

It's All Relative: Examining Student Ethical Decision Making in a Narrative Game-Based Ethical Intervention

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Abstract—This Innovative Practice Full Paper presents a novel, narrative, game-based approach to introducing first-year engineering students to concepts in ethical decision making. Approximately 250 first-year engineering students at the University of Connecticut played through our adventure, titled *Mars: An Ethical Expedition*, by voting weekly as a class on a presented dilemma. Literature shows that case studies still dominate learning sciences research on engineering ethical education, and that novel, active learning-based techniques, such as games, are infrequently used but can have a positive impact on both student engagement and learning. In this work, we suggest that games are a form of situated (context-based) learning, where the game setting provides learners with an authentic but safe space in which to explore engineering ethical choices and their consequences. As games normalize learning through failure, they present a unique opportunity for students to explore ethical decision making in a non-judgmental, playful, and safe way.

We explored the situated nature of ethical decision making through a qualitative deconstruction of the weekly scenarios that students engaged with over the course of the twelve-week narrative. To assess their ethical reasoning, students took the Engineering Ethics Reasoning Instrument (EERI), a quantitative engineering ethics reasoning survey, at the beginning and end of the semester. The EERI scenarios were deconstructed to reveal their core ethical dilemmas, and then common elements between the EERI and our *Mars* adventure were compared to determine how students responded to similar ethical dilemmas presented in each context.

We noted that students' responses to the ethical decisions in the *Mars* adventure scenarios were sometimes substantially different both from their response to the EERI scenario as well as from other decisions they made within the context of the game, despite the core ethical dilemma being the same. This suggests that they make ethical decisions in some situations that differ from a presumed abstract understanding of post-conventional moral

reasoning. This has implications for how ethical reasoning can be taught and scaffolded in educational settings.

Keywords—*ethics education, games, situated learning*

I. INTRODUCTION AND BACKGROUND

Ethical decision making in an engineering context is an important skill for students to develop as part of their education. Increasingly, engineering solutions to societal problems inevitably have important social and ethical considerations that must be evaluated alongside technical and economic ones. A simple review of the literature or news from the past several years reveals this to be the case, with examples including both physically engineered systems such as the Boeing 737 MAX accidents, as well as cyber engineered systems such as social media, artificial intelligence, and surveillance and privacy software. The accreditation body for engineering programs, ABET, places high importance on “an ability to recognize ethical and professional responsibilities in engineering situations...” [1]. Herkert at the time noted that there are numerous approaches to teaching engineering ethics, with two of the most common including standalone courses and integrated-across-the-curriculum models. He also noted the challenges with each approach, foremost among them faculty buy-in and resources, as well as approaches that frame ethics as either ancillary or disconnected from regular engineering practice [2].

Herkert also noted that students demonstrated strong interest in content that integrated engineering solutions with societal impacts, and referred to that model as “Integrating engineering ethics within the larger context of science, technology and society[2].” Citing successful implementations of this model at the University of Virginia and Drexel, common features of these curricula include not only coursework but also experiential learning that integrates ethics, such as senior projects and

laboratories. In a 2013 review of engineering ethics educational methods, Hamad, Hasanain, Abdulwahed and Al-Amari noted that the same approaches described by Herkert were still in play, but further categorized them into eight of the most prevalent instructional methods. These included 1) case study approaches, 2) collaborative/challenge games and role playing scenarios, 3) debates and group discussions, 4) presentations, 5) “traditional” methods - exams, reports, assignments, etc, 6) codes of ethics, 7) online instruction, and 8) multimedia, videos, and simulations [3]. Similarly, Hess and Fore conducted a systematic literature review of engineering ethics education interventions in the United States between 2000 and 2015, and identified twenty-six papers that met their inclusion criteria, from which they identified sixteen pedagogical strategies in use. Of these examples, 22 papers (85%) used a discussion of codes of ethics or rules, while 21 papers (81%) used case studies [4]. While codes of ethics and case studies are among the most commonly used methods of teaching engineering ethics, Carpenter noted that “often, students find it boring to review the factual material in the codes, and tend to lose interest after two or three case studies [5].” Voss noted that active and experiential pedagogical techniques are well positioned to teach engineering ethics concepts, yet were at the bottom of Hess and Fore’s list and most infrequently used were game-based approaches (an active learning technique), with only two papers (8%) identified [6]. Given the underrepresentation of active learning techniques in engineering ethics education, Fore and Hess recommended “a greater inclusion of less commonly utilized instructional strategies...” The small number of papers and attention given to game-based approaches to engineering ethics education motivates the focus of our present work [4].

