Collective vs. Individual Decision-Making in an Engineering Ethics Narrative Game

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Knowing what's right doesn't mean much unless you do what's right.

-Theodore Roosevelt

Fostering ethical decision-making skills in undergraduate engineering students is central to ABET accreditation and crucial to student engineers' success in future careers [1]. This ongoing research focuses on the development of a narrative game called *Mars: An Ethical Expedition* (*Mars*) [2]. The game draws on the contemporary learning theory of situated cognition to provide students with a situated, contextualized, and playful platform for using and reflecting on their ethical reasoning abilities [3, 4]. The game aims to be an engaging and immersive tool for the development of engineering ethics in the narrative setting of realistic decision-making. Our work to-date suggests that existing tools for assessing engineering ethical decision-making such as the EERI may not be sensitive to the applied, situated, contextually rich first-person decision-making in games like *Mars* [5].

In this work, we compared two primary methods for the implementation of the *Mars* game: individual play and whole-class play. By developing and studying both options, we seek to understand how personalized versus collective decision-making impacts ethical reasoning. The individual mode allows students to navigate through the game independently, making choices that reflect their personal ethical considerations. In contrast, the whole-class play mode encourages collaborative deliberation, enabling students to engage in group discussions and vote on decisions that mimic real-world engineering teamwork.

In the future, we plan to incorporate explanatory responses for each decision students make. These explanations not only encourage reflection and deeper engagement with ethical dilemmas but also serve as valuable pedagogical tools for instructors and facilitators. The integration of explanatory responses aims to promote a more comprehensive understanding of the ethical considerations underlying students' choices. To assess and provide feedback on the quality of students' ethical reasoning, we intend to employ text classification techniques. These techniques will enable us to analyze student responses and categorize them as either using ethical reasoning or lacking it, based on a predefined scoring rubric. This approach will help us understand the effectiveness of the game in promoting ethical decision-making skills.

Introduction

Ethical decision-making is a cornerstone of engineering education, critically shaping the professional integrity and societal responsibilities of future engineers. The ability to navigate complex ethical dilemmas is not just a desirable skill but a necessity in a field that significantly impacts public safety, environmental sustainability, and technological advancement. This imperative for ethical reasoning in engineering is underscored by ABET accreditation, which mandates that engineering programs instill in students the ability to recognize and act upon ethical responsibilities in diverse global, economic, environmental, and societal contexts [1].

Existing literature on engineering ethics education reveals a multi-faceted approach, ranging from traditional classroom-based instruction to innovative experiential learning methods [6]. Common methods for integrating ethics into the curriculum include exposing students to ethical standards, using case studies, and discussion activities [6]. Central to these discussions is the evaluation of ethical reasoning, wherein tools like the Engineering Ethics Reasoning Instrument (EERI) play a pivotal role [7]. The EERI, an assessment tool developed to measure engineering students' ethical reasoning, includes scenarios that reflect ethical challenges engineers might face, thereby providing a snapshot of students' ethical reasoning abilities [7]. However, as the complexity of ethical challenges in engineering escalates - consider the dilemmas in programming self-driving cars or decisions that affect personal relationships - the need for more immersive and contextualized educational approaches becomes apparent. This is where the concept of situated cognition becomes invaluable. Situated cognition theory posits that knowledge is inextricably linked to the context in which it is used, suggesting that learning occurs most effectively when it is part of an activity, culture, or context [3,4]. It emphasizes that cognition cannot be separated from the environment in which it occurs, making it a strong theoretical basis for engineering ethics education [3,4]. The application of situated cognition in learning contexts, especially through the use of narrative and role-playing games, represents a shift from traditional methods of ethics education to more dynamic, context-rich learning experiences.

Prior research has demonstrated the efficacy of games in education, particularly in complex subjects like ethics. Educational games, especially those with strong narrative elements and character development, offer an engaging, interactive learning environment that encourages exploration and discovery [8]. Our game, *Mars: An Ethical Expedition (Mars)* exemplifies this approach. As an interactive, narrative game, it situates students in the role of a head engineer on Mars, challenging them with high-stakes decision-making scenarios that closely mirror real-world engineering dilemmas. This game demonstrates how educational games can foster a deeper and more authentic engagement with ethical decision-making. As engineering education continues to evolve, so too must our approaches to teaching ethics. By integrating situated cognition principles and educational games, we can more effectively prepare engineering students to meet the ethical challenges of their future careers.

