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Norwich University's Experience Teaching and Assessing Student Learning of Professional Skills Using the EPSA Method

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Norwich University's Experience Teaching and Assessing Student Learning of Professional Skills Using the EPSA Method

Introduction

Proficiency in engineering professional skills, such as ethics, communication skills, and teamwork, are critical for success in the multidisciplinary, intercultural team interactions that characterize 21st century engineering careers. Boeing's list of "Desired Attributes of an Engineer" specifically include "Good communications skills", "High ethical standards", "A profound understanding of the importance of teamwork", "Understanding of the context in which Engineering is practiced", and "Curiosity and a desire to learn for life"[1]. Engineering program accrediting bodies worldwide recognize this importance and have required evidence of student mastery of related student outcomes since the adoption of ABET EAC EC2000[2].

Norwich University has successfully been utilizing the Engineering Professional Skills Assessment (EPSA)[3] method in the senior level course EG450 Professional Issues since 2012. This course covers a range of topics, such as ethics, licensure, and client interactions, which are related to the professional practice of engineering. Similar senior level courses at other institutions 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 and is difficult to quantify[4].

The Engineering Professional Skills Assessment (EPSA) method was created as a direct method to simultaneously teach and measure student performance of the professional skills learning outcomes included in ABET EAC Criterion 3 - student outcomes, shown in Table 1. While originally developed to work with the professional skills in EC 2000, EPSA has been continuously updated and addresses the professional skills in ABET EAC Criterion 3 2025-2026.

Table 1. Professional Skills in ABET EAC Criterion 3. Student Outcomes [5]

SO 3. an ability to communicate effectively with a range of audiences
SO 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
SO 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
SO 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Engineering Professional Skill Assessment Method

The EPSA method focuses on groups of students discussing a complex, real-world scenario. This discussion-based performance assessment has two components: (1) a student discussion guided by a 1-2 page scenario that presents a contemporary multi-faceted engineering problem in a complex societal and environmental context with no clear-cut solution along with a series of questions to prompt the discussion, and (2) a task-specific analytic scoring rubric designed to be used to evaluate the student discussion in response to a prompt and scenario.

The EPSA begins with a group of five to eight students discussing a complex, real-world scenario that includes current, multidisciplinary engineering issues. To initiate the 30-45 minute-long discussion, student participants first read a short scenario that includes both technical and non-technical details of the topic. Table 2 presents a list of sample scenario topics. The EPSA Scenario Topics listed in **bold** are presented in Appendix A.

Table 2. Sample EPSA Scenario Topics

AI in Healthcare	Energy Critical Minerals
Development of Offshore Wind Resources	Nuclear Power: Environmental Considerations
Power Grid Vulnerabilities	Hydraulic Fracturing
Facial Recognition	Water Projects in Developing Countries

While reading the scenario the students are given a series of questions to guide the discussion. These discussion prompts direct the students to identify the important problem/s and to discuss stakeholders, impacts, unknowns, and possible solutions. The EPSA discussion prompts are shown in Table 3

Table 3. EPSA Discussion Prompts

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 need not develop specific technical solutions. Just agree on what factors are most important and identify one or more viable ways to address the problem.

The student discussions may be conducted live in the classroom, in real-time using on-line discussion groups, or asynchronously using chat features of course management systems. The assessments may be conducted during the live discussions, from recordings of the live discussions, or from transcripts from the on-line chats or recordings of the discussions.

The EPSA method was the subject of a four-year reliability and validity study funded by the National Science Foundation (NSF DUE # 1432997)[6]. After the completion of the study, the team members introduced other faculty members to the EPSA method, who then independently started to utilize aspects of the EPSA method in their courses.

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. For example, in a recent semester one professor elected to use the EPSA "Offshore Wind Resources" scenario due to recent news concerning the offshore wind farms being constructed off the New

England coast. This scenario 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 EPSA Rubric provides a standardized means to evaluate the quality of student discussions and makes evaluation of students' work more consistent between the multiple sections of the course. The flexibility of the EPSA method allows it to be readily adapted for use in other courses[7]. Since Norwich University's School of Engineering has several programs that are accredited by ABET's Engineering Accreditation Commission and other programs that are accredited by ABET's Applied and Natural Science Accreditation Commission, and EPSA is used by institutions that are accredited by other accreditation organizations, as shown in Table 4, the EPSA Rubric provides data that may be used to demonstrate that the ABET criteria are addressed, but is not specifically linked to ABET EAC Criterion 3. Student Outcomes.

