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ENCOUNTERING ENGINEERING ETHICS IN THE WORKPLACE: STORIES FROM THE TRENCHES

Insight XIII - Education in Engineering Ethics ◆ Tuesday, Dec. 13, 2022

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Introduction: About Me

NIEE National Institute for Engineering Ethics

Education
- MS and PhD, Science & Tech Studies, Virginia Tech
- BS, Electrical Engineering, Michigan Tech

Titles
- Professor, ENE and ECE
- Director, National Institute for Engineering Ethics (NIEE)

Experience
- East Jordan Iron Works, Inc.
- 15th year working at Purdue

Research Areas
- Engineering practice
- Global engineering education
- Ethics and social responsibility

Teaching
- ENGR13200 – Ideas to Innovation II
- ENGR31000 – Engineering in Global Context
- ENE55400 – Globalization and Engineering

Travel

Canada, France, UK, Denmark, Qatar, the Netherlands, Switzerland, Austria, Slovakia, Sweden, Korea, Hong Kong, Macau, China, Japan, Taiwan, South Africa

I identify as an engineer, social scientist, and historian.

I am helping to relaunch an ethics institute that is now based at Purdue.

I have both industry and academic experience.

I study what engineers actually do, especially in industry settings.

I teach in the first-year engineering program, as well as other under/graduate elective courses.

I am passionate about global experiences and international education.

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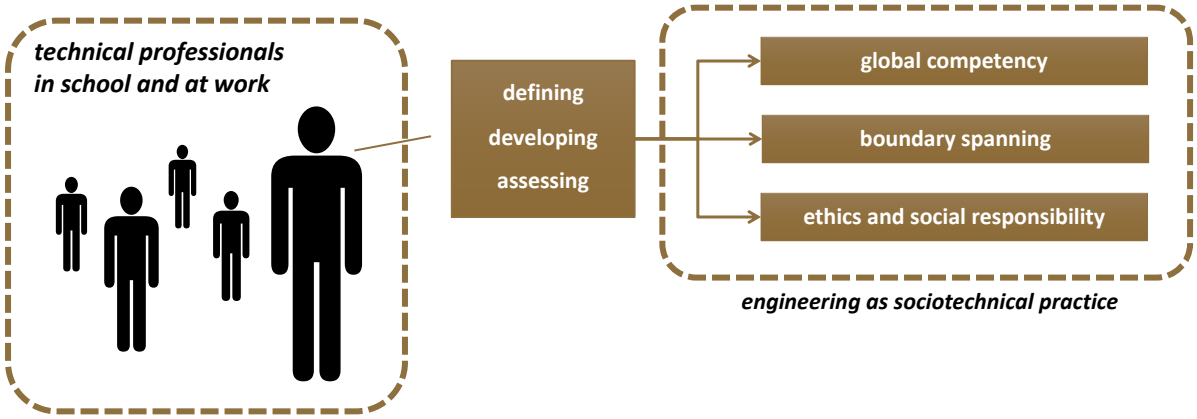
Introduction: Research on Engineering Practice



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Encountering Engineering Ethics: Agenda

Part 1 (~30 minutes)

- Four "stories from the trenches"
  (each illustrating aspects of ethics in practice)
- Four foundational claims
  (related to how I think about teaching ethics)

Part 2 (~15 minutes)

- Demonstration of scenario-based strategy for teaching ethics

Part 3 (Remainder)

- Discussion and Q&A

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Example #1: Graham's Story

Source: Kim, Dayoung. (2022). Professional socialization of engineers: Moral formation and organizational culture. [Doctoral dissertation, Purdue University].

Background: Chemical engineer with BS in chemical engineering and MS in safety, security, and emergency management. 40-year career in chemical/petrochemicals and refining industry.