Mars: An Ethical Expedition

Mars: An Ethical Expedition is an immersive, narrative-driven digital game, designed to simulate the ethical challenges of a human settlement on Mars. The game was programmed using the Godot™ game engine. *Mars* places students in the role of a head engineer responsible for critical decision-making in high-stakes scenarios. The narrative unfolds across 12 episodes, each presenting a unique dilemma. The story unfolds when players must confront a sabotage plot threatening the survival of the Mars settlement. In one episode, players must address the complications of an assistant trapped in an airlock with a potentially dangerous animal. In another, they must decide the rules an automated car must follow. These scenarios compel players to navigate complex ethical considerations, balancing regulations against the immediate needs and safety of the crew.

The primary objective of *Mars* is to enrich ethical decision-making skills among undergraduate engineering students. By immersing players in the role of a Mars settlement engineer, the game contextualizes ethical dilemmas within a realistic engineering project. Players are not merely presented with abstract right or wrong choices; instead, they must employ personal reasoning and context-dependent justifications in their decision-making process. Each game segment concludes with a pivotal decision, influencing the storyline and leading to various potential endings. *Mars* is novel in its approach to teaching engineering ethics. Unlike traditional methods for teaching ethics such as exposing students to ethical standards, using case studies, and discussion activities [6], which often present decontextualized scenarios, *Mars* offers a rich, interconnected narrative. The game's evolving narrative and character development provide a depth of context that allows players to deeply explore the nuances of ethical decision-making.

The game's impact is evident in its influence on student behavior. In previous *Mars* iterations, students displayed a tendency to increasingly deviate from established engineering guidelines as they progressed through the game. This trend, peaking in scenarios like deciding the fate of a pregnant subordinate against settlement rules, suggests increased context can influence students' ethical decision-making [9].

Methodology

The rollout of the alpha version of *Mars: An Ethical Expedition* began in January 2023 with 384 first-year engineering students. These students, enrolled in two sections of a Foundations in Engineering course at a public R1 university, represented a diverse range of engineering disciplines, excluding computer science. The study aimed to compare two distinct modes of gameplay: individual play and whole-class play, to evaluate their impact on students' ethical decision-making.

In the individual play section, which consisted of 196 undergraduates, each student was provided with a downloadable version of *Mars* compatible with Mac or Windows. The students were tasked with playing one episode of the game weekly outside of class for twelve weeks, excluding the Spring break. This mode was designed to assess how personal ethical considerations and decision-making are influenced when students navigate ethical scenarios independently. It provided insights into the students' autonomous ethical reasoning and decision-making processes in a simulated engineering context.

The whole-class play section involved 188 undergraduates. Here, the game was projected in the classroom, and the instructor facilitated gameplay with teacher-led controls. Each week, students were given a few minutes to discuss the presented scenario before responding to a Qualtrics™ survey with identical questions to the individual play section. The instructor then analyzed these surveys and advanced the game the following week based on the majority decision. This mode was implemented to understand the dynamics of collective decision-making and ethical reasoning within a group setting. It simulated real-world engineering teamwork, where decisions are often made collaboratively.

Quantitative Methodology: The gameplay modes' influence on ethical decision-making was evaluated using the Chi-Squared and Fisher's exact tests. The Chi-Squared test was primarily

used to identify significant differences in multiple choice responses between the individual and whole-class play modes. However, in instances where any category had fewer than 5 responses, rendering the Chi-Squared test less reliable, the Fisher's exact test was used to ensure accuracy in the statistical analysis.

Qualitative Methodology: Responses to an open-ended question asking students to evaluate the extent to which their ethical reasoning changed over the course of the twelve-week course were hand labeled as either positive (student perceived ethical change) or negative (student did not perceive ethical change). Results from this analysis were probed for statistical difference between individual and whole-class groups using a Chi-Squared test.

Text Classification Methodology: To evaluate the feasibility of using machine learning models for analyzing student responses, we applied a text analytics approach to the same open-ended question. Our objective was to train a model capable of classifying responses according to the same binary outcomes: 'Yes' (ethics changed) or 'No' (ethics did not change). Text classification was completed in Python and began with preprocessing the text. The preprocessing of the text involved several steps including removing unnecessary punctuation, converting all text to lowercase, removing NLTK stop words, such as 'the', 'is', 'at', 'which', and 'on' and stemming tokens to reduce words to their root form using NLTK's Porter Stemmer [10,11].

