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# Engaging Undergraduate Students in Ethical Thinking Through Fun and Movies

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# Engaging Undergraduate Students in Ethical Thinking *Through Fun and Movies*

## Abstract

This paper describes a classroom approach and activities that have been successful in increasing undergraduate student understanding and engagement with ethics in a first-year design course. Gamification, the incorporation of game-like elements into non-game contexts, has been shown to increase student motivation and engagement in learning activities [1], [2], [3]. By creating a fun and engaging learning environment, educators can more effectively convey complex concepts such as ethical reasoning and decision-making. The activities described here include group work and challenge-based learning where students create a code of ethics and analyze outlandish case studies from movies and tv shows. The goal of using this gamified approach was to create an immersive and interactive learning experience for students to become familiar with the major biomedical codes of ethics, foster critical thinking on ethical issues, and help students develop confidence in applying ethical principles in engineering design decisions. The effectiveness of the approach was observed by post-module analysis of deliverables and an instructor observed an increase in students' independently motivated exploration of ethical dilemmas in group design projects.

## Introduction

Engaging undergraduate students in ethical thinking can be a significant challenge, as ethics often involves complex philosophical concepts  seemingly disconnected from the practical, hands-on learning that many engineering students prefer [4], [5], [6]. However, the ability to navigate ethical dilemmas is a crucial skill for future engineers who will be tasked with making decisions that can have significant impacts on individuals, communities, and society as a whole. To address this challenge, instructors in a first-year design course have incorporated gamification to explore ethical concepts in familiar media (TV shows, films) in an engaging, interactive application.

Keywords: challenge-based learning, ethics, ethical thinking, ethical problem solving, gamification, resilience, failure, person-centered learning, human-centered design, design thinking, design, purposeful failure.

## Background

### Problem: A need to teach ethics to undergraduate engineering students

Learning to approach complex technical challenges within an ethical framework is crucial for engineering students. However, ethics can seem abstract and may be difficult for engineering students to contextualize and retain as part of their professional identity [4], [5]. Students often find ethics to be dry, and disconnected from their practical, hands-on learning [7], [8]. This pedagogical problem can be addressed by providing students with varied types of learning experiences and opportunities to engage in ethical decision making within existing engineering courses [4], [5], [6], [9].

### Solution: Gamification and Challenge-Based Learning

Gamification, the incorporation of game-like elements and challenges into non-game contexts, can engage students with complex material in fun and memorable ways [1], [2], [3]. It has been shown to increase student engagement and motivation in learning activities, making it a promising approach for teaching ethics in engineering curricula [7].Gamification and challenge-based learning combined together in a Purposeful Failure instructional framework can deepen students' ethical understanding and improve retention by creating engaging and easily contextualized experiences [7], [8], [10], [11], [12], [13]. These approaches were combined with traditional classroom methods to create a multimodal learning experience. Activities included drafting a student-written code of professional ethics and analyzing exaggerated “real-world” scenarios from popular science-fiction movies and TV shows.

**Instructional Design: Implementation of Purposeful Failure**

The instructional design of this course followed a framework developed by the author as part of doctoral research at the University of Colorado Denver. The pedagogical framework, referred to as Purposeful Failure, is based on the idea of training students in a manner similar to athletic coaching—where they are intentionally pushed into scenarios in which they are likely to fail, in order to build comfort with adaptation and to conceptualize resilience as an active, learnable process.

This particular ethics module was structured using the "Monkey Wrench" guideline within the Purposeful Failure and Active Resilience instructional framework written by the author as a part of her doctoral work [12], [14]. In this guideline, students first create a prototype product, system, or service—in this case, a collaboratively developed code of biomedical engineering ethics. They are then challenged with an unexpected or exaggerated scenario that causes strain or failure in that prototype. Here, their ethical codes were tested through the application to absurd, complex scenarios derived from science fiction and speculative fiction media.

Students applied their collaboratively written codes to analyze individual media case studies, identifying areas where their frameworks failed to address critical ethical dilemmas. This created an opportunity to engage with ethical reasoning in a playful yet rigorous format, encouraging deeper reflection and prompting revisions of their codes to better account for ambiguity, complexity, and edge-case scenarios in biomedical design ethics.

