INTEGRATING ETHICS AND SOCIETAL IMPACTS INTO ENGINEERING COURSES: OPPORTUNITY TO DEVELOP ACTIONABLE IDEAS

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2019 RMS ASEE Conference
Learning Objectives for Active Engagement Session

By the end of the session, you should:
1. Understand macroethics vs. microethics
2. Identify different settings for ESI integration
3. Develop specific ideas for how to write learning objectives related to your educational setting
4. Develop specific ideas for effective methods to teach ethics to students, mapped to your learning objectives
5. Develop specific ideas for how to assess the student learning related to ethics educational objectives
Session Outline

• Facilitator introductions
• Participant introductions
• Overview
• Learning Objectives
• Pedagogy
• Assessment
• Wrap-Up

mini-lecture, self work, small group

Sign-Up circulating…. 
Facilitator Team

- Maddie Polmear, PhD student
- Angela Bielefeldt, Professor

NSF Grant Nos. 1540348, 1540341, and 1540308

Survey: ~1400 responses from ~416 institutions
+ 37 interviews, 11 ‘exemplars’
Participant Introductions

- Name, university
- Your interest / context (briefly)
  - What problems or needs around ethics education do you have?
  - What do you hope to learn in the workshop?
Why ethics education?

- Behave ethically as engineers in practice
What is macroethics?

• Microethics
  • personal ethical responsibilities
  • Professional code of ethics
    • bribery, conflict interest, …

• Macroethics
  • Collective responsibility of profession to society
  • Sustainability, diversity, social justice…

• Ethics and Societal Issues (ESI)
Key Finding: Wide Range of Topics

- societal impacts
- responsible conduct of research
- environmental impacts
- decisions under uncertainty
- sustainability
- privacy & civil liberties
- theories
- professional practice issues
- bioethics, nanotechnology ethics
- war / peace / military
- social justice
- poverty
- code of ethics
- safety
- ethical failures / disasters
- ethics in design
- risk & liability
Key Finding:
Integrate ESI into any course
Key Finding:
Integrate ESI into co-curricular activities

professional societies
honor societies
engineering service groups
design competitions
research - REU

AIChE
IEEE
SWE
Tau Beta Pi
ACM
ASME
EWB
ASCE
Your Turn

• Think of a particular educational setting where you could help students learn about ethics
  • Current course you teach
  • Informal activity that you mentor
  • Course you could teach

• Local allies
  • Other engineering instructors
  • Faculty in philosophy, STS, etc.
  • Staff

• Write on your worksheet (~2 min)
Learning Objectives

• Ethics knowledge, affect, and/or behavioral goals?
• “Levels” in Bloom’s taxonomy
• Stages of ethical reasoning
• Specific topics
## Learning Objectives: ASCE BOK2

<table>
<thead>
<tr>
<th>Bloom’s Cognitive Domain Level of Achievement</th>
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</thead>
<tbody>
<tr>
<td>Level 1 Remember</td>
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<tr>
<td>Level 2 Comprehend</td>
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<tr>
<td>Level 3 Apply</td>
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<td>Level 4 Analyze</td>
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<tr>
<td>Level 5 Synthesize</td>
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<td>Level 6 Evaluate</td>
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</tbody>
</table>

### Level 1: Remember
- **List** the professional and ethical responsibilities of a civil engineer. (B)

### Level 2: Comprehend
- **Explain** the professional and ethical responsibilities of a civil engineer. (B)
- **Apply** standards of professional and ethical responsibility to determine an appropriate course of action. (B)

### Level 3: Apply
- Analyze a situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action. (B)

### Level 4: Analyze
- Synthesize studies and experiences to foster professional and ethical conduct. (E)

### Level 5: Synthesize
- Justify a solution to an engineering problem based on professional and ethical standards and assess personal professional and ethical development. (E)
## Learning Objectives: ASCE Draft BOK3