Two types of vectorization were used to create document-term matrices: SciKit-Learn's Bag of Words (BoW) and Term Frequency-Inverse Document Frequency (TF-IDF) [12]. The BoW method counts the number of times each word appears in a document, whereas TF-IDF is a measure of the importance of a word to a document in the corpus.

The preprocessed data was then split into two sets: training and testing. Three different machine learning algorithms were tested using the SciKit-Learn library: Logistic Regression, Lasso Regression, and Random Forest. Each model was applied to the data in two forms: BoW and TF-IDF [12]. SciKit-Learn's GridSearchCV was used for optimizing hyperparameters, ensuring the best model parameters were selected based on accuracy [12]. The performance of these models was evaluated based on their ability to accurately classify the responses.

Results

Quantitative Analysis: In the analysis of the 40 multiple choice decision points across the 12 episodes of Mars, significant differences between the individual and whole-class play groups were observed in 6 responses. These differences were evaluated using either the Chi-Squared or Fisher's Exact Test, depending on the response frequency in each category. Results from these 6 responses are displayed in Table 1.

1) Differences between individual and whole-class decisions: Statistically significant differences occurred in episodes two, four, seven, and ten of the Mars story.

Episode Two: The player, who has taken on the role of the temporary head of engineering on a Martian colony, discovers a crucial bridge between colonies has been sabotaged, threatening its stability and the upcoming supply caravan. The player must choose between re-establishing

communication with the other colony, investigating the sabotage, or focusing on the colony's self-sustainability. The difference in responses between the individual and whole class groups occurred when they were questioned on the leader's (the player's) culpability for the event. More students agreed that the leader should take responsibility for the bridge sabotage in the individual play group (58.40%) than the whole class group (41.43%).

Episode Four: The player encounters Jonathan, their assistant, visibly upset in the office. Jonathan expresses concern about the possibility of not returning to Earth to see his beloved dogs due to the ongoing bridge crisis. The player is faced with the choice of comforting Jonathan or focusing on the urgent investigations. The player's decision here is meant to reflect their approach to leadership, either prioritizing team morale or efficiency in crisis management. The individual play group chose to spend time comforting Jonathan more often than the whole class group (66.10% compared to 51.79%).

Episode Seven: Kevin, the head of the mechanical engineering department, reports that although the bridge has been repaired, it remains unstable and might collapse under the weight of the upcoming supply caravan. The player must choose whether to send their own engineers across the potentially hazardous bridge to warn the other colony or wait and risk the caravan crossing the unstable bridge. Both groups overwhelmingly thought it was better for someone to know the risks as opposed to being unaware of the risk when performing a difficult task, though the individual group agreed to a greater extent (97.27% compared to 88.97%).

Episode Ten: The player comes across Sybil, a biologist, who reveals her pregnancy and the dilemma it poses due to the Martian colony's strict rules against pregnancy. Sybil requests the player's help. The players must choose between bending the rules to support her or maintaining the rules as they are. This episode contained the greatest discrepancy between groups. More students in the individual group chose to change the rules to help Sybil (54.17% compared to 31.30%). More students in the whole class group agreed that companies can enforce strict rules concerning your body in exchange for the use of their facilities (65.65% compared to 46.88%). And more students in the individual group agreed that it is fair for the player to change major organizational rules while temporarily in charge (44.79% compared to 30.53%).

Table 1 - Individual vs. Whole Class Response Differences

Episode	Decision Point	Chi-Square/Fisher Test	Reponse	Response - Individual	Response - Whole Class
2	The leader of the settlement (you) should take the blame for the event.	Chi-Square = 9.78 $p = 0.021$	Strongly Agree	11 (8.80%)	13 (7.18%)
			Somewhat Agree	62 (49.60%)	62 (34.25%),
			Somewhat Disagree	36 (28.80%)	82 (45.30%)
			Strongly Disagree	16 (12.80%)	24 (13.26%)

4	Do you...	Chi-Square = 5.25 $p = 0.022$	Spend time comforting assistant	78 (66.10%)	87 (51.79%)
			Politely dismiss	40 (33.90%)	81 (48.21%)
7	When performing a difficult task, do you think it's better if someone knows the risks, or if they are ignorant to those risks?	Fisher's Exact = 0.0147	Ignorant of risks	3 (2.73%)	16 (11.03%)
			Knows the risks	107 (97.27%)	129 (88.97%)
10	What do you do?	Chi-Square = 11.1 $p = 0.0009$	Change rules and help Sybil	52 (54.17%)	41 (31.30%)
			Maintain current rules	44 (45.83%)	90 (68.70%)
10	Can a company enforce strict rules concerning your body in exchange for the use of their facilities?	Chi-Square = 7.25 $p = 0.007$	Yes	45 (46.88%)	86 (65.65%)
			No	51 (53.13%)	45 (34.35%)
10	Is it fair for you to change major organizational rules while temporarily in charge?	Chi-Square = 4.26 $p = 0.039$	Yes	43 (44.79%)	40 (30.53%)
			No	53 (55.21%)	91 (69.47%)

