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The Engineering Professional Skills Assessment 2.0: Preparing Engineering Students for Global Workplace Complexities

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Introduction

Proficiency in professional skills such as collaboration, knowledge application in contemporary contexts, ethical judgment, problem solving, and capacity for continued learning are among those identified by employers as necessary for success in the 21st century global work environment [1-6]. Engineering program accrediting bodies worldwide recognize this importance and ABET has required evidence of student mastery of related student learning outcomes for a quarter century [7-13]. Yet, faculty in engineering programs continue to struggle to define, teach and measure these professional skills in their efforts to generate accurate and useful data for course and program-level assessment purposes. [14-19]

The Engineering Professional Skills Assessment (EPSA) is the only direct method in the literature that can be used to teach and measure student performance of five engineering professional skills learning outcomes simultaneously [14, 15]. The EPSA is a discussion-based performance assessment. Small groups of students are presented with a complex, real-world scenario that includes multi-faceted, multidisciplinary issues relevant to professional engineers. The discussion can take place face to face in the classroom or online, asynchronously in the discussion board of a learning management system. Students are asked to determine the most important problems presented in the scenario and to discuss stakeholders, impacts, unknowns, and possible approaches to solve the problems.

The EPSA has two components: (1) a task in the form of a prompt and a scenario that presents a contemporary multi-faceted engineering problem in a complex societal and environmental context with no clear-cut solution and (2) a task-specific analytic scoring rubric designed to be used to evaluate the student group discussion in response to the task (i.e., the performance). The EPSA is flexible, easy to implement, and can be used at the course level for teaching and measuring student learning of the targeted skills and at the program level at critical points in the curriculum to gauge student cohort learning for formative and summative assessment purposes.

The EPSA has been used in engineering programs in the US since 2006 and internationally since 2008. The ASEE ERM conference proceedings paper describing the development of the method and the college-wide implementation of the EPSA (then called “curricular debrief”) at Washington State University won the ASEE 2008 Overall Conference Paper Award [20]. In 2010, a study of the reliability and validity of the EPSA was funded by the US National Science Foundation (NSF DUE 1432997). It also inspired the development of the Computing Professional Skills Assessment (CPSA) in 2012, which has undergone its own reliability and validity studies, funded by the Abu Dhabi Department of Education and Knowledge [21].

This research brief presents previously unpublished (1) updates to the EPSA Rubric that increase its clarity and relevancy while maintaining previously established instrument validity; (2) inter-rater reliability results of 191 scores of student discussion transcripts by the study’s engineering faculty using the 2016 EPSA Rubric; and (3) recommendations for EPSA use for course and program level assessment, as well as future research.

A more complete picture of the performance assessment is provided in Table 1, Figure 2, and Appendices A-C. Table 1 lists sample scenario topics. The student group discussion prompt is in Figure 2. A scenario is provided in Appendix A. Appendix B provides a sample "performance" of student discussion excerpts. The 2024 EPSA Rubric is in Appendix C.

Table 1. Sample EPSA Scenarios

Rare earth materials	Facial recognition
Offshore windfarms	Power grid vulnerabilities
AI in Healthcare	Hydraulic fracturing

Figure 2. Student Group Discussion Prompt

Imagine that you are a team of engineers working together for a company or organization on the problems 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 problems.
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 the problems?

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.

EPSA Background and Previously Published Work

In 2010, the US National Science Foundation funded a study to establish the reliability and validity of the method and of the inferences and uses made based on EPSA rubric scores for program-level assessment purposes. Data was collected from group discussions of 423 students in groups of 4-7 in mechanical, civil and electrical engineering programs from sophomore to senior levels in both technical and design courses from Norwich University, the University of Idaho and Washington State University. The project's theoretical proposition was that the EPSA effectively elicits and accurately describes the content and constructs that comprise engineering professional skills.

Initial validity of the use of the EPSA was established between 2006 and 2010 with the college-wide use of a previous iteration of the EPSA at Washington State University [14, 15, 19] Scenario development parameters and parallel task development were guided by McMartin, McKenna and Youssefi [22] and performance task assessment psychometricians Johnson and Penney [23]. The work to ensure the reliability and validity of the scenarios as parallel tasks was reported by McCormack, Beyerlein, Ater Kranov, Pedrow and Schmeckpeper [24]. Scenario and scoring sheet development, as well as methods for efficient and reliable scoring were detailed by the research project faculty team [25]. How to use the EPSA for course and program level improvement purposes, as well as examples of use in professional issues courses were described by members of the research team [26-28].