The EPSA analytical rubric is used to evaluate the student discussions. As shown in Table 4, the EPSA rubric is segmented into five dimensions to provide the information needed to assess the student outcomes. As discussed by D. Riley [8] ABET Criterio 3 Student Outcome SO 4 is a compound outcome which addresses several distinct student competencies: recognizing ethical and professional responsibilities, making informed judgment, consider relevant contexts, and consider contemporary issues.

Table 4. Professional Skills EAC Criterion 3. Student Outcomes addressed by EPSA Rubric

2024 EPSA Rubric Dimension	ABET EAC Criterion 3: Student Outcomes (SO) addressed
EPSA 1. Students solve problems in an ethical manner.	SO 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, …(first part of Student Outcome 4) SO 1. Students identify problem only (Technical Skill.)
EPSA 2. Students consider impacts of solutions on relevant contexts.	SO 4. …which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (second part of Student Outcome 4)
EPSA 3. Students consider contemporary issues.	SO 4. …which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (second part of Student Outcome 4)
EPSA 4. Students acquire, interpret, evaluate and apply information.	SO 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
EPSA 5. Students communicate with each other to reach consensus.	SO 3. Communicate effectively with a range of audiences SO 5. Function effectively on a team to meet objectives.

As shown in Figure 1 "EPSA Rubric – EPSA 1 Students problem solve in an ethical manner", some of the five dimensions of the rubric are sub-divided to provide more complete assessment of the student outcome. The entire EPSA Rubric is shown in Appendix B. Best practices for using the EPSA rubric to assess student discussions were covered by McCormack et al [9].

EPSA 1: Students problem solve in an ethical manner **(ABET EAC 1 & 4, ABET ANSAC 1 & 5)** Rater Score for Skill________

Definition: Students clearly frame the problem(s) raised in the scenario with reasonable accuracy and begin the process of resolution through offering approaches that could address the problem(s). 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, etc. and doing "what is right" for all involved).

	0 - Missing	1 - Emerging	2 - Developing	3 - Practicing	4 - Maturing	5 - Mastering
Problem Solving	Students do not identify the problem(s) in the scenario.	Students begin to frame the problem(s). Approaches suggested to address the problem(s) may be general and/or naive.		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 problem(s).		Students convincingly and accurately frame the problem(s) and parse sub-problems, providing justification. They suggest detailed and viable approaches to resolve the problem(s).
Stakeholder Perspective	Students do not identify stakeholders.	Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions.		Students explain the perspectives of major stakeholders and convey these with reasonable accuracy.		Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with clarity, accuracy, and empathy.
Ethical Consideration	Students do not identify ethical considerations.	Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds.		Students are sensitive to relevant ethical considerations and discuss them in context of the problem(s). Students may identify ethical dilemmas and discuss possible trade offs.		Students clearly articulate relevant ethical considerations in the context of the problem(s). Students may discuss ways to mediate dilemmas or suggest trade offs.

Figure 1: EPSA Rubric - EPSA 1: Students problem solve in an ethical manner

Implementation in the Classroom

In the Fall 2024 semester EPSA was utilized in Norwich University's EG450 course. The EPSA method used portions of four class periods near in the last month of the semester, each of which ended with an all-hands review. The class time for each period was 75 minutes. This amount of time was found to be adequate for setting-up the groups, reading of introduction, students reading of the scenario, student discussion, and post discussion analysis.

The EPSA method was introduced in a portion of the first of these four class periods. In the first class period session the students were introduced to the EPSA Discussion prompts, the Scenario "Facial Recognition", and the EPSA rubric. The next class period served as a practice session. The students were walked through all the portions of the EPSA method, discussion prompts, scenarios, the use of the EPSA's analytic rubric, and were divided into two groups to conduct a practice discussion and assessment. All students were given the discussion prompts and the "Power Grid Vulnerabilities" scenario. One group discussed the scenario, and the members of the second group were each issued a single dimension of the rubric to practice assessing the discussion. Since this was a practice session, the groups were larger than optimum and the discussion time was broken into short time blocks and reduced in total, so that the instructor and facilitator could provide comments and guidance on use of the EPSA method and the EPSA Rubric.