Though the case study approach has largely dominated the engineering ethics educational space, as the reviews have demonstrated, alternative approaches such as game-based or game-inspired methods have also been used by various researchers. Lloyd and van de Poel described the development and implementation of Delta Design, a board game that incorporates ethical decision making and scenarios into an engineering design-focused game [7]. Carpenter described the use of The Ethics Challenge, another board game developed by Lockheed Martin to engage with ethical scenarios in an engineering context [5]. Voss broadly described the use of existing games, such as massively multiplayer online role-playing games (MMORPGs) or world-building games to explore ethical issues that translate to engineering practice, such as group work and professional communication skills [6]. Lau, Tan, and Goh used a table-top game called BLOCKS with chemical engineering students that incorporated ethical decision making elements into gameplay [8]. The authors have also published various works on the use of game-based or game-inspired approaches to engineering ethics education [9],[10],[11].

Engagement is an essential first step to learning, and ultimately student achievement is one of the main goals of teaching. While game-based approaches in engineering education have widely been shown to promote student engagement with material being taught, far fewer studies tackle the potential learning gains that can be achieved [12]. We suggest that one potential way that game-based pedagogies can

impact learning beyond engagement is through the use of situated learning [13]. Broadly speaking, situated learning refers to the interaction of “learner plus context or surroundings.” Situated learning emphasizes that effective learning often takes place in the context of an authentic, engaging activity, and that absent rich authentic context, learners may experience disconnects that impair their ability to apply their knowledge to future situations. Winn suggested that in practice, situated learning can be achieved by 1) framing learning activities as apprenticeships, 2) framing learning activities in the classroom within authentic and realistic cases and scenarios or 3) providing real-world in situ learning experiences [14]. With regards to engineering ethics education, we argue that the first and third approaches can be problematic - while ethical dilemmas are sure to arise in natural settings, it is likely not feasible to manage their appearance in a controlled way to provide an authentic learning environment that aligns with an ethics curriculum. Additionally, potentially negative consequences of a decision made in a real environment would need to be weighed against any possible learning that may occur. Therefore, we suggest that game-based approaches to ethical education, in which we can frame the game in an authentic, engaging context, meets the second criteria for situated learning. Additionally, within a game context, failure or “losing” is seen as a normal and expected part of gameplay, and thus can become an important part of the learning process while occurring safely within the game environment [15],[16].

With this in mind, this work focused on the implementation of a semester-long, narrative, choose-your-own-adventure style game in a first-year engineering course at the University of Connecticut. Our objective was to compare how first-year engineering students approached ethical decision making in an extended narrative context with how they may approach it in a relatively short-form assessment such as the Engineering Ethics Reasoning Instrument (EERI), a current quantitative assessment of ethical reasoning in an engineering context. We examined how students responded to a subset of the core ethical dilemmas presented in the EERI (which are presented as mini cases) with similar dilemmas presented in a longer form, contextualized narrative in which the students collectively had agency in the story.

