

Rubric Assessment of Ethics and Societal Impacts Content of Student Assignments

Abstract: It is important that engineering students graduate with the “ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which consider the impact of engineering solutions in... societal contexts” [ABET Criterion 3 Student Outcome (4)]. One way that programs can document achievement of this outcome is using a rubric to assess student work. In this work we evaluated the extent to which a standard rubric could be successfully applied to assess a range of assignments. The *Pittsburgh-Mines Engineering Assessment Rubric* (2003, Shuman et al.) includes five categories measuring student’s abilities on a 1 to 5 scale: recognition of dilemma, argumentation, depth of analysis, perspective / fairness, and resolution (judgment). We also developed three additional categories based on the motivation cycle of Vanasupa et al.’s *Four Domain Development Diagram*, exploring evidence of autonomy, value, and interest around ethical issues. These rubrics were applied to five different student assignments (ranging from a half to 10 pages in length) from four different courses. Depending on the prompt, some categories of the rubric could not be reliably applied. For example, one prompt proposed to students a scenario where genetic engineering technology was available to society, and asked them to discuss ethical/societal issues or disruptions to I) values and ways of living, II) subsistence, III) freedom and autonomy, and IV) existence. This prompt made it more difficult to gauge student’s abilities to recognize a dilemma, but a wide range of ability to provide supporting information and analysis in their argument was evident. This poster will provide educators with ideas for assignments that allow students to demonstrate a range of abilities and motivation around ABET outcome 3(4).

EXTENDED ABSTRACT

It is important that engineering and computer science students are educated to understand the ethical expectations of the profession and to consider broader impacts of their work (ethics and societal issues, ESI). One way that programs can document achievement of this outcome is by scoring student assignments using a rubric. The goal of this project is to determine if a rubric developed for case studies [1] could be extended to other assignment types such as cost-risk analysis, reflective statements, etc. Additional rubric categories to evaluate aspects of Vanasupa et al.'s Four Domain Development Diagram (4DDD) [2] were also piloted.

Three assignments from different institutions, class types, prompts, and lengths were chosen (Table 1). These courses were being evaluated as potential exemplars of ESI education as part of a larger study [3]. Five categories from the Pittsburgh-Mines rubric [1] were used, plus evidence of student autonomy, interest, and value for ESI [2]. Interest and value were marked either explicit or implicit depending on the student's tone and amount of effort shown in the assignments. These 3 traits taken from the 4DDD rubric are positively correlated. Multiple raters (the first, second, and third authors) discussed the rating process to establish inter-rater reliability.

Table 1: Information about classes

Class Type	Assignment Prompt	Length	N Assignments / Scored Assignments
Class 1: Intro to Engineering (First-Year)	Watch three student videos. 1. Which ethical dilemmas would you find the most difficult to navigate? Why? 2. What steps can you take to navigate difficult ethical choices or situations where the "right" decision is unclear in professional engineering practice? 3. How does that transfer to your academic work? 4. Can you develop practices and strategies to avoid putting yourself in a difficult situation?	1-2 Pages	44 / 44
Class 2: Social and Ethical Issues in Engineering	Imagine that a genetic engineering technology was developed that would allow parents to design their future children to have certain cognitive and/or physical abilities that significantly exceed current human norms... Considering the list of concerns above, discuss any social or ethical problems or disruption you could foresee rising in society as a result of such a capability.	1 Page	62 / 36
Class 3: Cost Risk Analysis	Group essay including the description and analysis of a case study.	10-15 Pages	5 / 5

RESULTS & DISCUSSION

The rubric was reliability applied for the 3 assignments (results summarized in Table 2). Class 3 had the highest scores, perhaps not surprising since that assignment was a case study, students were allowed to work in groups, and they were incentivized to do well because it was worth a significant amount of their grade. In most cases, if interest and value were explicit throughout the assignment, they scored higher on categories from the *Pittsburgh-Mines* rubric (categories 1-5).

Across all three class assignments, median scores were higher for recognition of dilemma and information compared to the analysis, perspective, and resolution categories. We interpreted from this that students are able to recognize the ethical issues and are able to report on them, but when it comes to a more in-depth analysis and offering different perspectives, students aren't as comfortable. In some cases, the assignments were not formally structured (asking for an introduction paragraph, a thesis statement, a conclusion) so in these cases, most students did not put much thought in broader societal impacts as a conclusion. Those who did scored higher on *resolution (5)*, *autonomy (I)*, *interest (II)*, and *value (III)*.

Table 2: Rubric scores of assignments from the three courses

Category	Description of Highest Score	Class 1: Median	Class 2: Median	Class 3: Median
1. Recognition of Dilemma (1-5) ^[1]	Clearly identifies and frames key ethical dilemmas	5 (3-5)	4.5 (2-5)	5 (5-5)
2. Argumentation (1-5) ^[1]	Recognizes unknown facts in addition to known facts, identifies primary and secondary actors...	4 (3-5)	4 (3-5)	5 (4-5)
3. Depth of Analysis (1-5) ^[1]	Correctly applies ethical constructs, may offer more than one alternative resolution	5 (3-5)	4 (2-5)	5 (4-5)
4. Perspective (1-5) ^[1]	Has a global view of situation, considers consequences of various perspectives	4 (2-5)	3 (2-5)	4 (4-5)
5. Resolution (1-5) ^[1]	Resolves case through clear argumentation and consideration of all primary stakeholders...	4 (2-5)	3 (2-5)	3 (3-4)
I. Autonomy ^[2] (1-3)	Sense of freedom, control, choice.	2 (1-3)	2 (1-3)	2 (2-3)
II. Interest ^[2] (implicit, explicit)	Internal sense of enjoyment or pleasure in the activity/assignment	(ex, imp)	(ex, imp)	(ex, ex)
III. Value ^[2] (implicit, explicit)	If learning activity is relevant to satisfying personal goals	(ex, imp)	(ex, imp)	(ex, ex)

The research findings indicate that the Pittsburgh-Mines rubric may be widely applicable to a range of different assignment types. Eight other assignment types were evaluated (data not shown). If engineering students are asked to analyze their thoughts about ESI in writing multiple times during their education to become future professionals, this could provide evidence of growth in students' ethical reasoning abilities between first year and senior year.

REFERENCES

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