During the third class period, the students in the class were divided into two teams, the first with 14 students in room U125 and a second with 12 students in room U120. Half of each team was assigned to discuss the "AI in Healthcare" scenario, and the other half of each team was assigned to assess the discussion, as shown in Table 5. Each team met in a separate room so that the two teams did not influence each other's discussion.

During the last of these class periods, the team assignments were the same as from day 2, but the sub-teams switched roles, so that those who discussed the scenario on Day 2 were now assigned to the Assessors sub-team and those who were Assessors on Day 2 were now assigned to the

Discussion sub-team. This ensured that everyone had the opportunity to serve in both roles. Both teams discussed the "Hydraulic Fracturing" scenario.

Table 5. Organization of the discussion and assessment teams

Discussion Sub-Team	Assessment Sub-Team
5-8 individuals, all participate in the discussions. One person assigned as leader to ensure all questions in prompt are addressed and to ensure that all members in discussion group have opportunities to speak.	3-7 individuals, do not participate in discussions, assess discussion and take notes on the EPSA Rubric. One person assigned to lead assessment team and to assign each assessor to take notes on two rubric dimensions so that there is some overlap in coverage.

The students on the Discussion Sub-Teams read the scenario and discussion prompts and then discussed the scenario. The students on the Assessment Sub-Teams were also expected to read the scenario and discussion prompts, listen carefully to the discussion, note evidence heard about their assigned EPSA rubric areas, and provide a rating for each area by the end of the discussion. Table 6 summarizes the assessor findings. Since the discussion assessments were conducted during the discussion the discussions were not recorded. Scores are on the 5 point EPSA scale (1=emerging, 2=developing, 3=practicing, 4=maturing, 5=mastering).

There was faculty member or mature non-faculty member in each of the two rooms to serve as a facilitator, keeping time and answering questions related to the EPSA method operation and other logistical issues. The facilitator and Discussion Team leader were responsible for keeping the discussion team focused as the course instructor moved back and forth between discussion groups.

Table 6: Assessment Rubric Observation Summary (entire class – both scenarios)

EPSA Rubric Dimension	Number of assessments	Mean (day1:day2)	Low	High
EPSA 1. Students solve problems in an ethical manner.	9	4.28 (4.29:4.27)	3	5
EPSA 2. Students consider impacts of solutions on relevant contexts.	10	4.35 (4.20:4.50)	3.5	5
EPSA 3. Students consider contemporary issues.	9	4.11 (4.00:4.20)	4	5
EPSA 4. Students acquire, interpret, evaluate and apply information.	8	3.91 (3.88:3.94)	3	5
EPSA 5. Students communicate with each other to reach consensus.	8	3.75 (3.25:4.25)	3	5

There were 21 assessments from the AI in Healthcare discussion and 23 assessments from the Hydraulic Fracturing discussion, which had one additional assessment in EPSA 1 and EPSA 3 compared to the discussion on AI in Healthcare.

As shown in Table 7, the information collected using the EPSA rubric may be directly used to document ABET Criterion 3 Student Outcomes. Since Criterion SO 4 uses the combination of EPSA 1, EPSA 2, and EPSA 3 the course faculty will need to decide on the relative weights for each of these student assessments.