2) Breaking the rules: In episodes three, five, and ten, students are explicitly presented with scenarios in which they must choose between following engineering protocols or breaking the rules for various reasons. Results from these questions are presented in Table 2.

Episode Three: The player begins investigating the sabotage of the bridge. They must decide which department to investigate first: Mechanical Engineering, Chemical Engineering, or Biomedical Engineering, each with its own set of suspicious activities. As part of this scenario, students are asked to rate their agreement with the statement "It is important to follow protocol no matter the consequences." Students playing individually and as a whole-class had a similar distribution in their responses to this question with about a quarter of them disagreeing with the statement, indicating their preparedness to break the rules in abstract circumstances.

Episode Five: The player and Jonathan respond to an urgent call about a strange object approaching the colony. The object turns out to be a large Earth dog, causing confusion and

alarm. Jonathan impulsively tries to rescue the dog but ends up trapped in the airlock with it, risking potential contamination. The player must decide between following protocol and keeping Jonathan quarantined with the dog for 24 hours, or risking breaking safety rules to rescue him immediately. In this scenario, the individual and whole-class responses had similar distributions. Just under half of the students opted to break the rules to rescue Jonathan.

Episode Ten: As outlined previously, in episode ten of *Mars*, the players encounter Sybil, a subordinate who is pregnant - a clear violation of the settlement's rules and the astronaut agreements for Mars missions. Players must choose between breaking the rules to assist Sybil or follow the strict guidelines, resulting in Sybil being sent back to Earth.

Table 2 - Percentage of Students Who Break the Rules

Episode	Decision Point	Chi-Square/Fisher Test	Reponse	Response - Individual	Response - Whole Class
3	It is important to follow protocol no matter the consequences	Fisher's Exact = 0.7574	Strongly Agree	22 (18.18%)	31 (18.13%)
			Somewhat Agree	66 (54.55%)	101 (59.06%)
			Somewhat Disagree	31 (25.62%)	35 (20.47%)
			Strongly Disagree	2 (1.65%)	4 (2.34%)
5	Do you...	Chi-Square = 0.80 $p = 0.371$	Keep Jonathan in the airlock chamber with the dog for 24 hours, due to the mandatory quarantine	61 (52.59%)	98 (58.68%)
			Try and get Jonathan out of there and to the medical bay safely	55 (47.41%)	69 (41.32%)
10	What do you do?	Chi-Square = 11.1 $p = 0.0009$	Change rules and help Sybil	52 (54.17%)	41 (31.30%)
			Maintain current rules	44 (45.83%)	90 (68.70%)

Qualitative Analysis: We used a qualitative approach to analyze an open-ended question from episode twelve of Mars, which asked, "How has your view of ethics changed after participating in this story/taking this class?" The responses were hand-labeled as binary outcomes: 'Yes' (ethics changed) or 'No' (ethics did not change). 'Yes' examples included responses such as, "I think it has made me realize how difficult decision making can be when it comes to ethics. It is certainly not a clear line for yes and no," 'No' examples were along the lines of, "I don't think my views have changed much as I feel they were pretty ethical to start" (Table 2).

Table 3 - Open-Ended Response Binary Label Examples

How has your view of ethics changed after participating in this story/taking this class?	
Ethics changed:	"I think it has made me realize how difficult decision making can be when it comes to ethics. It is certainly not a clear line for yes and no." "I have realized that my decisions have huge impacts and I need to think about its impacts on me and its impacts on other people and their ethics as well."
Ethics did not change:	"I don't think my views have changed much as I feel they were pretty ethical to start." "It honestly has not changed much I think I have a pretty good moral compass."

In the individual play version, 59.65% of participants responded positively, indicating a perceived change in their view of ethics. Comparatively, in the whole-class play version, a slightly higher percentage of 67.42% reported a positive change in their ethical viewpoint. When we conducted a Chi-squared test, we found a Chi-squared value of 0.762 and a *p*-value of 0.3827, indicating that there was no statistically significant difference between the individual and whole-class groups in terms of how they believed their ethical perspectives were influenced by the game (Table 3).