II. METHODS

The Engineering Ethical Reasoning Instrument (EERI) is a survey-based instrument designed to quantitate student ethical reasoning in an engineering context [17]. The EERI was adapted from the Defining Issues Test (DIT-2) [18], and influenced by Kohlberg’s moral development theory [19] and McCuen’s Professional Moral Theory [20]. It was administered via Qualtrics to first-year students at the beginning and the end of their second semester in the context of an Introduction to Engineering course. The EERI instrument consists of six moral or ethical dilemmas in an engineering context, asks each respondent to make decisions about those dilemmas, and then rate or rank various (typically 12) considerations that may have impacted their thinking. Completing the EERI should take between 30 and 60 minutes. In between the pre- and post-administrations of the instrument, students in this section of the course were given a number of game-based interventions focused on engineering ethics: two games that were played in the context of a single course period and the Mars: An Ethical

Expedition game, which played out over the course of the entire semester.

Mars: An Ethical Expedition is a twelve-week, narrative-style, choose-your-own adventure type game developed by the authors where students are placed in the role of an administrator of a Martian settlement. Each week, new situations and moral dilemmas are presented to the students. In practical terms, the 2021 implementation of the game was a combination of live presentation of the situations, dramatically read each week at the start of the class by one of the graduate student researchers on the project, and a digital voting component, with students' individual responses recorded in the learning management system. Each narrative lasted between three and eight minutes, and at the end, students were asked to vote on a decision related to the week's narrative, as well as several related questions. After voting on the course of action, their individual responses would be aggregated and the majority decision would inform the direction of the narrative for the following week. In this way, the story unfolded dynamically; that is, future students would hear a different version of the story if they made different choices.

To compare data on ethical reasoning between the EERI and the Mars: An Ethical Expedition Game, we first performed a thematic analysis of the major ethical dilemmas presented in the EERI. We performed a comparable thematic analysis of the weekly dilemmas presented in Mars: An Ethical Expedition, and looked for similar thematic elements. We then matched these dilemmas and analyzed how students responded to them in the different contexts of the EERI and the Mars game and how these different presentations may have impacted decision making. For the purposes of this analysis, we used the posttest EERI data that the students completed at the end of the semester of game activities. A summary of the dilemmas in the Mars: An Ethical Adventure are included in the Appendix.

III. RESULTS AND DISCUSSION

The EERI's six ethical dilemmas, described elsewhere [17], were analyzed for the dominant theme or moral conflict, which were identified as follows:

1. Choosing between actions where a potential outcome has a negative impact on a vulnerable individual or group. The negative impact is an indirect, not direct consequence of your decision.
2. Deceiving or not informing stakeholders about an action, but that action carries minimal actual risk.
3. Reallocating resources for a clearly greater good.
4. Reallocating resources for a potentially equal good
5. Breaking rules or established protocols to achieve a goal subject to a constraint.
6. Reporting or withholding information that has differing consequences for different groups.

Each of the EERIs scenarios run about one paragraph in length, and are not thematically related - that is each scenario and its corresponding dilemma stands alone within its own context. In contrast, Mars: An Ethical Expedition's dilemmas are all contextually related through the overarching narrative.

Out of the twelve weeks of the narrative, we thematically analyzed each week's dominant storyline and mapped it to one of the EERI dilemmas noted above. These results are shown in Table 1.

The most common theme between the two activities related to a dilemma which focused on "breaking rules or protocols in order to achieve a goal within a constraint." In the context of the EERI, the scenario (Dilemma 5) involves bypassing a software security feature to finish installing a needed upgrade. The upgrade needs to be completed, but the respondent does not have the required clearance, and also cannot wait for an authorized user due to another responsibility they cannot be late for.

TABLE I. MAPPING OF WEEKLY MARS THEMES TO EERI SCENARIOS

Week 1	No Mapping	Week 7	EERI 2
Week 2	EERI 2	Week 8	EERI 1
Week 3	EERI 5	Week 9	EERI 5 or EERI 6
Week 4	No Mapping	Week 10	EERI 5
Week 5	EERI 5	Week 11	EERI 6
Week 6	EERI 1	Week 12	EERI 6

The immediate consequences for breaking the rule or protocol are not obvious to the reader, only that doing so allows the participant to complete the task within the time constraint presented. When asked whether or not they should break the rule or not follow protocol in the scenario, 22.7% of students said yes (break the rule), 26.4% of students said they couldn't decide, and 50.9% of students said no (do not break the rule) (n=110).