Table 7: ABET EAC Criterion 3. Engineering Professional Skills Assessment Summary

<table>
<tr><th>ABET EAC Criterion 3:
Student Outcomes addressed</th><th colspan="4">EPSA Rubric Dimension</th><th>Mean Score</th></tr>
<tr><td>SO 3. an ability to communicate effectively with a range of audiences</td><td colspan="4">EPSA 5. Students communicate with each other to reach consensus.</td><td>3.75</td></tr>
<tr><td rowspan="5">SO 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.</td><td></td><td>Mean</td><td>Weight*</td><td>Sum</td><td rowspan="4"></td></tr>
<tr><td>EPSA 1. Students solve problems in an ethical manner.</td><td>4.28</td><td>50%</td><td>2.14</td></tr>
<tr><td>EPSA 2. Students consider impacts of solutions on relevant contexts.</td><td>4.35</td><td>40%</td><td>1.74</td></tr>
<tr><td>EPSA 3. Students consider contemporary issues.</td><td>4.11</td><td>10%</td><td>0.41</td></tr>
<tr><td colspan="3">Total ABET EAC Criterion 3 Outcome SO4</td><td>4.29</td><td>4.29</td></tr>
<tr><td>SO 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.</td><td colspan="4">EPSA 5. Students complete assignment in allotted time and reach consensus.</td><td>3.75</td></tr>
<tr><td>SO 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.</td><td colspan="4">EPSA4. Students acquire, interpret, evaluate and apply information.</td><td>3.91</td></tr>
</table>

* Note: Weights used to determine score for ABET EAC Student Outcome SO 4 should be adjusted based upon the department's objectives for the course and the relative numbers of assessments.

Student Evaluations of the EPSA Implementation

26 students in the class. 21 of 26 completed the end of overall exercise assessment. 2 were absent on the last day of the exercise.

- 19 of 21 students answered Yes (choices: Yes, Maybe, No) in response to the question "Did these scenarios cause you to stretch and think about big ethical thoughts?"
- In response to "Which scenario exercise was the most meaningful?" 3 students selected the power grid vulnerabilities scenario from the practice exercise, 8 students selected the hydraulic fracturing scenario exercise, and 10 students selected the AI in healthcare scenario exercise. Some students selected exercises in which they participated as discussers and some selected exercises in which they participated as assessors.

Positive threads from written comments from student evaluations

- topics were good
- relevant that students "were informed" of important contemporary issues
- productive, professional, interesting conversations
- uninterrupted discussions (not interfered with by instructors)
- discussion prompts were helpful in keeping discussions focused

- small group size was good (group dynamics change if group is too large)
- having same group for discussing one day and assessing the other day was good
- mix of CEs, ECEs, Gen.Engrs on groups was good
- having a team leader was good (team leader selected randomly, so all students had to be prepared to serve in role. Team leaders changed every day.

Areas for improvement threads from student evaluations written comments

- notify students of scenario topics in advance so that the students can research the topics before the discussions
- go over the rubric more before starting
- none − really liked the process
- allow teams to strategize before the discussion time starts

Faculty Evaluation of the EPSA Implementation

All 26 students participated meaningfully in the both the practice and record exercises. Minimal differences between the two teams and minimal differences between the sub-teams on either team. No ratings were less than 3.0 (Developing), which is as expected for Seniors in Engineering.

There was the more variability for EPSA 5 "Students communicate with each other to reach consensus" between the students who discussed the first scenario and those who discussed the second scenario than there was for the other dimensions of the EPSA rubric. This might simply indicate that the students discussing the second scenario had more exposure to the EPSA method and did a bit better answering the discussion prompts. EPSA 5 provides a useful measure for assessing how well the students communicate with each other and conduct themselves during the EPSA discussion but is not intended to cover all aspects of Communication and Teamwork. EPSA 5 is a supplement to other measurement methods for assessing ABET EAC Criterion 3 – SO 3 Communication with a range of audiences and ABET EAC Criterion 3 – SO 5 Teamwork.

Compared to stand alone ethics case studies, the course faculty observed that students were kept engaged in the discussions since the students related to the topics and interdisciplinary aspects of the EPSA scenarios. Lewis et al [10] have noted that interdisciplinary scenarios, such as those used in EPSA, generate more enthusiastic and higher-level discussion than case studies that focus solely on ethics.

Conclusions

The EPSA method is flexible and easy to implement and provides information that may be used both at the course level for teaching and measuring engineering professional skills and at the program level for evaluating a program's efficacy. The flexibility of the EPSA Method allows it to be readily adapted for use in courses at all levels in the curriculum. The EPSA Scenarios, which show the complexity and interdisciplinary nature of contemporary real-world engineering problems afford students the opportunity to practice holistic engineering problem solving thinking with fellow students. The EPSA Rubric provides a standardized means to evaluate student discussions and makes evaluation of students' work more consistent between multiple assessors. The course instructor plans to continue using the EPSA method to assess the ABET Professional skills at both the course and the program level.