EPSA Rubric Evolution

A core tenet of rubric design and development is to refine and revise over time with input from users. The original EPSA Rubric learning outcomes were directly tied to six of the ABET Engineering Accreditation Commission (EAC) Criterion 3 Student Outcomes as published in the EC2000 in 1999. Three of the 5 faculty from the original 7 person NSF-sponsored research team updated the rubric to increase clarity, relevancy, and flexibility of use for faculty in engineering programs worldwide, no matter the programmatic accrediting body.

Thus, the 2024 EPSA Rubric is accreditation organization agnostic and the learning outcomes, their definitions, as well as some of the descriptors were modified. Modifications were informed by faculty use of the rubric, following accepted rubric development and evolution guidelines, to ensure that the original instrument validity was upheld [29, 30]. The modification team anticipates that the instrument validity will be strengthened as a result. Table 2 compares the 2016 EPSA Rubric learning outcomes with those of the 2024 EPSA Rubric.

Table 2. EPSA Rubric Learning Outcomes 2016 and 2024

2016 EPSA Rubric Learning Outcomes	2024 EPSA Rubric Learning Outcomes
Understanding of professional and ethical responsibility.	Students problem solve in an ethical manner.
Broad understanding of the impact of engineering solutions in global, economic, environmental, and cultural/societal contexts.	Students consider impacts of solutions on relevant contexts.
Knowledge of contemporary issues.	Students consider contemporary issues.
Recognition of the need for and ability to engage in life-long learning.	Students acquire, interpret, evaluate and apply information.
Ability to communicate effectively.	Students communicate with each other to reach consensus.

Learning outcomes revisions

The most significant revisions to the EPSA Rubric were in the learning outcomes wording in efforts to separate them from ABET EAC Criterion 3. The 2024 EPSA Rubric outcomes follow a traditional structure and describe what students should be able to exhibit as they participate in an EPSA scenario discussion. The revised outcomes also more accurately reflect the original and updated EPSA outcomes definitions and descriptors.

The outcomes revisions focused on wording that is easier to understand and identify when assessing a student discussion. For example, instead of students show "recognition of the need for and ability to engage in life-long learning", the 2024 wording for outcome 4 is more precise and specifies the skills that comprise life-long learning: "Students acquire, interpret, evaluate and apply information."

Competencies considered critical for career readiness by organizations and industry informed both the original EPSA Rubric learning outcomes and the 2024 version [1-6]. Thus, the learning outcomes align with skills criteria required by engineering program accreditation and quality assurance bodies in Australia, Canada, the European Union, New Zealand, the US, the United Kingdom, and Washington Accord signatories [7-13]. Appendix D presents a mapping of the EPSA learning outcomes to engineering quality assurance criteria. A mapping of the EPSA learning outcomes and rubric dimensions to these industry-relevant skills is presented in Appendix E.

Learning outcomes definitions and descriptors modifications

Four wording modifications in total were made to the learning outcome definitions in the 2024 EPSA Rubric to increase clarity and/or ensure stronger alignment with descriptors, in outcomes 2 and 4. For example, three changes were made to the definition for outcome 2 "Students consider impacts of solutions on relevant contexts." The word "approaches" substituted "solutions" since the performance task prompt doesn't ask students to specifically identify technical solutions to the problems raised in the scenario but, rather, to propose approaches that could address or begin to solve the problems. The next modifications were to add two contexts to the existing list: professional and legal. Thus, the revised definition reads: "Students consider how their proposed approaches to solve the problem(s) impact relevant local, global, professional, economic, legal, environmental, and cultural/societal contexts."

The fourth modification was in the last sentence of the definition for outcome 4 "Students acquire, interpret, evaluate and apply information." The word "information" was used instead of "issues" in the third sentence of the definition in efforts to be more precise: "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."

Similarly, relatively few modifications were made to rubric descriptors, and attention was paid to not change meaning, but to increase clarity and alignment with the outcome and its definition. The goal was to make sure that the instrument content and construct validity was not decreased or compromised. See Appendix F for the modifications made to the rubric descriptors in Outcome 5 "Students communicate with each other to reach consensus."