The EERI also asks students to rank the top considerations that influenced their decision. Out of the 12 choices presented, the top two considerations were: 1) whether or not the action in question was legal (36.3% said this was the most important consideration, 21% said it was the second most important) and 2) whether or not the action would result in more harm than good (18% said this was the most important consideration, 20% said it was the second most important).

With this as a baseline, we compared how students responded to similar types of dilemmas in the Mars: An Ethical Expedition Game - that is, ones which asked the student to break a rule or ignore an established protocol. This occurred most clearly in Weeks 3, 5, and 10. One of the important things to note is that in the Mars game, we typically did not give students an "out" by presenting them with a neutral option. As Blasius and Theissen noted, a non-trivial number of people will choose a neutral or "no opinion" option if given the chance, even if they do have a preference [21]. This does not allow *direct* comparison between choices that students made in the EERI vs. the Mars Narrative, but it does allow us to examine trends as to how students respond to a common ethical dilemma that is framed in different contexts.

In Week 3 of the Mars narrative, students are facing an act of sabotage within the settlement and are tasked with investigating as part of their role as administrator. The main choice before them is which suspects to investigate first. As part of that week's narrative, students were asked to rate their

agreement with the statement “It is important to follow protocol no matter the consequences”. Responses are presented in Table 2 (n=228).

TABLE II. STUDENT DECISION FOR WEEK 3 MARS NARRATIVE

<i>Strongly Agree</i>	<i>Somewhat Agree</i>	<i>Somewhat Disagree</i>	<i>Strongly Disagree</i>
14.0%	63.3%	20.6%	2.6%

In the EERI scenario, approximately half (50.9%) of the students said that they should not break the rules or not follow protocol; whereas here, the number is substantially higher - 77% say that they either strongly or somewhat agree that following the rules or protocol is important. It is possible that the elimination of neutral positions here forced students to choose, and in so doing, many defaulted to the “expected” behavior of conforming to the rules. This would be consistent with work on behavior in which people often over-predict their adherence to socially desirable behaviors, such as “following the rules [22].” The specificity of the situation may also be influencing student decision making. In the EERI scenario, the course of action is clear: the respondent would be overriding a software security protocol, whereas in the Mars scenario, students are presented with a less-well defined and more abstract concept of following the rules.

In Week 5 of the narrative, we again ask students a number of questions related to following the rules or breaking protocol. The context in this case is more concrete than it is in Week 3, and involves breaking a mandatory quarantine for a person potentially exposed to an unknown Martian lifeform. Students were asked whether or not they would enforce the quarantine as the administrator of the settlement. Responses are presented in Table 3 (n= 206).

TABLE III. STUDENT DECISION BREAKDOWN FOR WEEK 5 NARRATIVE

	<i>Yes</i>	<i>No</i>
Enforce Quarantine? (i.e., follow protocol)	55.0%	45.0%

Already we see some interesting differences in how students respond, even though the core ethical dilemma is the same. In Week 3, ~77% of the students strongly agreed or somewhat agreed that following protocol or not breaking the rules was important, yet here 45% of them chose to break protocol - an apparent disconnect. To follow up, we also asked students to weigh in on how important it was if they have a personal connection or relationship with the person being quarantined. Responses are presented in Table 4 (n=206).

