion similar to the Three Mile Island and Chernobyl accidents. Japan has taken all 54 of its reactors out of service, reversing 20 years of surplus and resulting in record $18 billion deficit. Oil and natural gas imports have increased and power shortages have been observed at factories. Germany plans to close all reactors by 2020 and will import natural gas and nuclear power created electricity in other countries to make up for the difference.

While the reaction in the United States has not been as severe, the projected resurgence of the nuclear industry has not come to fruition. Many nuclear power plants in the United States are nearing the end of their original projected operational life, which is about 40 years. The county’s 104 reactors are now on average 32 years old. Instead of building new reactors, reactors are being retrofitted and upgraded in addition to extending their licenses for 40 to 60 years. The cost of building a new reactor makes it risky and potentially cost prohibitive for any organization that is concerned with making a profit. The only 2 planned reactors (under construction) in the US (in Georgia) were designed to use a passive cooling system to avoid some of the problems at Fukushima.

An alternative approach to combating the risk associated with generating electricity via nuclear fission is to reduce consumption. A citizen led movement in Japan is trying to reduce electricity consumption by installing smaller, 20 or 30 amp, circuit-breaker boxes in their homes. The smaller breaker boxes are in contrast to the 100 and 200 amp boxes in most US homes. The restriction is not easy however, as many household items use substantial power (small AC unit – 10 amps, vacuum cleaner – 10 amps, microwave – 6 amps).

One author argues that the panic over many “hotspots” near the Fukushima disaster site was unwarranted. The International Commission on Radiological Protection recommends evacuation of a locality whenever the excess radiation dose exceeds .1 rem per year. However, citizens of Denver are exposed to three times that amount from the area’s natural radiation emissions.

Scenario Sources:
2) Development of Offshore Wind Resources

The US pioneered land-based wind farms in the 1980’s and in 2008 had a total installed land-based capacity of about 18,300 MW. Yet, it wasn’t until 2010 that the US Department of Interior gave its approval for the first US offshore wind farm called Cape Wind which will consist of 130 turbines with total output power 400 megawatts. Each turbine will extend 400 feet above the surface of the sea and the wind farm will cover 24 square miles of ocean about five miles off the Massachusetts coast near Hyannis Port and Nantucket Sound. In 2010, Google announced that they contracted for 37.5% of the startup equity for developing the Atlantic Wind Connection, a $5 billion project to build a 350-mile corridor of wind turbines located in shallow water 10 to 20 miles from the US Atlantic coast extending from New Jersey to Virginia. The AWC system take up to a decade to complete and government approvals are an important part of that process. The system could ultimately provide 6,000 MW of capacity.

Offshore wind patterns are known to contain larger wind energy content than land-based sites. One of the earliest offshore wind farms was constructed in 1991 by Denmark and it has a capacity of 5 MW which is arguably capable of supplying 5,000 households with electric power. This wind farm is named “Vindeby” and contains 11 turbines located about a mile from shore in water with a depth of 3.5 meters. Since the completion of Vindeby more than 25 other wind farms have been built near Europe with a total installed capacity exceeding 1,781 MW.

Sponsoring companies for these European wind farms include Denmark, Netherlands, Sweden, UK, Ireland and Belgium. Underwater power grids are required to move the electric power from the offshore generators to the land-based consumers. Distance of these offshore wind farms from land and the proximity to land-based grid connection points have substantial influence on construction and maintenance costs associated with these systems.

Negative impacts of offshore wind farms include maritime navigation safety, excessive bird mortality through collisions with the turbines, deleterious effects on mammals and fish, prospective reduction in property values, issues associated with travel of construction and maintenance crews to and from the offshore turbines, the corrosive environment associated with salt water and the influence of electromagnetic fields on the maritime environment.

Prospective damage to bird species is highlighted by the land-based wind farm at Altamont Pass in California where the bird strike mortality rate was relatively low but one of the impacted species was the golden eagle. Mammals and fish are especially influenced by noise associated with construction (pile drivers) and blade noise during normal operations. Some ocean species are known to perceive electric and magnetic fields and use these perceptions for orientation and prey detection. Electromagnetic fields emanating from the offshore power grid might interfere with these processes.
Positive results from offshore wind farms must also be considered by government policy makers. These positive results include a reduction in greenhouse gases, fish aggregation resulting from pilings acting as a substrate for species that attract fish, reduced reliance on fossil fuels, reduced freshwater withdraws by fossil-fueled power plants and added jobs within the local economy as well as added jobs within the economies associated with wind turbine manufacture. Life cycle analysis of multi-megawatt wind turbines shows that the turbine “pays back to the ecosystem” about 31 times the environmental damage that results from its manufacture, start-up, operation and decommissioning.

