

Instituting a praxis of change: a case study on the instruction of engineering ethics in the Anthropology, Performance, and Technology (APT) Program

Hortense Gerardo
Anthropology, Performance, and
Technology Program
UC San Diego
La Jolla, California, US
hgerardo@eng.ucsd.edu

Raymond de Callafon
Mechanical and Aerospace
Engineering
UC San Diego
La Jolla, California, US
callafon@eng.ucsd.edu

Abstract—This Work in Progress paper notes there is a growing awareness that humankind is not on a sustainable path and there is rising pressure for technological systems to positively contribute to our social condition and protect our natural environment. This paper describes a novel approach to teaching ethically-informed decision making in an engineering educational setting. Ethics had previously been taught by one of the authors in a three-part module. In an effort to re-contextualize and bring to life the *ad hoc* quality that drives decision-making in the working environment – that is, without knowing the immediate outcome – a new rubric was deployed. This paper describes the student outcomes and the effect of generating an experiential approach to communicating and addressing complex ethical problems and arriving at transdisciplinary solutions.

Keywords—anthropology, performing arts, engineering, ethics, transdisciplinary education

I. INTRODUCTION

A. Motivation

Technology was once seen as the solution to the complex social and environmental issues we face. It is important to educate new engineers in the coupling of technology and innovation in the appropriate cultural context. The Anthropology, Performance, and Technology (APT) Program was created to serve as an intersectional bridge between undergraduate, graduate, and faculty members at the Jacobs School of Engineering and other departments at the University of California, San Diego as a way to integrate a transdisciplinary approach to the education that will be seen not as an elective, but as an essential part of the training for engineers in the 21st century.

A transdisciplinary approach to teaching ethical decision making was introduced to students in ENG 175A Aerospace Engineering Laboratory, a required course for students in the Mechanical and Aerospace (MAE) Program at the Jacobs School of Engineering had previously been taught in a three-part module that consisted of:

1. Viewing a documentary film of the 1986 Challenger disaster.

2. Class discussion of unethical decision making contributing to the disastrous outcome.

3. Written, individual reflection on ethical aspects and observed impacts on the whistleblowers.

While this methodology has successfully served to convey fundamental themes and challenges around decision making within the context of this event, with the passage of time the complexity of the decisions that had been made circa 1986 had begun to be seen as a readily identifiable set of misjudgments that hindsight confers. Furthermore, the combination of a class-wide discussion, followed by completion of an individual handout missed a crucial point often encountered in ethical decision making in a working environment: the intimate and often pressured interaction between customers, engineers and managers.

B. A Novel Approach

A new experiential approach to communicating and addressing complex ethical problems was devised using transdisciplinary solutions. Adapting the three-class approach of the old module, the new module compressed the original three classes into the first one and a half classes. The new, APT-based ethics module was inserted into the remaining one and a half classes. A novel assignment was deployed that enabled the students to place themselves in the roles of various key players in the decision-making process of a working engineering project. Students in the course, all of whom had worked in groups of four since the start of the academic quarter, were tasked to select from a pre-determined list of contemporary design challenges in which the outcomes of decision-making were either only recently revealed or were still in the process of being determined.

The students were then instructed in the building blocks of effective storytelling and asked to write a short play script that incorporated three key roles associated with the design challenge their group chose: 1. Client 2. Manager and 3. Engineer, and which captured the product, the problem, and the solution or lack thereof of their chosen design challenge. The fourth member of the group was tasked with serving as dramaturg/director to oversee *either* the live performance *or* the

filmed video of the script produced by the group. The results of this new assignment were then screened and discussed in the third and final class of this newly-formed Ethics Module.

II. METHODS

A. Overview of the Process

It has been shown that interactive participatory forms of pedagogy are highly effective in creating memorable, life-long lessons from the classroom [1] Cooperative Learning (CL), in which students work in small groups to research, share ideas, and perform activities aimed at teaching specific learning objectives, has been demonstrated to promote critical creative thinking (CCT). [2], [3], [4]. To adopt this framework used for innovative practice and its associated positive outcomes, first author Hortense Gerardo, a professional playwright and screenwriter, wrote an original, fact-based, three-page script informed by the traditionally assigned documentary film of the 1986 Challenger Disaster, *Challenger Disaster: Mission 51L* [5] and references about the Challenger disaster. [6] [7]. The resulting play script, entitled, *A Calculus Deferred*, was intended to serve as both a formatting template for students to learn proper playscript formatting for ease of performance, as well as to serve as the actual script used by graduate students to create an original, three-minute film from the script. The film was intended to serve as an example for the students of the ways the given character roles of CLIENT, MANAGER, and ENGINEER might be engaged to create a compelling dialogue between the three characters that might convey the demands, constraints, and essential conflicts that ensue in a given engineering design problem. Asking the students to inhabit various iconic roles in the Challenger disaster de-coupled the lesson from the wisdom of hindsight that had come to characterize the way this classic case of ethical decision making had been taught in the classroom. The students were asked to watch the three-minute video and download the script of *A Calculus Deferred*, to help them in creating their own, original scripts from the alternative, model topics that were provided for them. It was expected that the students would be ready to screen their short film, or perform it in front of the class, if their group was chosen by random selection in the third installment of the ethics module.

B. Selection of Model Topics as Case Studies

Alternative model topics for the students to explore were selected by Gerardo and de Callafon according to the following criteria: 1. the topic had to concern an engineering design issue of relatively recent occurrence, 2. the topic had to hold social relevance 3. the topic had to involve systemically complex decision-making that were not readily or obviously solved from a cursory review of the topic. Case Study Topics offered to the students that fit the criteria imposed by Gerardo and de Callafon included but were not limited to the following selection (see Table 1.)