Table 4 - Self-Reported Change in Ethics

Chi-squared	*p*-value	Group	Percent Responded Ethics Changed
0.76206	0.3827	Individual	59.65% (34, n = 57)
		Whole-Class	67.42% (60, n = 89)

Text Classification Analysis: The BoW models outperformed the corresponding TF-IDF models for each of the three models. The Lasso Regression algorithm was the most effective model, yielding the best F1 Score of 87.49% on the testing data. This model demonstrated an accuracy of 83.78% and a precision of 84.00% (Table 4).

Table 5 - Text Classification Model Performance

Model	Vectorization	F1	Accuracy	Precision
Logistic Regression	BoW	86.95%	83.78%	86.95%
Logistic Regression	TF-IDF	73.91%	75.67%	85.00%
Lasso Regression	BoW	87.49%	83.78%	84.00%
Lasso Regression	TF-IDF	86.79%	81.08%	76.66%

Random Forest	BoW	84.62%	78.38%	75.86%
Random Forest	TF-IDF	83.64%	75.68%	71.88%

These results indicate that the Lasso Regression model was quite effective in distinguishing between students who reported a change in their ethical views and those who did not, based on their responses to the open-ended question.

Discussion

Social desirability bias may have had a significant influence on the decision-making process of the whole class group, particularly in high-stakes scenarios such as those encountered in episode ten of *Mars*. This bias refers to the tendency of individuals to respond in a manner that is viewed favorably by others, often conforming to perceived social norms or expectations [13]. In the context of the whole-class play mode, students were potentially influenced by the collective opinion of the group. This awareness could have led them to make decisions that they believed were more socially acceptable or aligned with the perceived majority's views. Specifically, in episode ten, where the decision revolved around maintaining strict rules against pregnancy or helping Sybil, the character in a dilemma, a notable difference was observed. The whole-class group was significantly more likely to choose to maintain the rules and not assist Sybil. This decision might reflect a conscious or unconscious inclination towards upholding established norms and regulations, a choice that could be perceived as more ethically and professionally responsible in a group setting. The presence of peers and instructors and the collective nature of decision-making in this mode could have amplified the social desirability bias, leading students to opt for the more rule-abiding choice, despite any personal inclinations they might have had to act differently if deciding alone.

Similar to our previous study's results using an earlier version of *Mars*, we found that as the game progressed, students were more likely to break the rules [9]. Interestingly, we saw similar results for episodes three and five as the last iteration of *Mars*, but there was less rule-breaking overall in episode ten and significantly less rule breaking for the whole-class group (Table 2). In our previous study, when faced with the choice of either adhering to the rules by sending her back to Earth or bending the rules to assist her, a substantial 67% of students chose the latter [9]. The disparity may be in part due to the difference in medium between versions of the game (previous versions of *Mars* were performed live in front of the class) [9]. This pattern indicates a possible link between the level of contextual detail in a scenario and the likelihood of students choosing to disregard rules. The more detailed and intricate the context, the more inclined students are to make decisions that defy the formal guidelines, suggesting a nuanced interplay between ethical decision-making and the immersive nature of realistic scenarios.

The Lasso Regression text classification model performed the best out of the six models (Table 5). As more responses are collected over time, the model will have access to a broader range of linguistic expression, which will improve its ability to classify responses more accurately. Exploring additional models, such as Support Vector Machines or Neural Networks, could potentially yield better performance, though these generally require more data than we currently have. Experimenting with additional preprocessing techniques such as lemmatization or the use

of word embeddings may capture nuances in language more effectively than basic stemming and could also lead to improved model performance. This finding underscores the potential of text analytics as a tool for assessing changes in ethical perspectives among engineering students. This preliminary analysis was crucial in determining the viability and accuracy of standard machine learning models in handling our data. Before integrating additional open-ended questions into *Mars*, it was essential for us to establish whether we could develop a reasonably accurate model for this specific question. This step served as a foundational test, laying the groundwork for more extensive application of text analysis in the game. Text analysis will be imperative for future iterations of the game, as we intend to deploy this method for large quantities of students across multiple universities. Accurately and quickly categorizing qualitative responses will make *Mars* more practical for assessing students' ethical reasoning.