**Assignment Description**

Students were challenged to create a discipline-specific code of ethics tailored to biomedical innovation. Rather than simply summarizing or quoting standard documents, they were expected to synthesize core concepts from foundational ethics texts with their own interpretations. The assignment sequence began with a lecture series on historical ethical failures in biomedical research, including the Tuskegee syphilis study, the Shiro Ishii biowarfare program, and the Henrietta Lacks case. Students engaged in small group discussions to analyze these events and explore how breakdowns in ethical decision-making contributed to harm. These discussions were scaffolded by assigned readings on professional ethics, including the Belmont Report, the Nuremberg Code, the Universal Declaration of Human Rights, and the Declaration of Helsinki.

With this foundation, students formed small groups of four to six and collaboratively authored their own codes of ethics specific to biomedical research and design. This collaborative process was designed to help students contextualize ethical reasoning both personally and professionally, while reinforcing the importance of shared norms, prompting thoughtful negotiation.
Students were then assigned individual case studies drawn from science fiction media and asked to apply their group-authored codes to these exaggerated scenarios. This assignment served as a purposeful failure exercise—highlighting weaknesses or gaps in the students' original frameworks while prompting critical engagement with the process of ethical iteration.

**Assignment Details**

The assignment was presented to students as shown below through the course LMS and as part of a week-long 'Ethics in Biomedical Design' module.

> **Title: Application of Biomedical Ethics Assignment**
>
> This assignment aims to apply the Code of Biomedical Ethics you created in class to a "real" scenario. You will select one of the film options below and watch it on your own time. For the assignment, you will use your ethical code to evaluate the events presented and summarize your thoughts on the events, including if your code would be sufficient in this scenario.
>
> Select a film from the following list for your evaluation:
> - Frankenweenie (2013)
> - Gattaca (1997)
> - The Andromeda strain (1971)
> - Young Frankenstein (1974)
> - Splice (2009)
> - Elysium (2013)
> - Altered Carbon (2018) Season 1 Episode 1
> - Rick and Morty (2013) Season 1 Episode 6 "Rick Potion # 9" AND Season 2 Episode 6 "The Ricks Must Be Crazy"
>
> Deliverables
>
> - PDF of the completed Ethics Evaluation Sheet uploaded to Canvas

Grading Criteria

- All major biomedical technology, research, and outcomes in the film are discussed and thoughtfully evaluated.
- Student effectively applies the ethical principles from their code.
- The students use their own words to articulate how each point is met or failed.
- The student's writing is clear and free of significant grammar or spelling errors.
- The final summary is based on the student's reflections and opinions on how their code fits into the larger Biomedical world.

**Ethics Evaluation Sheet**

Part I. Biomedical Code of Ethics
Attach or include a copy of the Biomedical Code of Ethics your team developed in class.

Part II. Application
Select a Biomedical/Biotech related film from the list posted to Canvas. Watch the film (pause
and take notes as needed) and evaluate the scenarios presented based on your code of ethics.

1. Identify 4 specific instances where bioethics can be applied.
   Write 1-2 paragraphs on the application of your code of ethics to each of the instances you selected. Did characters meet the expectations of each ethical principle in your code? How or how not?
2. Evaluate the actions of the primary character(s) throughout the film. Would you consider
   them to be ethical overall based on your code? Why or why not?

Part III. Review
After doing this evaluation, does your code of ethics need to be improved or changed? If the
characters had followed your code, would they have been able to conduct ethically sound research? What (if any) changes would you make to your code now and why?

**Course Context**

This module was implemented within a core first-year design course in the Bioengineering Department at the University of Colorado Denver. The author served as the primary instructor from Fall 2022 through Fall 2024. The module was introduced in Fall 2022 to address an identified need for early exposure to biomedical ethics within the undergraduate curriculum. The instructional design, assignment sequence, and assessment strategy have been iteratively refined across three academic years.

**Analysis Methods**

This study employed a sequential qualitative and mixed-method analysis to assess undergraduate students' ethical reasoning development across two scaffolded assignments in an introductory biomedical engineering course. The assignments included the development of a student-generated Code of Biomedical Ethics and a subsequent application of that code to ethically complex scenarios presented in film and television narratives. The primary goal was to evaluate growth in students' ethical conceptualization, applied reasoning, and moral reflection.