Calculation of Interrater Reliability

A consensus estimate approach was used to estimate interrater percentage agreement, also called consensus estimate. This approach is based on the assumption that raters should be able to come to exact or near exact (i.e., within one point, not straddling the cut score) agreement about how to apply a scoring rubric's levels to the observed performances. If two raters come to exact or near-exact agreement, then one can say that they share a common interpretation of a given construct in the rubric [30]. The target used for acceptable interrater reliability is 70% prior to rater team reconciliation of scores [30]. Reliability was calculated as the number of transcripts with identical scores divided by the number of transcripts evaluated.

Seventy-six students in groups of 4-7 from each of the three universities participated in the discussions that resulted in the first set of transcripts 1-14 that were used for establishing inter-rater reliability. Three hundred and forty-seven students in groups of 4-7 from each of the three universities participated in the discussions that resulted in the second set of transcripts 15-83, which were rated by faculty pairs after calibration.

The five faculty that comprised the NSF-sponsored research team used the 2016 EPSA Rubric to score the same set of 14 discussion transcripts, producing 70 scores and an overall inter-rater reliability percentage of 79.4% prior to reconciliation. 82.9% was the highest percentage recorded for EPSA 1 and EPSA 4. The overall average exceeds the acceptable target standard by nine percentage points. These results are presented in Table 4.

Table 4. Session 1: Interrater reliability pre-reconciliation.

	EPSA Learning Outcomes					
	EPSA1 Problem Solving/Ethical Manner	EPSA 2 Impact of Solutions on Contexts	EPSA 3 Contemporary Issues	EPSA 4 Information Acquisition, Interpretation, Evaluation, Application	EPSA 5 Communication for Consensus	
Number of assessments	70	69	70	70	70	Overall Average 79.4%
Number of identical scores	58	57	54	58	50	
Interrater Average	82.9%	82.6%	77.1%	82.9%	71.4%	

Then, the rater team discussed the results of the first set of transcripts using consensus estimate approach calibration guidelines and reconciled scores that were more than one point off or straddling a cut score [31]. Next, the same five faculty formed rater pairs and scored a second set of transcripts, producing 121 scores and an overall inter-rater reliability percentage of 91.6% prior to reconciliation, greatly exceeding the acceptability standard of 70%. All interrater reliability averages increased in session 2, with 94.2% as the highest percentage recorded for EPSA 2 and EPSA 4. The results are presented in Table 5.

These results show that EPSA Rubric scores reliably provide information about students' engineering professional skills proficiency levels.

Table 5. *Session 2: Interrater reliability pre-reconciliation*.

	EPSA Learning Outcomes					
	EPSA1 Problem Solving/Ethical Manner	EPSA 2 Impact of Solutions on Contexts	EPSA 3 Contemporary Issues	EPSA 4 Information Acquisition, Interpretation, Evaluation, Application	EPSA 5 Communication for Consensus	
Number of assessments	121	121	121	121	121	Overall Average 91.6%
Number of identical scores	107	114	108	114	111	
Interrater Average	88.4%	94.2%	89.3%	94.2%	91.7%	

Recommendations for EPSA use for course and program level assessment, as well as future research

At the course level, the EPSA can be used to both teach and measure student learning of the five targeted professional skills. Results over time can be used for course level improvements. The method can be incorporated into first year to final year engineering courses. It is particularly well suited for the following courses: intro to engineering, professional issues, ethics, design, and capstone. Faculty and students alike report that the EPSA promotes strong engagement and learning.

The EPSA can also be used for program and college continuous improvement purposes and to report out to accrediting bodies. Data from EPSA assessments could be gathered at key points in an engineering curriculum, for example: at entry to establish a college cohort's baseline knowledge and application of the targeted skills, midway through as student enter their engineering specialties in third year, and in the final year to gather end of the curriculum data to inform both program and college success at obtaining their targets and for ongoing improvement.

Research tracking program improvement in teaching and student learning of the professional skills over time would contribute to the literature. Action research or case studies of various implementations of the EPSA, such as: students researching and writing scenarios together using the EPSA scenario development guidelines; students using the EPSA Rubric for peer review or group self-assessment would be useful.

Appendix A Sample 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.

Scenario Sources

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Appendix B. Student Discussion Excerpt: Offshore Windfarms, Lines 124-235

Student 3: With that, it could both benefit – it could be negative in the short term, it could be more beneficial in the long term; it could create estuaries or habitats, and at the same time maybe certainly destroying some when you first put them out.

Student 4: Those big pipes going into the ocean (0:20:36) create some sort of environment for them.