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Appendix A. EPSA Scenario Examples

EPSA Scenario: Artificial intelligence in healthcare

NP, 24, sits in front of a computer in the city of Bhubaneswar in India. Noise from city life and traffic occurs outside while inside NP watches colonoscopy videos. NP looks for pre-cancerous polyps. When NP spots one, NP draws a digital circle around it. GH, in New Orleans, USA, instead of listening to the city's famous Jazz, is paid to listen to audio recordings of people coughing. GH's job is to differentiate between good coughs and bad ones. NP, GH, and thousands of others around the world are involved in training artificial intelligence (AI) systems that can do the work of a doctor.

AI systems can diagnose skin cancer like dermatologists, seizures like neurologists and ulcers like gastroenterologists. They can predict which patients will get diarrhea as a side effect of a drug, the length of time a patient will be in ICU after an operation and whose cancer is incurable. AI proponents project that the use of AI could cut down treatment costs by 50% and improve medical outcomes by 30 to 40%. In the US, AI is estimated to generate savings of $150 billion annually for the health industry. The UAE spends $1200 per capita on healthcare, which accounts for a quarter of all healthcare expenditure in the GCC. The UAE government has set itself the target of 2071 as the year where all public and private hospitals will be equipped with AI technology. 62% of UAE residents were found to be in favor of replacing doctors with AI.

Before an AI system learns how to identify medical conditions on its own, someone has to label the data supplied to it, which is what NP and GH do. Neither they nor other data entry workers, however, have any medical qualifications or specialist knowledge. Training for the job involved several online video calls with a non-practicing doctor located in the US. Medical experts question the reliability of non-experts in labeling data that will be fed into a machine and used to make real-life health decisions.

In addition to labeled images, data comes from medical journals, patient health records, lab results, radiology and pathology reports, doctor's notes, clinical care guidelines and the Internet. Machines analyze these data and identify patterns and rules using algorithms that computer programmers create. Algorithms generate new algorithms based on inferences from data, enabling machines to learn from experience, adjust to new inputs and perform human-like tasks. In this way, neural networks are created. AI companies keep quiet about where these data are obtained from and who they are supplied too. Privacy activists point out that large amounts of personal information is being stored and shared without patient consent. As the Internet expands and is meshed more and more into daily life, companies have easier access to sensitive information without patients' knowledge.

Doctors and healthcare administrators believe that AI can bring ubiquity to medical care – patients can be diagnosed and treated at any time and in any place. AI can eradicate barriers that have traditionally hindered access to medical care such as cost, geographical distance and language. The World Health Organization reports that a Google-based AI system has enabled India to make strides in detecting diabetic retinopathy, the leading cause of blindness among working-age adults in the world. Diabetic retinopathy is widespread in the Middle East too. Six of the 10 countries with the highest rates of diabetic blindness are in the Middle East. The prevalence of retinopathy among diabetic patients ranges from 19% in the UAE to 55% in Yemen and 64% in Jordan. Another benefit of AI systems is that they can compensate for doctor fatigue, oversight and lack of experience. In one study AI software was found to be more than 90% accurate in diagnosing asthma while trained doctors were accurate 80 to 84% of the time. For such levels of accuracy, though, an AI system needs access to clear, unobstructed images. A blurry X-ray or a cataract in a patient's eye prevents the AI from recognizing the disease.

While AI shows promise in the detection and diagnosis of illnesses, this does not guarantee that the decisions it makes are fair and ethical. Doctors and other medical experts are concerned that AI risks perpetuating health disparities that already exist. Medicine has excluded women and minorities in research despite knowing that they exhibit different symptoms and have risk factors different to mainstream groups. Some facial recognition software has shown a bias in favor of lighter skin tones. If AI is trained on electronic health records, it is building on only people who can access healthcare and is perpetrating any limits that are included those records. Health-related AI data need to represent a wide range of social and economic backgrounds; otherwise, algorithms will merely reflect the pre-existing biases of society when faced with situations that involve ethical and social complexity. For example, if poor patients' health conditions are found not to improve after chemotherapy, machine learning algorithms might recommend against such treatment for all lower socio-economic groups. In this way, AI can make discrimination invisible and automated.