### Bloom’s Affective Domain Level of Achievement

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
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</thead>
<tbody>
<tr>
<td>Receive</td>
<td>Respond</td>
<td>Value</td>
<td>Organize</td>
<td>Characterize</td>
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</table>

- **Acknowledge** the importance of ethical behavior in the practice of civil engineering. (UG)
- **Value** ethical behavior in the practice of civil engineering. (ME)
- **Comply with the ASCE Code of Ethics and statutory requirements** (UG)
- Adhere to ethical behavior in accordance with the ASCE Code of Ethics and statutory requirements. (ME)
- **Advocate for ethical behavior in the practice of civil engineering.** (SD)
Learning Objectives: Stages

- Recognition of ethical dilemmas
- Identify all relevant stakeholders
- Identify facts relevant to situation
- Analysis of situation correctly applies ethical constructs
- Consider multiple options to resolve dilemma
- Consider consequences of various actions
- Consider elements of risk
Examples: Two Courses
First-Year Introductory Course

• Introduction to Engineering II @ Elizabethtown College
• Required… all majors
• Learning Objectives:
  • Discuss and debate ethical considerations in engineering practice
  • (relates to project objective: Students will have an understanding of the field of engineering including contemporary issues and their ethical, global, and societal implications)

• 11 other learning objectives regarding MATLAB, team project, design
Professional Issues Course

- Norwich University
- Junior or senior year
- Civil engineering, construction management, electrical & computer engineering
- Learning objectives:
  - Students will develop a greater understanding of the professional issues of being a construction manager, an engineer, an officer in the armed forces, and in general – a young citizen and professional.
  - Students will journal and write about leadership and ethics and their own professional development.
  - Students will explore contemporary ethical issues facing engineers, construction managers, and other technical fields. Students will formulate an ethical framework for their futures.
  - Students will accurately assess themselves and assess their peers, aiding in personal development of all.
Capstone Design Course

- Cal Poly, San Luis Obispo
- Environmental Engineering
- Previously embedded, now largely in concurrent professional issues course
- Learning objectives:
  - Exploration of professional ethics and societal impact issues
  - Impact of gray areas on project design
  - Effective communication with client about non-technical issues
Your Turn

• Think of your educational setting where you would like students to learn about ethics

• Write 1 to 3 learning objectives
  • 1 if microinsertion (integrate into course with other key outcome goals)
  • 3 for a module or full course

• Raise hand if you would like help

• (~5-min)
Share with a 1-2 table mates

• In turn:
• Introduce yourself
• Briefly explain your educational setting
• Present one of your learning objectives
• Discuss / feedback
• Next person
• If time, can go through more than 1 learning objective per person
PEDAGOGY
NSF Study: Teaching Methods in Courses
Example: First-year Introductory Course

- Creative narrative assignment
- Work in groups to develop a realistic ethical situation that an engineering student or early career engineer could face
- Present the scenario to the class
Example: Professional Issues

- Peer facilitated discussion of ethical case study
- Engineering Professional Skills Assessment
- Write own scenario for term project
Example: Capstone Design

• Ethical curveball
• Follow-up to ethics instruction in professional practice course
• Surprise scenario from client that class discusses and decides how to respond in project groups
• Formulate email response to client
Your turn

• INDIVIDUALLY:
  • Think of how you could integrate ethics into your settings
  • How would the pedagogy support your learning objectives?
  • Do you have any questions or concerns related to different pedagogies?
  • ~2 min individually

• Share with 1-2 table mates
ASSESSMENT
NSF Study - Survey

- Group-based written assignment
- Individual critical and/or personal reflective essays
- Individual homework assignments where questions have fairly straightforward right and wrong answers (similar to Fundamentals of Engineering type questions)
- Individual homework assignment, essay, and/or papers that are graded with a rubric
- Individual standardized assessment method
  - DIT2, ESIT, ...
- Surveys
- Team ratings
- Test and/or quiz questions
Example: First-Year Introductory Course