Student 3: Right. I know the electromagnetic fields emanating it was talking about could interfere with some of the creatures, so you might have – I'm not sure how to state that, but, for example, that would specially affect maybe sharks, you know, because they have the sensitivity on their snout. So, I guess maybe that goes into Number 4, ways to address it. Maybe that's skipping ahead, but what organizations to deal with, what statistics to look at when it comes to placement, because certain creatures, like it mentioned the Golden Eagle, very specific creatures could be affected by the location, so that's skipping ahead a little. We kind of skipped 2.

Student 1: Yeah(ph).

Student 4: Probably need to know how deep they need to go so they still stay up when they're 400 feet above the water (0:22:35) how deep to put the base of them.

Student 3: So, they'd probably have to be in the bedrock, so maybe depths of bedrock. Maybe?

Student 4: Mm-hmm.

Student 5: You definitely need to know your location, because depending on where you are, you've got different temperatures, different water conditions, different crowds, so you have different spacing or different aesthetic problems. You know, people might complain if it's right next to their million-dollar mansion. But off the shore where no one is, no one is gonna complain –

Student 4: Yeah.

Student 3: Right, so –

Student 5: – so location is gonna take a – you're gonna have to put a lot into the consideration of your location.

Student 2: (0:23:30), yeah, because you obviously really need what shipping routes and then ports, or large ports and stuff like that (0:23:36).

Student 3: Maybe first addressing what areas you're not gonna place them, you know, and go from there, because there's gonna be a lot of factors where you're gonna immediately know. Migratory patterns.

Student 2: Yeah.

Student 3: Maybe it kind of helps to know a little bit about the stakeholders first, or to kind of run through that.

Student 4: It's probably like any state law, like depending on how close we are to the shore, or if we're in international waters. That'd probably go along with location.

Student 3: That's a great idea, though. That's a need-to-know. Am I incorrect, or is there two projects going on, where one was in a shallow area?

Student 1: I think the one was an example of the –

Student 5: Yeah, the one was the first approved U.S. shore wind farm, offshore. Sorry. That was Cape Wind, and then the other one was the Atlantic Wind Connection, which is the project that we're doing, or discussing.

Student 4: I guess you could probably look at what types of material you want to use. You'd have to find the ones that stand up in salt water.

Student 3: You had mentioned temperature of the water, density. I don't know how much of a factor that plays on these huge implements, but that would go with location. I think we're a little bit restricted. We've got a 10- to 20-mile difference in radius from the coastline, or distance from the coastline, and it's gonna be a 350-mile corridor from New Jersey to Virginia, so I guess really determining what that block represents, really coming up with a grid system of what that represents when you're talking about location.

Student 4: Yeah, 350 miles, that's pretty far, too, so should we put breaks in there in case ships need to go through, or something?

Student 3: Right, so how to orientate them or come up with somewhat of a schematic, so a grid for the 350-mile corridor.

Student 2: Should we move on to Number 4?

Student 3: Probably. I think we're done with (0:27:52) potential impacts and ways to address. I haven't seen it with land-based wind farms, but I know that there's been an issue with bird collisions there, also. The numbers, from what I'm told, aren't extremely high, but when you're dealing with affecting a certain species, you have to make some amendments, and again, I've never seen it, but is there a way to, considering they're a big bird, have a certain sized grid system that kind of encases the fan? You're adding material costs, you're adding weight, you're making it top-heavy, so you're maybe gonna have to anchor it deeper, like you were talking about, but looking at ways to shield the fan from the environment. But you're also maybe cutting down the convection. I don't know if it's relative, maybe not much, but the wind over the surface of the blades, are you gonna reduce that? Is the tradeoff gonna be enough, but maybe shielding the fan.

Student 4: Yeah, it might – that'd be like one of the things to look at for shielding those, like if it would block any wind going through there, or slow it down.

Student 2: From my personal experience of maintenance on wind turbines, even land, it's a real pain, and so for it to be in the ocean, it would be even worse, because then you have, what, you have travel time from the shore to there, and then you have unknown conditions and stuff out there, and wind turbines are really touchy. A lot of things break on them, like half the time they're not even running.

Student 4: Yeah, and it wouldn't really be beneficial if there was a bunch of them out there that were broken.

Student 3: Going back to Number 2, we really need to look at the wind corridors, what's the best location to be able to capture the –

Appendix C - 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.