TABLE IV. STUDENT DECISION BREAKDOWN FOR WEEK 5 SUPPLEMENTAL QUESTIONS

<i>Very Important</i>	<i>Somewhat Important</i>	<i>Somewhat Unimportant</i>	<i>Not Important</i>
18.5%	48.5%	21.4%	11.7%

Here, approximately $\frac{2}{3}$ (67%) of the students say that the fact that they have a personal connection to the person in quarantine

impacts their decision making (18.5% very important, 48.5% somewhat important). This suggests that nearly half the students would consider breaking a rule or protocol if they had a personal connection to someone being impacted. These results are consistent with those from The Moral Machine experiment, which showed that people will make different moral decisions based on the identity of those impacted by the decision [23]. In terms of Kohlbergian moral development, the focus on the consequences to the self or those in immediate personal circles is reflective of pre-conventional or conventional ethical reasoning.

Lastly we asked students to reverse the situation: *they* are the individual being quarantined - would they want the administrator to break the rules or follow the rules? Responses are given in Table 5 (n=206).

TABLE V. STUDENT DECISION BREAKDOWN FOR WEEK 5 NARRATIVE

	<i>Yes</i>	<i>No</i>
Enforce Quarantine? (i.e., follow protocol)	50.0%	50.0%

It appears here that some degree of self-interest is at play, as 50% of the students decided that enforcing the quarantine was fine for others, but not if it was them personally.

In Week 10 students are again presented with a dilemma that requires them to either break protocol or follow the rules. The Week 10 dilemma involves the participant finding out that one of the staff at the Martian colony is pregnant, but has been hiding the fact and taking extra resources. The settlement is set up as a scientific outpost and it is deemed too dangerous of an environment in which to have a baby, so the policy is that pregnant crewmembers would be sent back to Earth as soon as possible. The crewmember in question does not want to leave and is concerned that the stresses of spaceflight and the radiation environment in transit would be harmful to the developing child. Students were asked whether or not they should follow protocol (i.e., send the crewmember back to Earth) or break the rules (i.e. help the crewmember remain and provide them with extra resources). Responses are shown in Table 6 (n=108).

TABLE VI. STUDENT DECISION BREAKDOWN FOR WEEK 10 NARRATIVE

	<i>Yes</i>	<i>No</i>
Send Crewmember Home? (i.e., follow protocol)	37.0%	67.0%

In this case, by almost a 2-to-1 margin, students choose to break protocol to help the crewmember remain at the settlement. Recall that when asked about breaking a rule or following protocol in the EERI, only 22.7% of the students agreed with breaking protocol, with another 26.4% unable to decide. A few weeks earlier in the quarantine situation (Tables 3 & 5), students were nearly evenly split on the question.

IV. CONCLUSIONS

While the core ethical dilemmas in each of the selected scenarios was the same - follow the existing protocol or break with it - students responded in measurably different ways depending upon the context of the scenario. In the first Mars

episode, investigating a sabotage, the students strongly support following the rules and protocols - nearly 3-to-1. When asked about following quarantine protocols, this drops to nearly even, and seems to be impacted by the narrative choice that they know and have a personal relationship with the person being impacted by their choice. Finally, when asked about following protocol in the case of sheltering a crewmember in need, we find students favoring breaking protocol by nearly 2-to-1.

We believe that the connected narrative element of the Mars: An Ethical Expedition allows us to highlight the highly situated nature of ethical decision making and the challenges with using an isolated case study approach. In each of the scenarios presented, participants are faced with a generally identical moral question – whether to follow the rules as written or break them - and it is clear that the contextual clues as well as their personal relationships with those impacted by their decision making influences how they think about these decisions. One could imagine substituting one of the Martian scenarios involving breaking protocol for the one used in the EERI, which would then potentially produce very different results. The game-based, first person nature of the Mars intervention allows us to create realistic and authentic scenarios for students to consider and present them with different contexts for the same ethical decision. While the Mars game could be played in one sitting, the existing method of revisiting it weekly over the course of a semester also allows us to consider the differential effect of “strength of treatment” or “dosage.” Having the students engage with ethical material in a safe and playful way, and over the course of an entire semester, while needing to reflect on previous decisions in-context may have a meaningful impact on how they view certain ethical dilemmas. At the least, this work reinforces that students' approach to core ethical dilemmas can and does vary with time and context, which presents a counterpoint to instruments such as the EERI that measure ethical reasoning as a developmental stage, at a fixed point and in a fixed context.

