RATIONALE AND TEACHING OBJECTIVES FOR A CANADIAN ENGINEERING ETHICS GAME

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Abstract *This paper uses Tyler's rationale as a framework for analyzing the teaching objectives surrounding the design of a video game to teach Canadian engineering ethics.*

The two key challenges in this area are defining what should be taught in engineering ethics and then how it is evaluated in order to demonstrate improved understanding. Traditionally, engineering ethics courses are taught as either codes of conduct, or based on case studies with very constrained courses. The evaluation that follows then uses the Defining Issues Test (DIT) or an instructor's evaluation.

However, the above methods could be improved by focusing on engineering ethics as a situated, embedded, and applied discipline. That is, one in which decisions are made as part of a team, embedded in a workplace whose goals will likely be in conflict with the engineers, and whose outcomes are unknown at the time decisions are made.

By using a serious game in which the players are protagonists affords us the opportunity to present thick cases with multiple decision points and opportunities for players to demonstrate their ethical bias. Additionally, the progress of players and their interactions with non-playing characters can reveal information on their assumptions and ethical bias.

Keywords: Engineering, Ethics, Education, Canada, Serious Games

1. INTRODUCTION

When I decided to develop a video game to teach engineering ethics, two questions were quickly posed -- "What are you teaching?" and "How are you going to demonstrate you have been successful?" This paper examines these questions through the lens of Tyler's Rationale and literature around engineering ethics education.

2. BACKGROUND

2.1 Engineering Ethics

In Canada, the Canadian Engineering Accreditation Board (CEAB) requires that all graduates have the "ability to apply professional ethics" [1].

Engineering Ethics are those codes of conduct that apply to engineers and no one else by virtue of their specialized knowledge. In their Guideline on the Code of Ethics, Engineers Canada writes:

A code of professional ethics is more than a minimum standard of conduct; rather, it is a set of principles which should guide professionals in their daily work. [2]

This can be interpreted to mean teaching students to behave, think, and act within the special moral standards of the engineering profession.

The Code is based on broad principles of truth, honesty, and trustworthiness, respect for human life and welfare, fairness, openness, competence, and accountability. [2]

Engineering ethics is different from general morality, because it doesn't focus on what is right or wrong, rather it focuses on how member should behave given the elevated standard of conduct and expectations of society upon them [3] [4] [5].

Society in general tends to hold the professions, especially the engineering profession, to a elevated standard, and expects practicing engineers to perform on an higher ethical plane. [6]

2.2 Tyler's Rationale

Tyler's Rationale is set of foundational questions for curriculum development. Originally developed in the 1940's it is still in use today. Tyler's Rationale gets users to clarify what is important about the material they are teaching and how it should be implemented, organized, and evaluated.

Table 1: Tyler's Rationale [7]

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained?

3. DESIGNING AN ETHICS GAME

The Canadian Engineering Ethics game described in this section is a work in progress. And it is in this context that Tyler's Rationale will be used to take a structured look at what is involved.

Michael Davis [8], Deborah Long [9], the Royal Academy of Engineering [10] and others [11] [12] [13] [14] [15] offer insights about how ethics should be taught. Using these insights as a basis for how ethics should be taught, the content of this paper will focus on creating developing a framework for teaching engineering ethics using a an educational experience that makes sense computer based role playing game.

3.1 What educational purposes should the school seek to attain?

The educational purpose of this project is to help young engineers, recognize situations of professional ethics and take meaningful action within the context of legal and professional aspects of engineering.

To achieve this, engineering students need to understand what the legal and social expectations are and develop the attitude that engineering ethics as an integral part of the engineering profession.

- 1) Understand the legal framework of engineering in Canada.
- 2) Be aware of the consequences of unprofessional/unethical behaviour on an engineer's career.
- 3) Develop a personal sense of the expectations of professionalism and ethical behaviours that exist within the engineering community.
- 4) Recognize situations around them in which unethical and unprofessional conduct exists.