**Assignment Sequence**

The first assignment required students to create a code of biomedical ethics grounded in professional ethical standards, including the Belmont Report, Nuremberg Code, Declaration of Helsinki, and Universal Declaration of Human Rights. Students worked collaboratively in class

to synthesize a group code and submitted an individual version reflecting any additions or personal refinements.

The second assignment, completed after submission of the ethics code, required students to apply their self-authored code to four specific scenes from a selected biomedical-themed film or television episode (e.g., Gattaca, Altered Carbon, Rick and Morty, Frankenweenie). They were asked to assess whether the ethical principles in their code were upheld or violated and propose revisions to their code in response to the dilemmas observed.

**Data Collection and Preparation Methods**

The ten collaborative student Code of Ethics (COE) submitted were used for qualitative analysis. The COE principles were extracted from each and organized for thematic review. The film-based Application of Ethics (AOE) assignments were scored using a custom 5-domain rubric titled the Ethical Thinking and Awareness Scale, developed by the instructor for this purpose and based on literature review of current ethical education publications to reflect key dimensions of applied ethics in engineering contexts.

The data collection for this writing was part of an ongoing doctoral research project in the field of biomedical engineering education, under an IRB protocol approved by the Colorado Multiple Institutional Review Board. As part of this protocol, students were given the option to have their information excluded from the study and any analysis. Any data submitted by students who opted out or who withdrew from the course were excluded from the analysis.

**Qualitative Coding Method for Code of Ethics Assignment**

For analysis of the Code of Ethics (COE) assignment, an open–axial–thematic coding framework was used. Open coding was conducted line-by-line on all submissions to identify discrete ethical principles. Redundant or synonymous codes were merged. Axial coding was then used to group the open codes into five conceptual themes:

- Autonomy and Consent
- Beneficence and Non-Maleficence
- Justice and Equity
- Professionalism and Integrity
- Oversight and System Safeguards

These themes were subsequently compared to core ethical domains articulated in the Belmont Report, Nuremberg Code, Declaration of Helsinki, and UDHR. A comparison matrix was created to assess alignment between student-emergent values and professional standards.
Quantitative Rubric Scoring and Descriptive Analysis.

**Mixed Method Data for Application of Ethics Assignment**

The Ethical Thinking and Awareness Scale, shown in Table 1, was created for analysis of the Application of Ethics (AOE) assignment deliverables. For this film-based assignment, each student submission was evaluated using a human-AI two scorer system (where the first coder

was human and the second was a trained OpenAI 4.0o or Microsoft CoPilot virtual assistant). Scoring was based on using the Ethical Thinking and Awareness Scale developed for this purpose, with ratings (0–3) assigned across five domains: Applied Empathy, Theoretical and Professional Ethics, Discipline-Specific Application, Dynamic Ethics Perspective, and Ethical Challenge Identification.

**Table 1. Ethical Thinking and Awareness Scale**

| Domain | Criteria |
|---|---|
| **Applied Empathy** | - Addressing needs beyond personal experience - Human-centered values - Adaptability to unaddressed scenarios - Comprehensive and thoughtful application [5], [15], [16], [17], [18] |
| **Theoretical and Professional Ethics** | - Use of ethical theories (e.g., virtue ethics, utilitarianism) - Use of codified professional ethics (e.g., BMES, NSPE, Belmont Report) [5], [15], [16] |
| **Discipline-Specific Application** | - Technical needs (usability, safety, sustainability) - Human needs (comfort, communication, quality of life) - Societal impacts and justice - Historical awareness [9], [15], [16] |
| **Dynamic Ethics Perspective** | - Awareness of social and systemic factors - Adaptation during ongoing design - Recognition of new or evolving ethical issues [15], [17], [18] |
| **Ethical Challenge Identification** | - Recognizing ethical dilemmas and failures - Identifying lapses in professional standards - Distinguishing systemic vs. individual issues - Proposing preventive or corrective measures [16], [17], [18] |

Scoring:
0 = Missing/Not demonstrated
1 = Minimal understanding/application
2 = Developing understanding/application
3 = Competent understanding/application

Total scores (maximum 15) were calculated, then descriptive statistics were computed across all domains. Thematic correlations and inter-domain relationships were assessed using a Pearson correlation matrix. Score distributions were visualized with a correlation heatmap (not shown here).