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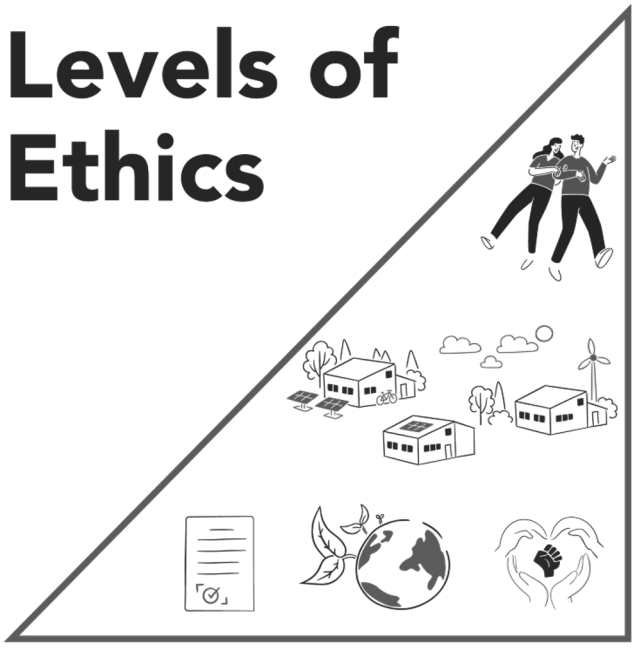
Levels of Ethics



SMALL SYSTEMS

Micro

Families, relationships, individuals

MEDIUM SYSTEMS

Meso

Organizations, communities, ethnicities, religions

LARGE SYSTEMS

Macro

Nations, legal systems, economies, societies, the world

Source: https://bootcamp.uxdesign.cc/levels-of-design-ethics-ceee9af2c93b

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Source: https://www.baldwinpl.org/career-path-graphic/

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Kline argued that engineering ethics needs to "move beyond this concern with what might be called 'disaster ethics' to study the ethical and social aspects of everyday engineering practice" (2001, p. 14).

R. R. Kline, "Using history and sociology to teach engineering ethics," *IEEE Technology and Society Magazine*, vol. 20, no. 4, pp. 13-20, 2001.

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Four Foundational Claims

1. **ABET Outcome 3.4 emphasizes ethical awareness and judgment - but everyday ethical situations often involve intuition, emotion, self-interest, moral disengagement, personality, group dynamics, organizational culture, etc.**
2. **Developing the ethical competencies of engineers is bound up with other aspects of professional formation, and is also intertwined with lifelong moral development, where morality and ethics cannot in practice be separated.**
3. **Engineering ethics education demands across- and beyond-the-curriculum approaches, such as targeted interventions in technical and professional courses, and reflective learning opportunities in extra/co-curricular roles.**

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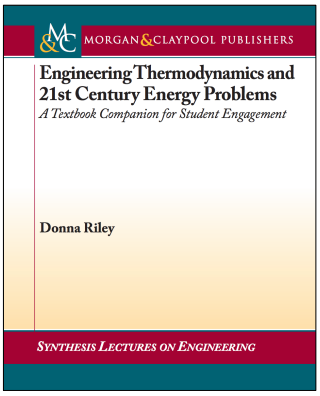
Intervention #1: Contextualized Technical Problems



4.3.3 EXPLORATION 3: COAL TRAIN [19]

1. **Engage**. Read the essay "Coal Train" in John McPhee's book *Uncommon Carriers* [20]. Why did the Clean Air Act of 1970 reinvigorate the railroading industry? Why don't all eastern power plants use higher-Btu coal from nearby West Virginia and Pennsylvania as opposed to Wyoming?
2. **Analyze**. Perform a back-of-the-envelope calculation based on information in McPhee's chapter. If a coal train weighs 3000 tons empty, and 19,000 tons when loaded with low-sulfur coal from Powder River Basin, and travels 1800 miles from Wyoming to Georgia:
   a. How much energy does it take to haul the coal this distance? Make simplifying assumptions for an initial estimate.
   b. How much energy is in the coal being hauled?
3. **Reflect**. Under what conditions is it the "right" thing to do to move coal across the country? What criteria are you using to determine whether it is "right" or not? What other criteria that you haven't considered might change the outcome of your evaluation?
4. **Change**. How does what you've learned here change your views on energy, if at all? How (if at all) does it change your consumption of energy?

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Four Foundational Claims

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2. **Developing the ethical competencies of engineers is bound up with other aspects of professional formation, and is also intertwined with lifelong moral development, where morality and ethics cannot in practice be separated.**
3. **Engineering ethics education demands across- and beyond-the-curriculum approaches, such as targeted interventions in technical and professional courses, and reflective learning opportunities in extra/co-curricular roles.**
4. **There are significant variations in engineering culture and practice in different disciplines and settings, as well as local and regional differences in standards of professional conduct and maintaining one's integrity.**

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Background: NSF-Funded Research Projects

NSF CCE STEM Grant – Foundations of Social and Ethical Responsibility Among Undergraduate Engineering Students: Comparing Across Time, Institutions, and Interventions

PRIMARY RESEARCH QUESTIONS:

1) What do engineering students perceive as responsible (and irresponsible) professional conduct, and what do they perceive as socially just (and unjust) technical practices?