Scenario Sources:

Rater’s Name:________________ Date:______ Student Work:__________________

EPSA TEAM: This is an internal use rubric for the time being – one that we are using to guide our rigorous rubric and method validation process. The scoring protocol, general decision rules and scoring tips are thus targeted to this objective and us as the audience. Most likely we will refine this rubric for outside audiences towards the end of the summer. It’s possible (and admissible) that our scoring rules will inform descriptor refinement (not performance indicator major revisions) after summer 2013 scoring is complete.

Note: The engineering professional skills that comprise this rubric are taken directly from the ABET Engineering Criterion 3, Student Outcomes. Each dimension of the EPSA Rubric comprises one ABET student outcome, an EPSA definition of the outcome, and the outcome’s performance indicators. Thus, “ABET skill 3 f” can also be read as “ABET criterion 3 student outcome 3f” with three performance indicators: stakeholder perspective, problem identification, & ethical considerations.

Scoring Protocol:
1. Skim the scenario students used for the discussion.
2. Quickly read the discussion, marking passages where a given skill is exhibited. A given passage may exhibit more than one skill simultaneously.
3. During a second read, highlight passages that provide strong evidence (either positive or negative) related to the skills.
4. Read the skill definition. Assign scores for each of the performance indicators.
5. In the comment boxes, provide line numbers and a short phrase, such as: 3f = lines 109-112: trade off of wall height/plant safety vs costs; lines 828-836: risk analysis. Be sure to refer back to the skill definition.
6. Update your initial scores should the data provide evidence for a score change.
7. Ultimately assign one score for the skill. Use whole numbers; no increments.

General Decision Rules
1. Assess what is transcribed. Don’t “read between the lines” (e.g., don’t make assumptions about what the group should know given what is transcribed.).
2. When conflicted on assigning a score, reference adjacent score description boxes to determine whether a higher or lower score within the description box is more accurate.
3. Weigh all performance indicators within a category equally in assigning the overall score.
4. Assign the higher score associated with a box only when evidence for all performance criteria is present.
5. Read the skill definition after scoring to check the score for accuracy.
6. When averaging scores for the performance indicators, round down. For example, 2.6 would be a 2 not a 3. The rationale is to report the level they attained, not the level that they almost attained.

Scoring Tips
1. Supply line numbers and/or student numbers for reference in the comment box.
2. Strive to complete transcript review and scoring within a 45-60 minutes.
**ABET Skill 3f. Understanding of professional and ethical responsibility**

**Definition:** Students clearly frame the problem(s) raised in the scenario with reasonable accuracy and begin the process of resolution. Students recognize relevant stakeholders and their perspectives. Students identify related ethical considerations (e.g. health and safety, fair use of funds, risk, schedule, trade-offs, and doing “what is right” for all involved).

<table>
<thead>
<tr>
<th>Stakeholder Perspective</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 - Mastering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not identify stakeholders.</td>
<td>Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions.</td>
<td>Students begin to frame the problem, but have difficulty separating primary and secondary problems. If approaches to address the problem are advocated, they are quite general and may be naive.</td>
<td>Students explain the perspectives of major stakeholders and convey these with reasonable accuracy.</td>
<td>Students are generally successful in distinguishing primary and secondary problems with reasonable accuracy and with justification. There is evidence that they have begun to formulate credible approaches to address the problems.</td>
<td>Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with great clarity, accuracy, and empathy.</td>
<td></td>
</tr>
<tr>
<td>Problem Identification</td>
<td>Students do not identify the problem(s) in the scenario.</td>
<td>Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds involving primary stakeholders.</td>
<td>Students are sensitive to relevant ethical considerations and discuss them in context of the problem(s). Students make linkages between ethical considerations and stakeholder interests. Students may identify ethical dilemmas and discuss possible trade-offs.</td>
<td>Students clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problem(s). Students make linkages between ethical considerations and stakeholder interests and incorporate them into their analysis and resolutions. Students may discuss ways to mediate dilemmas or suggest trade-offs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethical Consideration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments**
**ABET Skill 3g. Ability to communicate effectively**

**Definition:** Students work together to address the problems raised in the scenario by acknowledging and building on each other’s ideas to come to consensus. Students invite and encourage participation of all discussion participants. Note: The ABET communication outcome can include several forms of communication, such as written and oral presentation. This definition focuses on group discussion skills.