Appendix D: EPSA Learning Outcomes Mapped to Quality Assurance Organization Outcomes

Each organization that accredits Engineering Programs use different student outcomes to assess Engineering Professional Skills. For example, ABET Engineering Accreditation Commission lists 7 student outcomes. EPSA 3 may be used to assess EAC SO 3 “Communication Skills”, EPSA 4 may be used to assess EAC SO 7 “Acquire and apply new knowledge”, and EPSA 1 and EPSA 2 together may be used to assess ABET EAC SO 4 “Ethical Responsibilities”. In contrast EPSA 1 may be used to assess Washington Accord WA07 “Ethics” and EPSA 2 and EPSA 5 together may be used to assess Washington Accord WA06 “The Engineer and the World”

ABET Engineering Accreditation Commission (EAC) Learning Outcomes (Student Outcomes)		Assessed Using EPSA
SO 1	Identify, formulate, and solve complex problems	EPSA 1 Identify only
SO 2	Design solutions to meet needs	*Not assessed*
SO 3	**Communication skills**	EPSA 5
SO 4	**Ethical Responsibilities**	EPSA 1, EPSA 2, EPSA 3
SO 5	**Individual and Collaborative Team Work**	EPSA 5
SO 6	Conduct experiments & interpret data to draw conclusions	*Not assessed*
SO 7	**Acquire and apply new knowledge**	EPSA 4

https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2025-2026/

International Engineering Alliance, Washington Accord Learning Outcomes (Graduate Attributes 2021)		Assessed Using EPSA
WA01	Engineering Knowledge	*Not assessed*
WA02	Problem Analysis	EPSA 1 Identify only
WA03	Design/Development of Solutions	*Not assessed*
WA04	Investigation	*Not assessed*
WA05	Tool Usage	*Not assessed*
WA06	**The Engineer and the World**	EPSA 2, EPSA 3
WA07	**Ethics**	EPSA 1
WA08	**Individual and Collaborative Team Work**	EPSA 5
WA09	**Communication**	EPSA 5
WA10	Project Management and Finance	*Not assessed*
WA11	**Life-long Learning**	EPSA 4

The Washington Accord is an international agreement between organizations responsible for accrediting engineering degree programs. https://www.internationalengineeringalliance.org/assets/Uploads/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf accessed 01/03/2025.

ENAEE EUR-ACE® system Learning Outcomes (Program Outcomes)		Assessed Using EPSA
1	**Knowledge and understanding**	EPSA4
2	**Engineering Analysis**	EPSA 1 Identify only
3	**Engineering Design**	*Not assessed*
4	Investigations	EPSA 4
5	**Engineering Practice**	EPSA 2
6	**Making Judgements**	EPSA 1, EPSA 2, EPSA 3
7	**Communication and Team-working**	EPSA 5
8	**Lifelong Learning**	EPSA 4

ENAEE European Network for Accreditation of Engineering Education, founded in 2006 by 14 European Associations associated with engineering. https://www.enaee.eu/eur-ace-system/standards-and-guidelines/#standards-and-guidelines-for-accreditation-of-engineering-programmes

Engineers Canada Accreditation Criteria and Procedures 2024 Learning Outcomes (Accreditation Criteria 3.1 Graduate Attributes)		Assessed Using EPSA
1	A knowledge base for engineering:	*Not assessed*
2	Problem analysis	EPSA 1 Identify only
3	Investigation	*Not assessed*
4	Design	*Not assessed*
5	Use of Engineering Tools	*Not assessed*
6	**Individual and Team Work**	EPSA 5
7	**Communication Skills**	EPSA 5
8	**Professionalism**	EPSA 2, EPSA 3
9	**Impact of engineering on society and the environment**	EPSA 2, EPSA 3
10	**Ethics and equity**	EPSA 1
11	Economics and project management	*Not assessed*
12	**Life-long learning**	EPSA 4

Engineers Canada. https://engineerscanada.ca/sites/default/files/2024-11/Accreditation_Criteria_Procedures_2024.pdf

UK Engineering Council, Accreditation of Higher Education Programs (AHEP) 4th Ed, 2020 Learning Outcomes			Assessed Using EPSA
1	Science, Mathematics, and Engineering Principles		*Not assessed*
2	Engineering Analysis	**Problem Analysis**	EPSA 1 Identify only
		Analytical tools and techniques	*Not assessed*
		Technical Literature	EPSA 4
3	Design and Innovation (integrated/systems approach)		*Not assessed*
4	The Engineer and Society	**Sustainability**	EPSA 2, EPSA 3
		Ethics	EPSA 1
		Risk	EPSA 2, EPSA 3
		Equality, diversity, inclusion	EPSA 2, EPSA 3
5	Engineering Practice	**Teamwork**	EPSA 5
		Communication	EPSA 5
		Lifelong Learning	EPSA 4