Scenario References: Artificial intelligence in healthcare

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EPSA Scenario: Development of Offshore Wind Resources

The US pioneered land-based wind farms in the 1980's and by 2022 had a total installed land-based capacity of about 144,000 MW (megawatts). 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 was planned to have 130 turbines with total output power 400 MW. Each turbine was design to extend 400 feet above the surface of the sea and the wind farm was to cover 24 square miles of ocean about five miles off the Massachusetts coast near Hyannis Port and Nantucket Sound. After the project lost several key power supply contracts and suffered licensing and financial setbacks the sponsor of the project terminated the project in 2017. Other large projects such as 6,000 MW Atlantic Wind Connection, sponsored by Google, also were terminated. Despite these setbacks, by 2023 there were 3 operational utility-scale offshore wind farms (RI, VA, and MA) with a combined capacity of 172 MW, plus several under construction with a planned capacity of 4159 MW.

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 100 other wind farms have been built near Europe with a total installed capacity exceeding 16,000 MW. Sponsoring companies for these European wind farms include Denmark, UK, Germany, Netherlands, Belgium, Norway, France, Belgium, and Sweden. 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 their construction and maintenance costs

Negative impacts of offshore wind farms include maritime navigation safety, excessive bird mortality through collisions with the turbines, deleterious effects on marine 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. The BOEM NY Bight Final Programmatic Environmental Impact Statement identifies Avoidance, Minimization, Mitigation and Monitoring (AMMM) measures that would be required to minimize environmental disturbances.

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. While earlier Life cycle analysis of multi-megawatt wind turbines indicated that the turbine “pays back to the ecosystem” several times the environmental damage that resulted from its manufacture, start-up, operation, maintenance, and decommissioning, more recent research has indicated that the maintenance costs and failure rate of offshore wind systems are substantially higher than originally estimated. This research also shows that there is a higher failure rate with higher winds speeds for offshore systems than there is for onshore systems.

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EPSA Scenario: Power Grid Vulnerabilities

Electric power grids are vulnerable to wide area failures from events that include: malicious computer software introduced by criminals or saboteurs; natural phenomena such as space weather that interacts with the earth's ionosphere; man-made catastrophes such as nuclear explosions and physical attacks; and human errors at the system operator level or the system design level. Today, both government and private investments are being made to improve both cyber and physical security at power transmission and distribution centers nationally.

The 2021 ASCE Report Card for America's Infrastructure highlights a power grid with some components over 100 years old, far past their 50-year life expectancy, and others, including 70% of transmission and distribution systems, are well into the second half of their expected lifespans. The distribution networks have become increasingly "congested" in certain areas of the country during the past several years, which furthers the need to upgrade the current distribution and transmission systems. ASCE estimates that it would require over $100 billon to upgrade both transmission and distribution systems by replacing existing devices or retrofitting those already in use.

While natural phenomena, human error, and physical attacks are all of significant concern to the power grid, cyber security is one of the government's primary concerns. According to studies performed in 2022 by USA Today, a cyber or physical security attack occurs against the power grid on the average once every three days. The Department of Energy (DOE) has recently launched a new initiative focusing on upgrading the U.S. electrical grid, with the DOE Office of Cybersecurity, Energy Security, and Emergency Response announcing the funding of 15 research projects on topics including Automated Cyberattack Prevention and Mitigation, Cybersecurity through Advanced Software Solutions, and Automatic Methods to Discover, and Mitigate Vulnerabilities. The grants will enable research to be performed on building technologically advanced energy delivery systems which are cost efficient as well as "secure" and "resilient" against cyber-attacks. In addition to research studies to improve the cybersecurity of the power grid, utilities must work with multiple federal agencies including the Federal Energy Regulatory Commission, Department of Homeland Security, and the Department of Energy.