In assessing ethical decision-making, both quantitative and qualitative data offer unique insights with their respective pros and cons. Quantitative data provide straightforward, measurable insights. This type of data is invaluable for quickly gauging the general trends in students' ethical choices, offering a clear, objective framework for analysis. However, it might not fully capture the complexity and depth of students' thought processes in response to ethical dilemmas. Qualitative data allows for a more nuanced exploration of students' ethical reasoning. By encouraging students to articulate their thoughts and justifications at critical decision points, such as deciding whether to follow regulations or bend rules for the greater good, qualitative data provides richer, more detailed insights. This depth is particularly beneficial in understanding the layers of ethical reasoning that a simple 'yes' or 'no' cannot convey. The primary challenge with qualitative data lies in its analysis, which is more time-consuming and labor-intensive due to the need for careful interpretation and thematic coding. Despite this, we believe the depth and quality of insights gained from qualitative analysis make it a more effective method for assessing ethics in a nuanced and contextual manner. To mitigate the intensive labor involved in analyzing qualitative data, text analytics algorithms are a powerful tool. These algorithms can efficiently process large volumes of text, identify patterns, and categorize responses, significantly reducing the instructor's workload. This makes a qualitative approach practical for in-depth ethical assessment.

Future Enhancements and Research

To accurately assess students' ethical decision-making at an individual level, with a focused effort to reduce the influence of social desirability bias, we plan to continue the iterative development of the individual version of *Mars*. Our enhancement strategy encompasses two main areas: the integration of explanatory, open-ended responses and the implementation of text classification techniques for a more refined assessment process. We have incorporated several open-ended response questions at critical points in the story where rule-breaking is a potential outcome. These questions are designed to elicit thoughtful, reflective responses from students, providing a rich source of data for analysis. To analyze these open-ended responses, we intend to use supervised text classification techniques. This approach will involve categorizing responses based on whether they meet or do not meet ABET's criteria for ethical decision-making [1]. We will develop a detailed codebook that outlines specific criteria and standards for ethical reasoning, adhering to ABET guidelines [1]. This systematic and automated method of text classification will not only facilitate individual assessment of ethical reasoning skills but is also

crucial for scaling *Mars* for use in other universities. These algorithms will aid in efficiently processing and categorizing the open-ended responses, easing the instructor's burden and making the qualitative assessment more manageable. By integrating text analytics, we can leverage the comprehensive insights offered by qualitative data, enriching our understanding of ethical decision-making in engineering classrooms.

Another direction for future research involves the development of two distinct versions of *Mars*, employing an ABAB design to experimentally assess the impact of context on ethical decision-making. This approach would involve alternating episodes between the versions – one set enriched with additional context and the other presenting scenarios in a more straightforward manner. The rationale behind this experimental design stems from the principles of situated cognition, which posits that learning is inherently tied to the context in which it occurs [3,4]. By deliberately adding or removing contextual elements in different episodes, we can observe and analyze how these changes influence students' ethical decision-making. This method of manipulating the game's context aligns perfectly with the concept of situated cognition, as it allows for a direct examination of how the environment and situational complexities impact ethical reasoning.

Conclusion

The findings from this *Mars* study offer valuable insights into the ethical decision-making processes of undergraduate engineering students. The game, designed around the concept of situated cognition, places students in realistic, high-stakes scenarios, compelling them to navigate complex ethical dilemmas. The data collected reveals significant differences in decision-making patterns between individual and whole-class play modes, highlighting the influence of social dynamics and individual reasoning on ethical choices. The potential impact of *Mars* on engineering ethics education is noteworthy, particularly in the context of situated cognition. By immersing students in the role of engineers on a Mars mission, the game provides a contextual, interactive platform for exploring ethical issues. This approach aligns with the principles of situated cognition, emphasizing learning in context and through experience. The game's realistic scenarios and the requirement for immediate decision-making foster a deeper understanding and internalization of ethical principles compared to traditional, more abstract methods of ethics education.

Looking ahead, future research directions will focus on further refining *Mars* to enhance its educational impact. This includes the integration of more open-ended response questions and the development of advanced text analytics algorithms to efficiently analyze qualitative data, as well as the development of different game versions with varying contextual depths to validate the importance of context in ethical decision-making. By evolving *Mars* and its assessment methods, we aim to equip future engineers with a robust ethical framework, prepared to navigate the multifaceted moral challenges of their profession. These improvements will not only deepen our understanding of students' ethical reasoning but also make the game more accessible and adaptable for broader use in different educational settings.

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