3.2 What educational experiences can be provided that are likely to attain these purposes?

In order for students to have the "ability to apply professional ethics, accountability, and equity" [1], they

must have ways of evaluating the situation, and models of good and ethical behaviour that they can emulate. Ethics courses that focus on big media, bad news cases, can cause students to disassociate [16, p. 401], believing that ethical challenges are uncommon events, and only affecting senior engineers. To be most effective students need to:

- 1) See models of good behaviour in which resisting social pressures and taking an ethical stance is beneficial to the engineer and the profession.
- 2) Encounter both "big media, bad news cases" and smaller ethical situations that are more representative of an engineer in training's situation [8, pp. 148-158] [16, p. 401].
- 3) See engineering cases as being embedded in real environments with multiple people decision points and involved in the scenario [5, p. 199]

To embrace the ideas of good behaviour, representative cases, and embedded environments, this game is being developed around the idea of a new graduate being asked to serve on a professional practice investigation committee. In this role, the player will interview the parties affected, interface with the investigations committee, and ultimately recommend a course of action based on their interpretation of the facts.

Doing this allows the player to have positive role models from the investigation committee, see how a lack of ethics and professionalism can tarnish an engineer's reputation and potentially cost them their career, and have an opportunity to explore how group dynamics and non-technical elements affect an ethics story. To be successful though, students will also need to be trained in:

- 1) Interpreting (stylized) versions of the act, bylaws, and code of ethics relevant to professional practice.
- 2) Recognizing Kantian, Utilitarian, and virtue based ethical standpoints.
- 3) Using legal and an ethical framework for resolving ethical issues.

3.3 How can these educational experiences be effectively organized?

Although video games support non-linear play, a good story line is important to the overall development of a game [17]. For this game, the traditional five act story arc of introduction, rising action, climax, falling action, and resolution [18] will be followed.

3.3.1 Act 1: Introduction. The opening sequence of a game serves to hook the players in, teach the game mechanics, introduce the story, and establish the role of the player within the game. For this game, the introduction will consist of meeting the engineering

association registrar and investigation committee. During this time, players will be asked to investigate a case of professional misconduct (role), meet with the committee members (thematic elements), and take a brief ethics test (mechanics). The ethics test will also serve as a brief pre-test of the player's attitudes to establish a baseline for moral reasoning.

3.3.2 Act 2: Rising Action. Once the players have had their role in the story established, the learning and story elements will be introduced for the players to consider. One of the first challenges for the players will be in understanding what the committee members think is ethically important. As the player arrives, the members will be at an impasse because of differences in their individual ethical stances and personal opinions of the parties involved. As a trio, the committee will embody Kantian, Utilitarian, and Virtue ethical stances. They will also have predetermined biases about the guilt and innocence of the parties involved based on prior interactions with the plaintiff and defendant.

As the free agent, the player will act as the intermediary between the committee, plaintiff and defendant. Thereby being exposed to the case from multiple angles, and developing an understanding of what is going on.

As play evolves, and the player meets the plaintiff and defendant, they will also be introduced to the how business ethics and goals differ from those of engineering. The plaintiff will demonstrate a means-end mentality, while the engineer is trying to do his best to balance the needs of his client against those of his own firm. What should strike the players most in this portion of the story is that the plaintiff will try to manipulate and use the players, while the defendant is need to have the players explain while technical competence alone is not sufficient for dealing with this situation.

Throughout this act, the players will have to deal with conflicting ethical positions, biases, and expectations. By doing so, the players will have to investigate what the associations expectations for professional practice are, determine what aspects of the case are important, and understand what is required to create ethical arguments that make sense to each of the committee member viewpoints.

Overall, this portion of the of the story arc is where the players are discovering the details and complexity of the story, being drawn in, and set up for the climax. From a testing and evaluation standpoint, this is the formative stage where players are given guidance and encouragement as they build and test their knowledge.

3.3.3 Act 3: Climax. During the climax of the story, the players will be faced with a dilemma over their own expectations of engineers in practice.

During the climax, it will be revealed that The plaintiff has been manipulating the player and withholding information regarding how the contract specifications were written. And that the specifications purposefully neglected mentioning the issue for which the plaintiff is now claiming the defendant was negligent.