| Rater Score for Skill________ |

<table>
<thead>
<tr>
<th><strong>Group Interaction</strong></th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 - Mastering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not interact as a group.</td>
<td>Students pose individual opinions, without considering other student’s ideas.</td>
<td>Students try to balance everyone’s input and build on/clarify each other’s ideas. The majority of students are give thoughtful input and attempt to build on and/or clarify other’s ideas with some success.</td>
<td>Students clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Group Self-Regulation</strong></th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 - Mastering</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no evidence of group self-regulation.</td>
<td>Some students may dominate (inadvertently or on purpose), or become argumentative. Students may attempt to regulate the discussion, but without success. There may be some tentative, but ineffective, attempts at reaching consensus.</td>
<td>Students regulate the discussion by identifying unproductive communication. Students attempt to reach consensus, but may find it challenging to implement strategies that equitably consider multiple perspectives. The majority of students work to achieve consensus in order to frame the problem and propose approaches.</td>
<td>Students use self-regulation strategies to ensure a productive discussion. Students clearly work together to reach a consensus in order to clearly frame the problem and develop appropriate, concrete ways to resolve the problem.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

**Scoring Rules specific to group communication**

1. Consider level of individual engagement (as measured by length and depth of utterances) in weighting score.
ABET Skill 3h. Broad understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts

1. **Definition**: Students consider how their proposed solutions to address the problem(s) impact relevant global, economic, environmental, and cultural/societal contexts.

**NOTE TO RATER**: Consider assigning a subscore to each context, similar as is done for individual performance indicators. Recognize that some contexts are not necessarily as relevant as others to the scenario discussed.

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

**Economic**: Students relate the issue or proposed approaches to trade and business concerns (such as project costs).

**Environmental**: Students relate the issue or proposed approaches to local, national or global environmental issues (such as ozone depletion).

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

<table>
<thead>
<tr>
<th>Impact/Context</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 - Mastering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not consider the impacts of potential solutions.</td>
<td>Students give cursory consideration to how their proposed solutions impact contexts. Contexts considered may not be relevant. Students don’t seem to understand the value or point of considering impacts of technical solutions or the contexts within which the solution is proposed.</td>
<td>Students consider how their proposed solutions impact major relevant contexts, and possibly re-think their understanding of the problem(s) themselves. Students justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems.</td>
<td>Students clearly examine and weigh how their proposed solutions impact major relevant contexts. Students justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems. Students understand how different contexts can affect solution effectiveness. Students may decide to reframe the primary and/or secondary problems after considering impacts.</td>
<td></td>
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</tbody>
</table>

**Comments**
**ABET Skill 3i. Recognition of the need for and ability to engage in life-long learning**

**Definition:** Students refer to and examine the information and sources contained in the scenario. Students differentiate between what they know and do not know. Students utilize their own past experiences as they analyze issues in the scenario. Students engage one another as they examine the information.

<table>
<thead>
<tr>
<th>Identify Knowledge Status</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 – Mastering</th>
</tr>
</thead>
</table>
| Scratch the Information   | Students do not refer to or scrutinize information presented in the scenario. | Students refer to the information presented in the scenario (e.g. “it says”). Students begin to examine information presented in the scenario. Examples include, but are not limited to:  
  - questioning the validity of information sources  
  - distinguishing fact from opinion | Students examine information presented in the scenario, and potentially the information sources. Examples include, but are not limited to:  
  - questioning the validity and potential biases of information sources  
  - distinguishing fact from opinion  
  - recognizing what is implied and what is explicit | Students examine not only information, but also information sources. Examples include, but are not limited to:  
  - discussing potential and probable biases of the information sources  
  - distinguishing fact from opinion in order to determine levels of information validity  
  - analyzing implied information. |

| Identify Knowledge Status | Students do not differentiate between what they do and do not know. | Students begin to identify the boundaries of their knowledge of the issues raised in the scenario. Examples include, but are not limited to:  
  - recognizing information that is new to them  
  - beginning to ask questions  
  - injecting their own life experiences, possibly without questioning the validity in relationship to other sources | Students identify the limits of their knowledge of the issues raised in the scenario. Examples include, but are not limited to:  
  - connecting personal experiences or information read/heard elsewhere  
  - recognizing that personal experiences may or may not benefit analysis of the issues  
  - considering related historical events  
  - identifying specific knowledge gaps and reliable sources to consult | Students identify the specific limits of their knowledge of the issues raised in the scenario and how those limitations affect their analysis. Examples include, but are not limited to:  
  - checking assumptions related to personal experiences or information read/heard elsewhere  
  - considering related historical events  
  - acknowledging that they learned from the scenario, each other and the discussion  
  - identifying specific knowledge gaps and a variety of reliable sources to consult |

Comments

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EPSA Rubric October 2013 ©2013—Washington State University; University of Idaho; Norwich University; NSF DUE #: 131896
ABET Skill 3j. Knowledge of contemporary issues

Definition: Students consider non-technical issues, such as contemporary political and/or geo-political concerns, in framing the problem(s) and possible solutions to address the problem(s). Students display awareness of relevant modern technical issues/methods/tools relevant to framing and solving the problem(s) with reasonable accuracy.