## Results

### Analysis of Code of Ethics Submissions

Qualitative analysis of the ten student-generated COEs yielded a total of 20 distinct open codes, which were then merged and organized into five axial themes. The most frequently cited principles were informed consent, beneficence, and confidentiality—appearing in nearly all submissions. Less common were accountability, ethical oversight, and cultural competence, suggesting gaps in awareness or emphasis.

**Table 2. Frequency of Ethical Principles in Student-Authored Codes of Ethics**

| Ethical Principle | Frequency |
|---|---|

| | |
|---|---|
| **Informed consent** | 10 |
| **Beneficence / Do no harm** | 10 |
| **Confidentiality / Privacy** | 9 |
| **Risk minimization** | 8 |
| **Equity and inclusion** | 8 |
| **Transparency / Truth in data** | 6 |
| **Cultural competence** | 5 |
| **Continuous monitoring** | 4 |
| **Conflict of interest disclosure** | 3 |
| **Independent ethical review** | 1 |

To assess the foundational values emphasized by students, we conducted open coding on the student COE submissions. This process identified 20 distinct ethical principles, ranging from core concepts like informed consent and confidentiality to less commonly cited ideas such as conflict of interest disclosure, cultural competence, and patient education.

The open codes where further categorized into axial themes. The themes identified were Autonomy and Consent, Beneficence and Non-Maleficence, Justice and Equity, Professionalism and Integrity, and Oversight and System Safeguards.

**Table 3. Axial Theme Summary from Open Coding of Student COE Submissions**

| Theme | Total Frequency | Codes Included |
|---|---|---|
| **Autonomy and Consent** | 26 | Informed consent, Right to withdraw, No coercion |
| **Beneficence and Non-Maleficence** | 28 | Beneficence / Do no harm, Risk minimization, Harm prevention |
| **Justice and Equity** | 14 | Equity and inclusion, Cultural competence, Environmental sustainability |
| **Professionalism and Integrity** | 18 | Transparency, Truth in data / integrity, Accountability, Conflict of interest disclosure |
| **Oversight and System Safeguards** | 10 | Ethical review / oversight, Confidentiality / Privacy, Monitoring and feedback mechanisms |

A presence/absence matrix was constructed to track the inclusion of each student axial theme compared to key principles from the professionally recognized codes that were introduced in the module. Notably, informed consent and beneficence appeared in all 10 submissions, while only one submission included reference to independent ethical review. When the themes were compared to professional bioethics standards (Belmont Report, Nuremberg Code, Declaration of Helsinki, UDHR), strong alignment was observed for core domains (autonomy, harm reduction, justice). Students also contributed novel emphases, particularly around environmental sustainability, truth in data, and continuous monitoring, which are not yet central in historical frameworks.

**Table 4. COE Alignment with Professional Ethics Standards**

| Theme | Belmont Report | Nuremberg Code | Declaration of Helsinki | UDHR |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Autonomy and Consent** | Respect for Persons | Voluntary Consent | Informed Consent, Right to Withdraw | Autonomy, Freedom from Coercion |
| **Beneficence and Non-Maleficence** | Beneficence | Avoid Harm | Risk/Benefit Assessment, Patient Welfare | Right to Health and Safety |
| **Justice and Equity** | Justice | — | Equity in Access to Care | Equality, Non-Discrimination |
| **Professionalism and Integrity** | — | Qualified Researchers | Scientific Integrity, Conflict Disclosure | Accountability in Scientific Endeavors |
| **Oversight and System Safeguards** | — | Independent Oversight | Privacy, Ethics Committees | Right to Privacy, Institutional Protections |

**Evaluation of Applied Ethics Reasoning Submissions**

Descriptive statistics from the AOE assignment revealed high overall performance in applied ethical reasoning. Across the 23 evaluated student submissions, the mean total score was 12.78 out of 15. The most frequently achieved scores were in the "Competent" (11–13) and "Competent–High" (14–15) range, indicating a strong ability to apply ethical reasoning to complex biomedical scenarios.
Among the five rubric domains:

- Ethical Challenge Identification received the highest average score (2.91/3), suggesting students could reliably recognize and articulate specific ethical failures within the narratives.
- Applied Empathy was also highly rated (2.74/3), reflecting students' sensitivity to participant dignity, psychological impact, and power dynamics.
- Theoretical and Professional Ethics had the lowest average score (1.91/3), indicating that students often referenced core ethical principles without explicitly naming formal frameworks (e.g., Belmont Report, Nuremberg Code).