- Evaluation of creative narrative using rubric (~1/2 of the grade for ethics unit which is 30% of the course grade) all of the presentations were video recorded and the pre-recorded presentations/videos were submitted so the 2 instructors who team-teach the course are able to evaluate and grade the presentations together
  - Ethical Struggle: Story involves a situation where the ethical situation/dilemma is realistic and difficult.
  - Struggle Depiction: The focus of the story is on the struggle of navigating this realistic difficult situation.
  - Compelling and engaging: The plot and storytelling are compelling and engaging. The narrative captures the audience's attention and maintains interest in the characters.
  - Professionalism/Communication Delivery: Timing, familiarity, vocal, and visual elements
  - Creativity: Original creative story telling
- Reflection on class presentations
Example: Professional Issues Course

- EPSA rubric: during discussion, half of each group participated in the case and half observed the discussion and evaluated it using ESPA rubric. Each student was responsible for focusing on 1-2 criteria, marking instances it was apparent and providing a grade on the scale. The discussions were also audio recorded so instructors could listen to the exercise and grade using the rubric to validate the students’ scores of each other
Example: Capstone Design Course

• The deliverable after the exercise was each project group had to submit an email to the client outlining their response to the situation and a justification for their response including relevant ethical issues and relevant codes, Professor collected those emails for grading.
Your turn: individual reflection

• INDIVIDUALLY
  • Think about how you would like to assess your settings?
  • Which assessment tools would be a good match with your learning objectives?
  • Do you have any questions or concerns related to different assessment tools to assess ESI?

• Share with 1-2 table mates
Share with whole group

- Example of:
  - Setting
  - Learning objective
  - Teaching method
  - Assessment
Wrap-Up

• Lots of resources available

• Find local allies

• May be student resistance

• Iterative process

• Questions?
Key Finding: Education currently not adequate?

In your opinion, do students in your program receive sufficient education on the societal impacts of technology and ethical issues?

**Undergraduates**
- No: 40%
- Yes: 31%
- Not on broader impacts: 16%
- Lack ethics: 12%

**Graduate Students**
- No: 62%
- Yes: 19%
- Not broader impacts: 9%
- Lack ethics: 10%
Key Finding: Disciplinary Differences

- **Topics**
  - Environmental impacts: 76% EnvE, 6% CS
  - Sustainability: 74% EnvE, ~16% CS, Biomedical
  - Safety: 76% Chemical, 26% CS
  - Decisions under uncertainty: 71% Industrial, 45% avg all
  - Bioethics: 46% biomedical, 7% average all disciplines

- **Teaching Methods**
  - In-class discussions: 90% General Eng, 47% Aerospace

- **Teaching Settings**
  - e.g., Engineering science courses
Key Finding:
Ethics across the curriculum

423 different programs at 244 institutions

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<thead>
<tr>
<th>EAC = core course PLUS total number different course types =</th>
<th>n</th>
<th>%</th>
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<tbody>
<tr>
<td>3</td>
<td>469</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
<td>309</td>
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</tr>
<tr>
<td>6 capstone dsn, FY</td>
<td>67</td>
<td>6</td>
</tr>
<tr>
<td>8 + full ethics crs</td>
<td>6</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Key Finding: Obstacles

• Curriculum
  • Limited space
  • Separate from technical
• Engineering skills
  • “Soft” skills
  • Outside purview of “engineering”
• Faculty
  • Lack of training and experience
  • Lack of support
• Institution
  • Lack of support and incentive
• Students
  • Resistance
  • Difficult to learn
“I have used the Engineering and Science Issues Test (ESIT), the standard test, multiple choice, I have also used the Defining Issues Test... I have used those for my drive-by sessions or we’re testing out a new video to see if it has any effect...Last time I used either one, we had no significant difference and it’s partly because how can you expect students to advance on a scale of reasoning when they just had one or two hours of exposure and no homework...When you’re using these assessment methods, it’s ideal if your assessment methods match your instructional goals...