NOTE TO RATER: Contemporary refers to current issues easily accessed in a variety of media and those that have been relevant in the previous year (e.g., a war, civil unrest or strife, economic collapse, deposed head of state, etc.). Modern refers to up-to-date engineering methods, technologies and tools relevant to the framing and/or solving of the problem (e.g., fault and risk analysis, concept generation, concept solution, product or process design/simulation, performance optimization, testing, etc.).

<table>
<thead>
<tr>
<th>Non-Technical Issues</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
<th>5 - Mastering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not consider contemporary political or geo-political issues.</td>
<td>Students give limited consideration to contemporary political and/or geo-political issues. Non-technical issues may be treated in a condescending manner, or without understanding of why an engineer may need to consider non-technical issues.</td>
<td>Students give meaningful contemporary political and/or geo-political issues. Students show some accurate understanding of how non-technical issues may affect framing the problem(s) and possible solutions.</td>
<td>Students give extensive meaningful consideration to contemporary political and/or geo-political issues. Students fully understand the importance of how the non-technical issues considered impact framing the problem(s) and possible solutions.</td>
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</tbody>
</table>

| Technical Issues | Students do not consider modern methods, technologies and/or tools. Students may not show awareness that certain methods, technologies and/or tools are not relevant in framing and/or solving the problem(s). | Students give passing consideration to modern methods, technologies and/or tools. | Students give relevant consideration to modern methods, technologies and/or tools in framing and/or solving the problems(s). | Students give extensive relevant consideration to modern methods, technologies and/or tools in framing and/or solving the problems(s). |

Comments

Scoring Rules
1. Keep track of the number and depth of non-technical and technical issues raised/discussed. Limited discussion of many possibly non-relevant issues may justify a score of 3 over a 4. In-depth discussion of a few highly relevant issues in both non-technical and technical areas may justify a score of 4 or 5.
## Appendix C. The Engineering Professional Skills (EPSA) Rubric

### ABET Skill 3f Understanding of professional and ethical responsibility

<table>
<thead>
<tr>
<th>Stakeholder Perspective</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Students do not identify stakeholders</td>
<td>Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions.</td>
<td>Students explain the perspectives of major stakeholders and convey these with reasonable accuracy.</td>
<td>Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with great clarity, accuracy, and empathy.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students do not identify the problem(s) in the scenario.</td>
<td>Students begin to frame the problem, but have difficulty separating primary and secondary problems. If approaches to address the problem are advocated, they are quite general and may be naive.</td>
<td>Students are generally successful in distinguishing primary and secondary problems with reasonable accuracy and with justification. There is evidence that they have begun to formulate credible approaches to address the problems.</td>
<td>Students convincingly and accurately frame the problem and parse it into sub-problems, providing justification. They suggest detailed and viable approaches to resolve the problems.</td>
<td></td>
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</tr>
<tr>
<td>Students do not give attention to ethical considerations</td>
<td>Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds involving primary stakeholders.</td>
<td>Students are sensitive to relevant ethical considerations and discuss them in context of the problem(s). Students make linkages between ethical considerations and stakeholder interests. Students may identify ethical dilemmas and discuss possible trade offs.</td>
<td>Students clearly articulate relevant ethical considerations and address these in discussing approaches to resolve the problem(s). Students make linkages between ethical considerations and stakeholder interests and incorporate them into their analysis and resolutions. Students may discuss ways to mediate dilemmas or suggest trade offs.</td>
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</tr>
</tbody>
</table>

### ABET Skill 3g Ability to communicate effectively

<table>
<thead>
<tr>
<th>Group Interaction</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
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<tr>
<td>Students do not interact as a group.</td>
<td>Students pose individual opinions, without considering other student’s ideas.</td>
<td>Students try to balance everyone’s input and build on/clarify each other’s ideas. The majority of students give thoughtful input and attempt to build on and/or clarify other’s ideas with some success.</td>
<td>Students clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Group Self-Regulation</td>
<td>Some students may dominate (inadvertently or on purpose), or become argumentative. Students may attempt to regulate the discussion, but without success. There may be some tentative, but ineffective, attempts at reaching consensus.</td>
<td>Students regulate the discussion by identifying unproductive communication. Students attempt to reach consensus, but may find it challenging to implement strategies that equitably consider multiple perspectives. The majority of students work to achieve consensus in order to frame the problem and propose approaches.</td>
<td>Students use self-regulation strategies to ensure a productive discussion. Students clearly work together to reach a consensus in order to clearly frame the problem and develop appropriate, concrete ways to resolve the problem.</td>
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### ABET Skill 3h Broad Understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts.