2) How do foundational measures and understandings of social and ethical responsibility change during a four-year engineering degree program, both in general and in relation to specific kinds of learning experiences?

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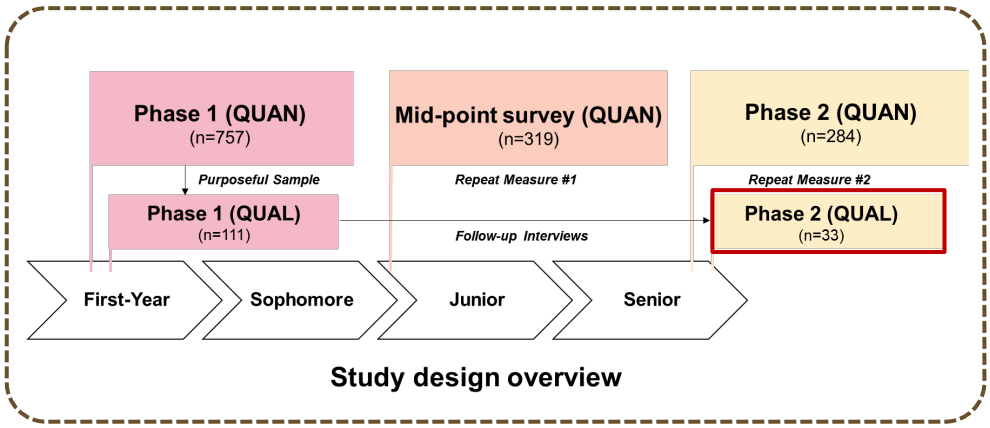
NSF CCE STEM Project: Foundations of Social and Ethical Responsibility Among Undergraduate Engineering Students: Comparing Across Time, Institutions, and Interventions



Study design overview

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WHERE DO STUDENTS LEARN ABOUT ETHICS?

- Background: Longitudinal, mixed-methods study of engineering student perceptions of ethics and social responsibility, including interviews with students (n=33) in their fourth year of university.
- RQ1. In what types of settings and experiences do undergraduate engineering students learn about ethics and morality?
  - Work: Mentioned by 26 of 33 students; Includes internship, co-op, and other types of jobs; Both engineering and non-engineering roles; Before and during college
  - Academic: Mentioned by 24 of 33 students; Contexts include senior/capstone design, other coursework, and case-based learning activities
  - Family: Mentioned by 22 of 33 students
  - Others: Extracurricular involvement (e.g., student clubs, optional programming), volunteer/service activities, religion, exposure to media, undergraduate research

Source: Howland, S. J., D. Kim, and B. K. Jesiek. (2022). Senior engineering students' reflection on their Learning of ethics and morality: A qualitative investigation of influences and lessons learned. *International Journal of Ethics Education, 7*: 171-199.

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WHERE DO STUDENTS LEARN ABOUT ETHICS?

- Background: Longitudinal, mixed-methods study of engineering student perceptions of ethics and social responsibility, including interviews with students (n=33) in their fourth year of university.
- RQ2. What and how do students learn from those experiences?

Work	Academic	Family and Friends
1. Broader social and ethical considerations 2. How different organizations and sectors approach ethics 3. Exposure to real ethical issues 4. Other specific outcomes (e.g., moral fortitude, integrity)	1. Working fairly with others 2. Understanding of the broader implications of engineering 3. Academic integrity	1. Parents as moral exemplars 2. influence of family background and history (e.g., poverty) 3. Influence from other family members

Source: Howland, S. J., D. Kim, and B. K. Jesiek. (2022). Senior engineering students' reflection on their Learning of ethics and morality: A qualitative investigation of influences and lessons learned. *International Journal of Ethics Education, 7*: 171-199.

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Example #2: Benson – "That's not real, that's an ideal"

Source: Kim, Dayoung, Shiloh Howland, and Brent K. Jesiek (2021). Encountering engineering ethics in the workplace: Stories from the trenches.

Background (at time of interview): Fourth-year chemical engineering student at Brigham Young University (BYU), internship role in risk management department of a large corporation.