Computer security experts are concerned with increased vulnerability of the systems used to manage and monitor the smart grid infrastructure. Supervisory Control and Data Acquisition (SCADA) systems represent the legacy technology most prevalent for today's power grid energy management system. SCADA systems are susceptible to cyber-attacks because many are built around older technologies with weaker communication protocol. To increase access to management and operational data, these systems and their underlying networks re progressively more interconnected. One such example of data required from a large interconnected system is the potentially damaging low frequency mass-spring type electric power oscillations that slowly shuttle energy between Canada and Mexico via the US power grid.

Physical security of power generation, transmission, and distribution networks is also considered paramount. Historically the main purpose of physical security was to protect the public from getting into a particular facility, but over the years the focus has shifted to protect the facility from the public. This encompasses crime as basic as copper theft, to more malicious acts with the intent of severely crippling a local area's electrical supply which could have very serious outcome depending on the area being supplied. Physical security is primarily accomplished using video surveillance, locks, and fencing around substation perimeters. Following an attack on a main substation in California, the Federal Energy Regulatory Commission wrote new guidelines on prioritizing the significance of substations and treating physical security accordingly. Even with new guidelines however, there are still concerns regarding how physical security must be treated due to the lack of a single governing body which can enforce penalties for non-compliance.

Scenario References: Power Grid Vulnerabilities

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Appendix B: EPSA Rubric

Engineering Professional Skills Assessment (EPSA) Rubric

Washington State University - College of Engineering and Architecture,
University of Idaho - College of Engineering, Norwich University - David Crawford School of Engineering, Rose-Hulman Institute of Technology

Rater's Name:________________________ **Date:** _______________ **Student Work:**____

Note: The engineering professional skills that comprise this rubric relate directly to criteria such as ABET Engineering Criterion 3, Student Outcomes. Each dimension of the EPSA Rubric comprises one student learning outcome, an EPSA definition of the outcome, and the outcome's performance indicators. Thus, "EPSA 1 relates to "ABET criterion 3 student outcomes 1 and 4" 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 in transcript and a short phrase, such as: EPSA 1 = lines 109-112: tradeoff of wall height/plant safety vs costs; lines 828-836: risk analysis. Be sure to refer 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 spoken, written, or transcribed. Don't "read between the lines" (e.g., don't make assumptions about what the group should know given what is spoken, written, or 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 45-60 minutes.

EPSA 1: Students problem solve in an ethical manner. **Rater Score for Skill________**

Definition: Students frame the problem(s) raised in the scenario with reasonable accuracy and begin the process of resolution through offering approaches that could address the problem(s). Students recognize relevant stakeholders and their perspectives. Students identify related ethical considerations (e.g. health and safety, fair use of funds, risk, schedule, tradeoffs, etc. and doing "what is right" for all involved).

	0 - Missing	1 - Emerging / 2 - Developing	3 - Practicing / 4 - Maturing	5 - Mastering
Problem Solving	Students do not identify the problem(s) in the scenario.	Students begin to frame the problem(s). Approaches suggested to address the problem(s) may be general and/or naive.	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 problem(s).	Students convincingly and accurately frame the problem(s) and parse sub-problems, providing justification. They suggest detailed and viable approaches to resolve the problem(s).
Stakeholder Perspective	Students do not identify stakeholders.	Students identify few and/or most obvious stakeholders, perhaps stating their positions in a limited way and/or misrepresenting their positions.	Students explain the perspectives of major stakeholders and convey these with reasonable accuracy.	Students thoughtfully consider perspectives of diverse relevant stakeholders and articulate these with clarity, accuracy, and empathy.
Ethical Consideration	Students do not identify ethical considerations.	Students give passing attention to related ethical considerations. They may focus only on obvious health and safety considerations and/or fair use of funds.	Students are sensitive to relevant ethical considerations and discuss them in context of the problem(s). Students may identify ethical dilemmas and discuss possible tradeoffs.	Students clearly articulate relevant ethical considerations in the context of the problem(s). Students may discuss ways to mediate dilemmas or suggest tradeoffs.

Comments

EPSA 2: Students consider the impact of solutions on relevant contexts. **Rater Score for Skill________**

Definition: Students consider how their proposed approaches to solve the problem(s) impact relevant local, global, professional, economic, legal, 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.