<table>
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<tr>
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<tr>
<td>Students do not consider the impacts of potential solutions</td>
<td>Students give cursory consideration to how their proposed solutions impact contexts. Contexts considered may not be relevant. Students don’t seem to understand the value or point of considering impacts of technical solutions or the contexts within which the solution is proposed.</td>
<td>Students consider how their proposed solutions impact major relevant contexts, and possibly rethink their understanding of the problem(s) themselves, justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems.</td>
<td>Students clearly examine and weigh how their proposed solutions impact major relevant contexts, justify possible solutions with reasonable accuracy. Impacts considered may be associated with relevant secondary problems, and understand how different contexts can affect solution effectiveness.</td>
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</table>

### ABET Skill 3i Recognition of the need for and ability to engage in life-long learning.

<table>
<thead>
<tr>
<th>Scrutiny Information</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
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<tbody>
<tr>
<td>Students do not read or scrutinize the information presented in the scenario.</td>
<td>Students refer to the information presented in the scenario [e.g., “It says”]. Students begin to examine information presented in the scenario. Examples include, but are not limited to: questioning the validity of information sources, distinguishing fact from opinion.</td>
<td>Students examine information presented in the scenario, and potentially the information sources. Examples include, but are not limited to: questioning the validity and potential biases of information sources, distinguishing fact from opinion, recognizing what is implied and what is explicit.</td>
<td>Students examine not only information, but also information sources. Examples include, but are not limited to: discussing potential and probable biases of the information sources, distinguishing fact from opinion in order to determine levels of information validity, analyzing implied information.</td>
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</table>

### ABET Skill 3j Knowledge of contemporary issues.

<table>
<thead>
<tr>
<th>Identify Knowledge Status</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
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<th>3 - Practicing</th>
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<tbody>
<tr>
<td>Students do not differentiate between what they do and do not know.</td>
<td>Students begin to identify the boundaries of their knowledge of the issues raised in the scenario. Examples include, but are not limited to: recognizing information that is new to them, beginning to ask questions, injecting their own life experiences, possibly without questioning the validity in relationship to other sources</td>
<td>Students identify the limits of their knowledge of the issues raised in the scenario. Examples include, but are not limited to: connecting personal experiences or information read/heard elsewhere, recognizing that personal experiences may or may not benefit analysis of the issues, considering related historical events, identifying specific knowledge gaps and reliable sources to consult</td>
<td>Students identify the specific limits of their knowledge of the issues raised in the scenario and how those limitations affect their analysis. Examples include, but are not limited to: checking assumptions related to personal experiences or information read/heard elsewhere, considering related historical events, acknowledging that they learned from the scenario, each other and the discussion, identifying specific knowledge gaps and a variety of reliable sources to consult</td>
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### ABET Skill 3k Knowledge of contemporary issues.

<table>
<thead>
<tr>
<th>Non-Technical Issues</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
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<tr>
<td>Students do not consider contemporary political or geo-political issues.</td>
<td>Students give limited consideration to contemporary political and/or geo-political issues. Non-technical issues may be treated in a cursory manner, or without understanding of why an engineer may need to consider non-technical issues.</td>
<td>Students give meaningful contemporary political and/or geo-political issues. Students show some accurate understanding of how non-technical issues may affect framing the problem(s) and possible solutions.</td>
<td>Students give extensive meaningful consideration to contemporary political and/or geo-political issues. Students fully understand the importance of how the non-technical issues considered impact framing the problem(s) and possible solutions.</td>
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</tr>
</tbody>
</table>

### ABET Skill 3l Knowledge of contemporary issues.

<table>
<thead>
<tr>
<th>Technical Issues</th>
<th>0 - Missing</th>
<th>1 - Emerging</th>
<th>2 - Developing</th>
<th>3 - Practicing</th>
<th>4 - Maturing</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Students do not consider modern methods, technologies and/or tools.</td>
<td>Students give passing consideration to modern methods, technologies and/or tools. Students may not show awareness that certain methods, technologies and/or tools are not relevant in framing and/or solving the problem(s).</td>
<td>Students give relevant consideration to modern methods, technologies and/or tools in framing and/or solving the problem(s).</td>
<td>Students give extensive relevant consideration to modern methods, technologies and/or tools in framing and/or solving the problem(s).</td>
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