**Discussion**

The results of this analysis suggest that the progressive failure-based ethics curriculum successfully promoted the development of biomedical ethics reasoning among undergraduate engineering students. By comparing the student-authored ethics codes to their subsequent application in narrative-based case evaluations, we observed a meaningful shift from declarative knowledge to applied ethical thinking—especially in the domains of empathy, reflection, and challenge identification.

This is also reinforced by the correlation analysis – which showed a strong connection between the student's use of their own discipline-specific codes of ethics and the application of empathy in the scenarios found in the films.

**Progression from Principle to Practice**

The most significant finding is the increase in applied empathy and critical analysis/identification of ethical challenges in the AOE assignment. Students were not only able to identify ethical violations but also contextualize them in terms of stakeholder dignity, systemic harm, and justice—often going beyond their original codes to propose new standards. This progression was expected based on observations from prior year cohorts, bridging ethical abstraction in real-world moral complexity through applications of narrative media examples, fictive casework and a purposeful failure instructional framework

In contrast, performance in the Theoretical and Professional Ethics category was relatively low scoring. This reflects a common pattern in early ethics education, in which students internalize the spirit of formal codes (e.g., informed consent, harm reduction) but may not recall or cite professional documents (e.g., Belmont Report, Declaration of Helsinki) by name. This gap may be addressed in future iterations through more explicit citation practice, ethics mapping exercises, or scaffolds that promote transfer from professional frameworks to personal writing.

**Strengths in Student-Derived Ethics Codes**

The qualitative analysis of the COE submissions showed strong grounding in autonomy, beneficence, and privacy—aligning with professional standards across all four referenced codes (Belmont, Nuremberg, Helsinki, UDHR). The presence/absence matrix further validated this trend, with high frequencies of informed consent, confidentiality, and risk minimization. What was particularly notable, however, were several emergent themes not emphasized in the professional codes covered in class. These included:

- Environmental sustainability in biomedical design
- Continuous monitoring and feedback as a duty of care for engineers
- "Truth" in data and transparency across the research lifecycle

These additions reflect a growing awareness of the interdisciplinary ethical challenges of contemporary biomedical design, showing that students are thinking beyond compliance. Their novel ideations illustrate awareness towards broader definitions of responsible innovation and towards further critical ethical thinking. Instructors also observed a notable increase in unprompted discussion and thoughtful consideration of ethical concerns when working on the semester long group project work that followed this course.

**Pedagogical Implications**

The results of the analysis demonstrate the value of gamified instructional design in engineering ethics. The observed shift in student thinking from abstract rulemaking to situational ethical reasoning suggests that early exposure to participatory code development, followed by immersive and fun case engagement through film, can be an effective strategy in undergraduate

bioethics instruction. The module outcomes highlighted students' growing moral imagination and as well as a sense of epistemic humility as students created and then revised their ethical codes in response to their evaluations of the narrative movie/TV ethical failures.

For instructors, this approach offers a scalable way to introduce discipline-specific ethics without over-relying on rote memorization or decontextualized readings. Instead, students engage bioethics actively on the upper-level Bloom's Taxonomy tiers of creation, evaluation and (self-) analysis [19], [20]. They also get to have fun, which makes the content more engaging and memorable overall.

## Conclusion

This ethics module demonstrated that undergraduate engineering students are capable of deep ethical reflection when provided with engaging, contextually rich learning experiences. By combining collaborative authorship of a Code of Ethics (COE) with a narrative-based Application of Ethics (AOE) assignment, this framework supported both personal interpretation and professional grounding. Students exhibited strong alignment with core ethical principles and demonstrated the ability to adapt their thinking in response to complex, and sometimes absurd, science-fiction case study scenarios.

The incorporation of purposeful failure as a design strategy created an authentic opportunity for students to reflect, revise, and refine their ethical reasoning. Analysis of both COE and AOE submissions showed that students developed a growing awareness of human dignity/autonomy, interdisciplinary problem analysis complexity, and the broader reaching effects of ethical challenges. Student understanding moved beyond simple compliance to a more mature understanding of responsible innovation. This work contributes to ongoing efforts in engineering education to meaningfully integrate ethics into technical training. Through intentional scaffolding and purposeful failure challenge, students not only learned about biomedical ethics—they practiced ethical engineering.

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