Engineering Council, United Kingdom, The Accreditation of Higher Education Programs (AHEP) 4th Edition, 2020. https://www.engc.org.uk/media/3410/ahep-fourth-edition.pdf

Engineers New Zealand Accreditation Criteria, and Procedures 2024 Learning Outcomes (Washington Accord: Graduate Attributes)		Assessed Using EPSA
WA1	Engineering Knowledge	*Not assessed*
WA2	Problem Analysis	*Not assessed*
WA3	Design/Development of Solutions	*Not assessed*
WA4	Investigation	*Not assessed*
WA5	Tool Usage	*Not assessed*
WA6	**The Engineer and the World**	EPSA 2, EPSA 3
WA7	**Ethics**	EPSA 1
WA8	**Individual and Collaborative Team Work**	EPSA 5
WA9	**Communication**	EPSA 5
WA10	Project Management and Finance	*Not assessed*
WA11	**Life-long Learning**	EPSA 4

Engineering New Zealand
https://d2rjvl4n5h2b61.cloudfront.net/media/documents/ACC_02_Accreditation_Criteria_V4.1_FINAL_10-May-2024.pdf

Appendix E. EPSA Learning Outcomes Mapped to Skills Desired by Employers

A variety of organizations publish lists of professional skills valued in the workplace. As shown in the mapping below, these skills align with the EPSA rubric's learning outcomes. These skills may be assessed using the EPSA rubric.

National Association of Colleges and Employers (NACE) Competencies https://career.ufl.edu/gain-experience/career-readiness-competencies/	Assessed Using EPSA
Critical Thinking	EPSA 1, EPSA 4
Communication	EPSA 5
Teamwork/Collaboration	EPSA 5
Technology	EPSA 4
Leadership	EPSA 5
Professionalism	EPSA 1
Career Management	EPSA 2
Equity and Inclusion	EPSA 2, EPSA 3

Indeed Professional Skills https://www.indeed.com/career-advice/resumes-cover-letters/skills-to-put-on-resume	Assessed Using EPSA
Critical Thinking	EPSA 1, EPSA 4
Communication	EPSA 5
Teamwork	EPSA 5
Adaptability	EPSA 2, EPSA 4
Problem Solving	EPSA 1
Leadership	EPSA 5
Technology	EPSA 3, EPSA 4
Conflict Resolution	EPSA 5
Creativity	EPSA 1
Interpersonal Skills	EPSA 5

National Association of Manufacturers (NAM) Workforce Development Skills https://www.nam.org/initiatives/workforce-development	Assessed Using EPSA
Systems Thinking	EPSA 1, EPSA 2, EPSA 3
Critical Thinking and Problem Solving	EPSA 1, EPSA 4
Collaboration and Teamwork	EPSA 5
Innovation	EPSA 1, EPSA 4
Digital and Technical Literacy	EPSA 3, EPSA 4
Continuous Improvement	EPSA 4
Safety Awareness	EPSA 1
Leadership	EPSA 5
Adaptability	EPSA 1, EPSA 2, EPSA 3
Data Analysis and Interpretation	EPSA 1

National Research Council (NRC) Professional Skills https://nap.nationalacademies.org/catalog/13398	Assessed Using EPSA
Critical Thinking	EPSA 1, EPSA 4
Problem Solving	EPSA 1
Reasoning and Decision-Making	EPSA 1
Systems Thinking	EPSA 2
Communication	EPSA 5
Collaboration	EPSA 5
Leadership	EPSA 5
Conflict Resolution	EPSA 5
Adaptability	EPSA 2
Self-Management	*Not assessed*
Ethical Responsibility	EPSA 1

Appendix F Descriptor modifications example EPSA Rubric Outcome 5

Descriptor modifications example EPSA Rubric Outcome 5

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. *[previously read: Students do not encourage participation of others]*	*Students notice other students' ideas. [added]* Students may pose individual opinions without linking to what others say. *[previously read: Students pose individual opinions. They may not link what they say to others.]* *Students may make attempts to bring others into the discussion. [added]* Some students may dominate (inadvertently or on purpose) or become argumentative. There may be some tentative, but ineffective, attempts at reaching consensus. *[previously read: Students may attempt to regulate the discussion, but without much success.*		Students acknowledge, build on, and/or clarify other's ideas with some success. *[previously read: Students give thoughtful input and attempt to 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).

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