Unfortunately, it will also turn out that the defendant may in fact be guilty of unprofessional practice because their company only has limited expertise in this area of design. Further, the defendant assigned the work to an Engineer in Training, who was minimally supervised and who was trained in this area as the project evolved.

So, the questions facing the player are who do they believe, and what do they think should happen? Should the charges be dropped? Should the engineer receive a warning and a fine? Or should the defendant have their engineering licence removed? Everyone around them is pulling for their own choices, now the player must decide for themselves who to trust and what course of action they will take.

3.3.4 Act 4: Falling Action. In this act, the player will work to influence the story to the outcome they desire. They will use their understanding of professional ethics, the committee member's ethical biases, and the facts of the case to create the ending they desire. Through dialog, players will convince the investigation committee members to take a common stance. And in doing so, the players will have to synthesise their positions into logical arguments and appreciate how different people might perceive the same situation.

3.3.5 Act 5: Resolution. In the closing of the story, the player's actions, level of inquiry, and recommendations will result in one of several endings being played. If the player fails to acquire enough of the facts, the decision could be contested or appealed. If the player favours the plaintiff, then the engineering firm is closed and its employees are put out of work. And if the player favours the defendant, then further cases of professional misconduct ensue. At the end of the day, these outcomes serve to demonstrate that the players actions will have unseen consequences that impact the lives of others within their professional community.

3.4 How can we determine whether these purposes are being attained?

When justifying a curriculum we should be prepared to answer "have we achieved what we set out to do?". But answering this question not only implies clear purpose, it also implies having objective evidence about our success or failure. Because we are embedding this evaluation into a video game, the factors affecting assessment are:

- 1) It should be automated and able to generate easy to interpret results.
- 2) It satisfies a sponsoring or accreditation body that the skills have actually been learned.
- 3) It is transparent to the player, either by being hidden in the game engine, or included as a logical game element.

Traditionally, assessment has been done using either instructor assessment or the Defining Issues Test (DIT and DIT-2) [15, pp. 29-37] [19].

With instructor based assessment, the instructor evaluates the students understanding of ethics, how well developed the student's arguments are, and to what depth he or she have examined the problem. The challenge with instructor assessment is instructor bias and the inability to scale up this method easily.

The Defining Issues Test [20] (DIT and DIT-2), use a Likert-style test to assess moral judgement. Respondents review five case studies and identify the moral considerations they consider important in each. Then they rank the considerations to reveal which issues were most important to them. The advantages of this test are that it is well established and uses automated evaluation. This makes it scalable for large audiences and easy to use for pre and post testing. The problem with the DIT is that it measures morality, and not engineering ethics.

Recently, the University of Georgia has been working on creating the "Test of Ethical Sensitivity in Science and

Engineering (TESSE)" [21]. This test is a derivative of the DIT whose cases are more representative of engineering ethics.

Using these two methods as inspiration, assessment, a Likert style test could be used for ongoing evaluation during the game, by incorporating it into the players method of selecting what actions are taken next. Thus, ongoing assessment is available, and play can be blocked until either a number of ethical positions have been considered, or the player understands the underlying issues in each scene.

In addition to this visible testing methodology, players can be evaluated based on how they construct arguments and the information they choose to act upon in the game. During the falling action stage of the game, players will have to demonstrate their understanding by synthesizing what they have learned in order to bring the investigation committee to a consensus about how the case should be resolved.

3.5 Implementation

A key element of this project is developing a dialog tree that allows players to interact with the committee members and the affected parties. The following two screen captures are of the test environment being used during development, and the opening dialog tree between the player and the lead member of the investigations committee.

Figure 1: Unity® graphical development environment

Figure 2: Sample of the introductory game dialog

4. CONCLUSION

Serious game design is much like any other design project, before you can develop the product, you need to clearly articulate what you are trying to achieve and how you will evaluate your success. To this end, I have used Tyler's rationale as a framework for developing the

learning objectives, supporting story, and assessment methodology for an engineering ethics based role playing game.

The major challenges in this process were resolving what is meant by engineering ethics and how could it be evaluated as a logical component of game play. Once these were determined, the structure of the story emerged.

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