During his internship he was tasked with going through about 15 years' worth of data on risk evaluations carried out for different sites and units. For this task, he had to read and listen to transcripts of relevant meetings and exploring considerable amounts of data. During the task, he observed that for the "engineers doing these safety analyses […] there's a real conflict of interest," especially because it is hard for engineers to recommend high-cost options to address safety issues when interacting with other company stakeholders in charge of those sites.

Benson explained, "So in the meetings between the risk engineers and the site engineers, I felt uncomfortable at times listening to how they would brush off risk in terms of cost… So I felt like there could have been a better use of a middleman to eliminate the conflict of interest."

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Example #2: Benson – "That's not real, that's an ideal"

For the risk assessment scenarios, he observed that it was "[…] kind of thing where the manager says, 'It's too expensive. Change your numbers.'" When asked about how he responded to this situation, he added that "ethically, it was hard for me." He also talked to his supervisor about how to balance risk and cost properly, but he was not fully satisfied with the supervisor's answer, which he paraphrased as "Oh, yeah. It's a hard thing to balance."

From this experience, Benson reported learning that "**you're not always going to see a perfect commitment to ethics in industry**." He also pointed out that even though there is a code of ethics for chemical engineers, "**nobody sticks to that 100%. That's not real. That's an ideal.**"

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Example #3: Beatrice – "There aren't ethical dilemmas"

Source: Kim, Dayoung, Shiloh Howland, and Brent K. Jesiek (2021). Encountering engineering ethics in the workplace: Stories from the trenches.

Background (at time of interview): Fourth-year civil engineering student at Brigham Young University (BYU), minor in fine arts, internship role at a structural design company.

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Phenomonographic Outcome Space for CCE STEM Interview Data (DRAFT)

How do participants in our study experience ethical situations?

(SCALE) MICRO.....MACRO	(ETHICAL FRAME) Ignorance or lacking awareness	RELATIVISM To each their own	ABSOLUTISM Definitive right or wrong	PLURALISM Multiple ethical considerations
Societal				Considering Broader Societal Impacts
Organizational			Driving Organizational Accountability	Balancing Stakeholder Needs
Other groups or individuals		Silent Observer	Ethical Policing	
Self/individual		Self-Interest	Commitment to Personal Values	
Unclear or lacking in focus	Avoidance			

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Background: NSF-Funded Research Projects

NSF ER2 Grant – Early Career Engineers' Views of Ethics and Social Responsibility: Trends, Influences, and Contexts

PRIMARY RESEARCH OBJECTIVES:

1) Characterize patterns of ethical development as engineering students transition from their undergraduate studies to the beginning of their professional careers and/or graduate studies,

2) Investigate how prior and current experiences impact early career professionals' understandings of ethics and social responsibility, and

3) Identify how professional contexts (including the culture of a specific company or institution, discipline, and/or industry sector) influence early career professionals' views of ethics and social responsibility.