Local: Students relate the problem and proposed approaches to local situations and concerns (such as proximity to proposed hazardous waste production/storage/processing facility, proposed transportation infrastructure, or other large development).
Global: Students relate the problem and proposed approaches to larger global issues and concerns (E-Waste, Supply Chain Issues, GeoPolitical Conflicts).
Professional: Students relate the problem and proposed approaches to professional engineering codes, standards, references, and guidelines.
Economic: Students relate the problem and proposed approaches to economic issues such as project costs, consumer costs, trade and business concerns.
Legal: Students relate the problem or proposed approaches to local, national, or global laws and regulations.
Environmental: Students relate the problem and/or proposed approaches to local, national or global environmental issues.
Cultural/Societal: Students relate the problem and/or proposed approaches to the needs of local and/or national groups impacted by the problem.

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

Comments

EPSA 3: Students consider contemporary issues. **Rater Score for Skill________**

Definition: Students consider non-technical issues, such as contemporary events, 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, supply issues, a pandemic, 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.).

	0 - Missing	1 - Emerging	2 - Developing	3 - Practicing	4 - Maturing	5 - Mastering
Non-Technical Issues	Students do not consider contemporary, political, or geo-political issues.	Students give limited consideration to contemporary events, and/or 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.		Students give meaningful consideration to contemporary events, and/or 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.		Students give extensive meaningful consideration to contemporary events, and/or 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.
Technical Issues	Students do not consider modern methods, technologies, and/or tools.	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).		Students consider relevant modern methods, technologies, and/or tools in framing and/or solving the problems(s).		Students thoughtfully consider relevant modern methods, technologies, and/or tools in framing and/or solving the problems(s).

Comments

Scoring Rules

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.

EPSA 4: Students acquire, interpret, evaluate, and apply information. **Rater Score for Skill________**

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 information in the scenario.

	0 - Missing	1 - Emerging	2 - Developing	3 - Practicing	4 - Maturing	5 – Mastering
Scrutinize Information	Students do not refer to or scrutinize information presented.	Students refer to the information presented in the scenario (e.g. "it says"). Students may distinguish facts from opinion. Students may question the validity of one or more sources of information.		Students examine information presented in the scenario. Students may recognize that the information sources may have potential biases. Students may recognize what is implied or implicit.		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 information presented. Students may inject their own life experiences, possibly without questioning the validity in relation to other sources of information.		Students identify the parameters of their knowledge of the information presented. Students may connect personal experiences or information read/heard elsewhere, while recognizing the limits of their contributions. Students may refer to related historical events. They may identify specific knowledge gaps, and reliable information sources to consult.		Students identify the specific limits of their knowledge of the information presented and how those limitations affect their analysis. Students may check assumptions related to personal experiences or information read/heard elsewhere, including related historical events. They specify a variety of reliable information sources to be consulted.

Comments

EPSA 5: Students communicate with each other to reach consensus. **Rater Score for Skill________**

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: Assessment of students' communication skills can include several forms of communication, such as written and oral presentation. This definition focuses on group discussion skills.

	0 - Missing	1 - Emerging / 2 - Developing	3 - Practicing / 4 - Maturing	5 - Mastering
	Students do not stay on task. Students do not acknowledge or encourage participation of others.	Students notice other students' ideas. Students may pose individual opinions without linking to what others say. Students may make attempts to bring others into the discussion. Some students may dominate (inadvertently or on purpose) or become argumentative. There may be some tentative, but ineffective, attempts at reaching consensus.	Students acknowledge, build on, and/or clarify other's ideas with some success. Students attempt to reach consensus but may find it challenging to implement strategies that equitably consider multiple perspectives. Students defer quickly to a dominant opinion, converging rather than attempting to reach consensus.	Students clearly encourage participation from all group members, generate ideas together and actively help each other clarify ideas. Students actively work together to reach a consensus to clearly frame the problem and develop appropriate, concrete ways to address the problem(s).
Comments:				

<u>Scoring Rules specific to group communication</u>

1. Consider level of individual engagement (as measured by length and depth of utterances) in weighting score.