TABLE I. CASE STUDY TOPICS

Topic Number	Table Model Topics as Case Studies		
	Topic	Subtopic Choice 1	Subtopic Choice 2
Topic 1	Space Junk [8],[9],[10]		
Topic 2	Social Media Engineering [11]	Data Mining and Security Issues	Self-image Effect
Topic 3	Chrysler Gasoline Tank Design [12]		
Topic 4	Boeing 737 Max [13]		
Topic 5	Racial Bias in Tech	Hand Sanitizer Design [14]	Facial Recognition Technology [15]
Topic 6	Airbag Design	Weight Issues [16]	Shrapnel Issues [17]
Topic 7	Caprioliola Bridge [18]		
Topic 8	Dubai Hotel Construction [19]		
Topic 9	Airport Scanners and Gender Identity [20]		
Topic 10	Student Choice		

C. Teaching the Building Blocks of Storytelling

The students were provided with the script for the original, fact-based, three-minute film, *A Calculus Deferred*, informed by printed and documentary film references to the Challenger disaster. The script template itself was based on the standard formatting template provided by The Dramatists Guild of America [21]. The second half of the second lecture in the newly-created Ethics Module from the offerings of the APT program, provided a brief, interactive, audience participatory discussion on the building blocks of storytelling. Students were taught to create a six-panel storyboard used in screenwriting that included the following stages of a story (see Fig.1).

Fig. 1. Example of a six-panel storyboard [22]

The six panels consist of the following:

1. Status Quo – the events in the engineering design topic that required an engineering design solution
2. Inciting Incident – the creation of the engineering design
3. Complicating Event – a problem faced by the creators of the engineering design

4. Secondary Complicating Event – Design requirements imposed by the Client, translated by the Manager to the Engineer
5. Climax – the result of addressing (or not) the design challenge
6. Outcome – the aftermath of a solution or flaw.

Utilizing this structure for storytelling, the students created brief films to capture the essential issue and the ethical decision making that led to the outcome of the case study. Students presented the fruits of their labors in the third and final class session of the Ethics Module. Five groups were randomly selected to screen their projects during the third class. For each screening, the authors posed questions to the students about what they learned about the character roles they had researched in order to create their short film. Other students were invited to pose questions to the film's creators, and lively discussion ensued.

III. DATA

A survey was created and distributed in hardcopy format to the students at the end of the third lecture of the newly-formed Ethics Module. Questions were posed in the form of a five-point Likert scale to provide answers to ten questions about: A. Instructor Evaluation, B. Ethics Module Evaluation. The final four questions were in the form of a short answer to the following: 1. What aspects of this ethics module were most useful or valuable? 2. How would you improve this ethics module? 3. The thing that I liked best about this ethics module was? 4. General comments.

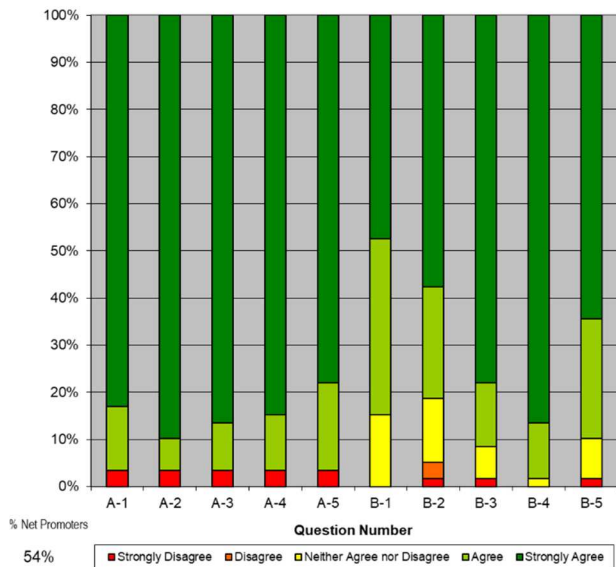


Fig. 2. Net Promoter Score (NPS) for the Ethics Module Evaluation.

IV. ANALYSIS

The evaluation response resulted in a net promoter score of 54% which is relatively high, particularly for a first offering of a course. The Net Promoter Score is widely used in industry to measure customer satisfaction and loyalty. It is a simple, one-question survey that has been shown to be indicative of future

company success. Although the NPS was originally created to measure loyalty and satisfaction in the corporate world, it is found to be empirically relevant in education as well [23]. In general the response was very positive. Students liked:

- the interaction with their peers in making the script and video for their use cases
- the independent research for the contemporary use cases
- but wished for more time to do the assignment (one week may have been too short)

Students highly valued:

- the in-class discussion after the student videos were screened, about potential, ethically problematic issues they might face in their current or future work situations
- the in-class participation (as teaching is usually a one-way street of communication for them)

V. CONCLUSIONS AND FUTURE WORK

The updated Ethics module was met with great enthusiasm from the students, going by the evaluation forms distributed at the end of the third presentation. The students asked for more in-class discussion, more time to complete the assigned scripts and videos, and a request to show all the students' videos in class or online. The presence of both faculty instructors to facilitate the discussion after sharing the students' videos was much appreciated by the students, and perhaps a more focused, extended time for discussion and inviting guest engineers as speakers in the course would improve the overall structure of the Ethics Module. A complimentary module on Cognitive Bias is currently being developed, utilizing the tools of interactive participation and the development of multidisciplinary skill sets like script writing, performance, and film editing. The APT Program is further developing the use of "micromodules" for the introduction of similar APT Etude skill sets in the newly-formed Veteran Forge Program and the Master of Advanced Studies in Convergent Engineering.

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