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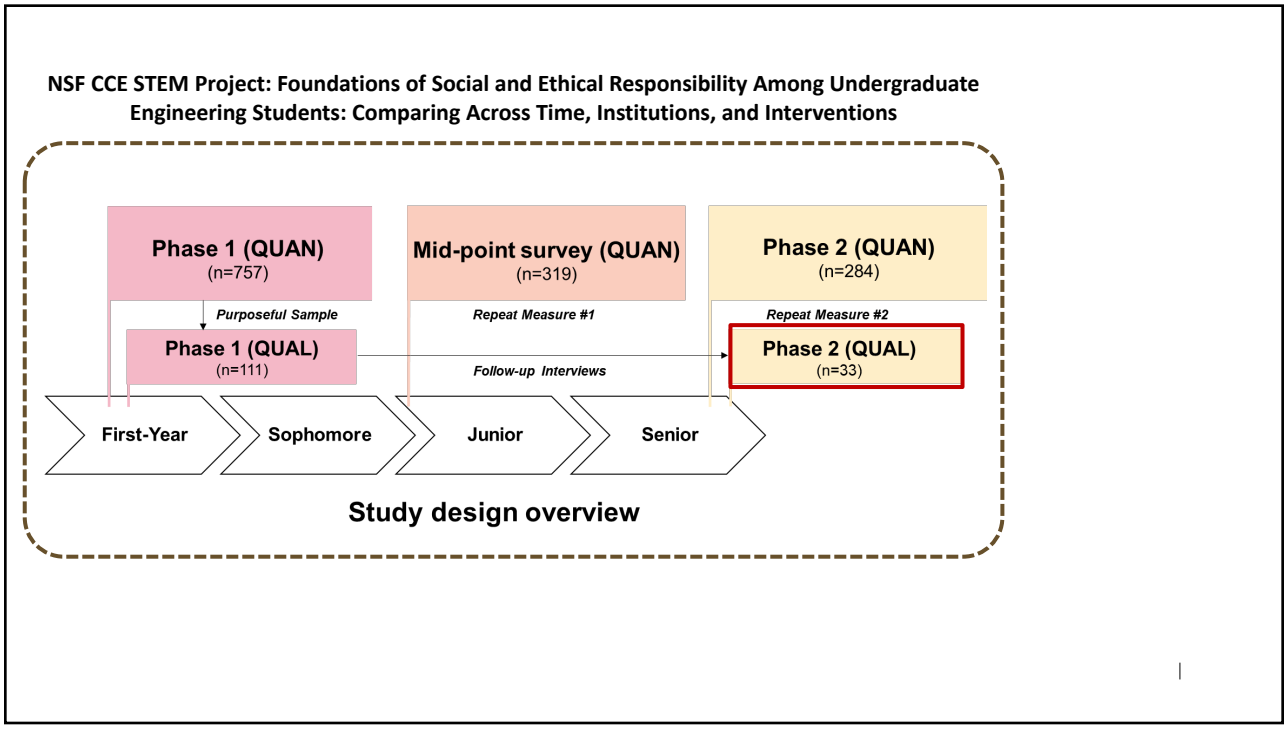
NSF CCE STEM Project: Foundations of Social and Ethical Responsibility Among Undergraduate Engineering Students: Comparing Across Time, Institutions, and Interventions
Phase 1 (QUAN)
(n=757)
Mid-point survey (QUAN)
(n=319)
Phase 2 (QUAN)
(n=284)
Purposeful Sample
Repeat Measure #1
Repeat Measure #2
Phase 1 (QUAL)
(n=111)
Follow-up Interviews
Phase 2 (QUAL)
(n=33)
First-Year
Sophomore
Junior
Senior
Study design overview

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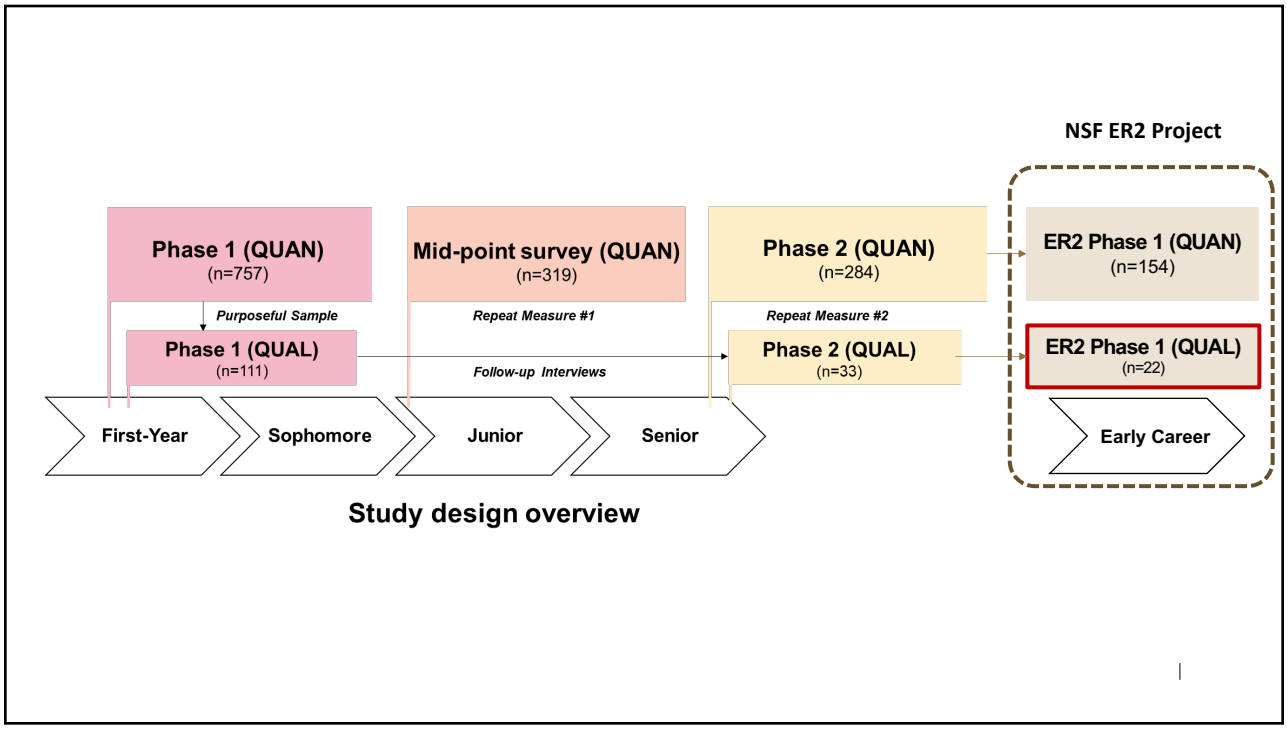
NSF ER2 Project
Phase 1 (QUAN)
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Phase 2 (QUAN)
(n=284)
ER2 Phase 1 (QUAN)
(n=154)
Purposeful Sample
Repeat Measure #1
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Phase 1 (QUAL)
(n=111)
Follow-up Interviews
Phase 2 (QUAL)
(n=33)
ER2 Phase 1 (QUAL)
(n=22)
First-Year
Sophomore
Junior
Senior
Early Career
Study design overview