V. LIMITATIONS

There are a number of limitations to this present work that we present here for additional context. First, this work was carried out at a single institution in the northeast United States during the Spring 2021 semester, during which many educational practices were impacted by the COVID-19 pandemic. Additionally, the EERI and the Mars game were carried out as part of an introductory first-year engineering course and as part of normal educational practice. As such, a subset of the students chose to participate each week and respond to the activities. It is not possible to guarantee that the same students responded each week to each of the prompts, which will introduce some variability into the data. For each question, the number of students responding is given, and the total number of possible students was approximately 250.

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VI. APPENDIX

TABLE VII. SUMMARY OF MARS: AN ETHICAL EXPEDITION WEEKLY DILEMMAS

<i>Week</i>	<i>Summary of Dilemma</i>
1	Introduction (No Dilemma)
2	Dilemma focuses on a decision to withhold information about a potential act of sabotage at the settlement, despite the fact that there is nothing the settlers could do about it. (Is it ethical to withhold the whole truth about the situation?)
3	Dilemma focuses on the player's role as administrator, and whether they should strictly follow the protocol for investigating the sabotage or explore other methods of investigation (Is it always required to follow the rules or are there situations where it is OK to break them?)
4	Interlude (No Dilemma)
5	Dilemma focuses on following the protocol of quarantining a crewmember exposed to an unknown Martian lifeform or allowing them out of quarantine prematurely. (Is it always required to follow the rules or are there situations where it is OK to break them?)
6	Dilemma focuses on the player's role as an administrator. The settlement employs autonomous vehicles, and the player is tasked with deciding which course of action the autonomous vehicle should follow in the event of an accident – i.e. whose life should be prioritized (Choosing between multiple scenarios with adverse outcomes.)
7	Dilemma focuses on the player's role as an administrator. A nearby bridge used for supply deliveries has been damaged, and you must decide to either send your own engineering team or wait for the team from the other settlement to address the issue. Additionally, you are asked whether you reveal the full extent of the potential danger or not. (Is it ethical to withhold the whole truth about the situation; Assessing and assigning risk.)
8	Dilemma focuses on the respect for life and the environment. The Martian lifeform that required the quarantine in Week 5 has been captured. It is not clear what the sentience level of the being is, but it is potentially important to understand it. Testing may induce unknown harm to the creature since it is poorly understood. (Is it ethical to sacrifice the creature for the potential knowledge gains it represents?)
9	Dilemma focuses on the player's role as an administrator. The settlement needs to deploy a new waste treatment facility and needs to choose between several options. Each option has potential pros and cons that must be weighed. (Choosing between multiple scenarios with adverse outcomes.)
10	Dilemma focuses on your role as an administrator. A member of your team has been caught taking excess supplies, and reveals it is because she is pregnant. Due to the harsh environment, the policy is that any pregnant individuals would be returned to Earth, but the crewmember has worked hard to be on Mars and doesn't want to be sent home. (Is it always required to follow the rules or are there situations where it is OK to break them?)
11	Dilemma focuses on your role as an administrator and your ability to be impartial during an investigation. Your investigation of the sabotage at the beginning of the story has revealed potential suspects, but you have a personal relationship or connection to both suspects. (Do you make different ethical decisions when you have a personal stake in the outcome?)
12	Dilemma focuses on your role as an administrator and whether to reveal or conceal activities undertaken by subordinates that may be ethically dubious – this relates to biological experiments on the Martian lifeform discussed in Week 5. Revealing the activities may have adverse impacts on the overall mission and funding due to negative press. (Choosing between multiple scenarios with adverse outcomes.)

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