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Example #4: Benson – "There has to be some limit"

Background (at time of interview): Three years after graduating with BS, employed by a large chemical manufacturing company that operates in the energy sector. Originally worked in safety relief group, then shifted to a role in scheduling and planning.

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Teaching Engineering Ethics in (Global) Context

A situational approach

- **Inspired by situational judgment assessment methods and scenario/case-based instructional approaches**
- **Compatible with what Davis calls a "micro-insertion" strategy to bring more ethics into technical courses**
- **Primarily concerned with micro-ethical issues, but a few scenarios created to engage with macro-ethical concerns**
- **More than 70 scenarios created, with examples and other resources available at: https://geec.info/gec-about**

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Teaching Ethics: A Situational Approach

GEC-SJT Scenario #35: Wine with Lunch

Describe
↓
Interpret
↓
Evaluate

As a chemical engineer working for a U.S.-based multinational firm, you travel to the company's plant in France to support development of a new product. One day during your lunchtime at a local bistro, you notice that three French technicians from the plant had finished two bottles of wine and were about to polish off a third before going back to work. When you returned to the office, you informed the plant manager that the technicians had consumed large amounts of alcohol, despite regularly working with poisonous and corrosive chemicals. He replied by saying it is very normal for the French to enjoy a leisurely lunch with wine, and added that since the workers do so frequently it seems the alcohol does not affect them. He tells you not to worry, and that wine is even served during lunch at the company canteen. What would you do?

(Scenario adapted from Fotheringham's 2007 teaching case titled "French Engineers.")

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Teaching Ethics: A Situational Approach

GEC-SJT Scenario #35: Wine with Lunch

Describe
↓
Interpret
↓
Evaluate

As a chemical engineer working for a U.S.-based multinational firm, you travel to the company's plant in France to support development of a new product. One day during your lunchtime at a local bistro, you notice that three French technicians from the plant had finished two bottles of wine and were about to polish off a third before going back to work. When you returned to the office, you informed the plant manager that the technicians had consumed large amounts of alcohol, despite regularly working with poisonous and corrosive chemicals. He replied by saying it is very normal for the French to enjoy a leisurely lunch with wine, and added that since the workers do so frequently it seems the alcohol does not affect them. He tells you not to worry, and that wine is even served during lunch at the company canteen. What would you do?

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Teaching Ethics: A Situational Approach

GEC-SJT Scenario #35: Wine with Lunch

1. Send an e-mail to the plant manager that again states your concerns about drinking in the workplace.
2. Seek out the plant manager's supervisor to inform him/her about your disagreement with the plant manager.
3. Ask the plant manager for written confirmation that the practice you observed is acceptable.
4. Report this issue to appropriate staff at your company's U.S. headquarters.
5. Find relevant policies on alcohol use in the company's employee handbook and share them with the plant manager.
6. Take no further action.
7. Directly inform the technicians that you will report them the next time you see so much wine being consumed at lunch.
8. Ask a more-experienced colleague for advice on how to handle the situation.

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