CONUNDRUM: A SERIOUS GAME INFORMED BY BLOOM'S TAXONOMY FOR TEACHING ETHICS AND SOCIAL ISSUES

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ABSTRACT

Building technology to support students who must learn ethics and social issues is a difficult problem. In fact ethics and social issues is an example of an ill-defined domains, which typically are resistant to standard intelligent tutoring systems techniques. An analysis of current pedagogical tools for teaching Computer Science ethics and social issues using Bloom's Taxonomy shows that the task needs tools for achieving Application, Evaluation and Creation educational goals. One promising approach which has the potential to achieve such goals is educational games. This paper explores a proof of concept educational game called Conundrum. This serious game provides three ways for learners to interact with it, each supporting a level of Bloom's Taxonomy. An experiment was run in a Computer Science ethics and social issues class showing promising results that the design of Conundrum led to students achieving Application, Evaluation and Creation goals. A multidimensional student model was also developed to aid instructors and learners understand their progress. The experiment showed that the design of Conundrum did have some good aspects but leaves a lot of future work to maximize its potential.

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Dedication

This dissertation is dedicated to my late sister Cora. For the masters and PHD she would have done but never got a chance to.

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CHAPTER 1
INTRODUCTION

A course in Computer Science ethics and social issues is difficult to teach due to its subject matter being an ill-defined domain [19]. This means it is difficult to design a traditional automated e-learning system because it will be difficult to automatically evaluate the progress of learners. Looking at the current state of the art for teaching ethics and social issues there are many approaches instructors use including presenting frameworks, expert testimonials, case studies and role playing. Of these approaches role playing is the best at helping students learn deep lessons of how to apply their knowledge but suffers from being difficult to set up, requiring good student participation and favoring students who are more extraverted. All of these educational approaches fail to exercise students on the even deeper issues of how to evaluate their choices and hypothesize about possible ethical scenarios and creative solutions. The hypothesis of this thesis is that serious games can be used to support students learning at all the Bloom's Taxonomy levels of Apply, Evaluate and Create in the social issues domain.

Therefore, a proof of concept prototype called Conundrum was created with components designed to help students apply, evaluate and create knowledge of ethical and social issues. It was used in a senior Computer Science ethics and social issues class on a suitable group of students in an experiment that showed that most of the students demonstrated evidence of exercising their Application, Evaluation and Creation skills when it comes to ethics and social issues in Computer Science

This thesis will cover related work including Bloom's taxonomy that informed the pedagogical needs of the game and related educational technology that supports learning ethics

and social issues. It will next discuss the design of Conundrum including the three parts of the system: the game itself, the flashback component and the Act Editor. Afterwards it presents the design and results of the experiment used to show Conundrum's effectiveness on students in an ethics and social issues class. Finally, there is the future work and conclusions learned from running the experiment with Conundrum.

CHAPTER 2
RELATED WORK

It is very important for professionals such as Computer Scientists to understand ethics and social issues because the ramifications of these issues on themselves and others could be tremendous. Bloom's Taxonomy categorizes pedagogical goals including upper level targets such as Application, Evaluation and Creation goals. There is educational technology to help achieve some of these goals but they aren't targeted for Computer Science students, and they fail to achieve the goals of Evaluation and Creation. Games provide a way of helping achieve Application objectives, and serious games seem ideal for supporting Evaluation and Creation levels of learning. This thesis presents a serious game entitled "Conundrum" that does achieve these three goals. But, first I will discuss existing technology to support learning of ethics and social issues.

Bloom's Taxonomy of Educational Objectives

Bloom's Taxonomy [10] classifies all learning into three domains: Cognitive, Emotional and Kinesthetic. In the Cognitive domain using the updated version of Bloom's Taxonomy [3], in which ethics and social issues reside, there are 6 categories arranged in order of increasing complexity: Remember, Understand, Apply, Analyze, Evaluate and Create. One of the strengths of Bloom's Taxonomy is that it is practical for instructors to reflect upon their instructional activities. They write:

> "…a teacher, in classifying the goals of a teaching unit, may find that they all fall within the taxonomy category of recalling or remembering knowledge. Looking at the taxonomy categories may suggest to him that, for example, he could include

some goals dealing with the application of this knowledge and with the analysis of the situations in which the knowledge is used." [10]

So in a Computer Science ethics and social issues course, giving learners an opportunity to practise making correct and incorrect decisions in ethical and social situations would be an example of meeting Application goals. Confronting learners with the ramifications that their choices will have on themselves, coworkers, and society at large, would be meeting Evaluation goals. Practising the Creation of an intricate scenario involving ethics and social issues will give learners a broader perspective on ethics and social issues as they consider difficult positions, perspectives, choices and outcomes these individual situations present.

Bloom's Taxonomy and Ethics and Social Issue Pedagogy

Current pedagogy for teaching ethics and social issues covers a wide spectrum of Bloom's Taxonomy from Remembering to Analyzing. Application, however, has proven difficult to support and there are no good methods for Evaluation and Creation. In this next section I will cover the different pedagogical tools of Remembering ethical frameworks to reach Remember goals, expert testimonials to achieve Understand goals, case studies for Analyze goals and role playing for Application goals. I will discuss the benefits and drawbacks for each of these approaches and why Conundrum fulfills the necessary Application, Evaluation and Creation goals better than any of these approaches.

Learners can be taught ethics through the learning and application of ethical frameworks such as Kantianism (if everyone does what I plan to do, how will it affect everyone) or Utilitarianism (attempting to make decisions to maximize overall utility such as happiness) [28] to achieve the Remembering Bloom level. This gives them a tool set that they can use in making ethical decisions and analyzing ethical issues from different perspectives. However, it doesn't allow

learners to make ethical decisions in a realistic and practical context and so fails to support the Bloom levels of Application and above.

The instructor can also bring in experienced industry professionals to give personal testimonies on ethical and social issues that they have experienced. For example if the instructor was covering the topics of Copyright and Intellectual Property, s/he could bring in the law professor Dr. Michael Geist [18] to speak about the current reforms in Copyright law and his own experience creating awareness and activism. This will help students with the Bloom categories of Remembering and Understanding of ethical issues. These testimonies may help the students to appreciate the ethical and social issues from a realistic and personal perspective to prepare them for choices in their own careers. They bring weight because of their origin in a realistic context. The downside is that this doesn't give learners practical experience in making their own ethical or social choices. However, testimonies do help learners Understand how their ethics and social issue decisions interact with the real world.

Also used by instructors are case studies [4] that give students practise in Evaluating ethical and social issues decisions. In case studies, students are exposed to enough of a particular context that it becomes more real to them than talking about issues broadly. If the instructor wants to give practical experience to the students in making ethical and social issue decisions, she or he might ask the students what they would decide to do if they were in the role of different stakeholders in that context. However, these decisions are made by students retroactively with no consequences and with more perfect information than someone would have as a stakeholder in the actual situation.

If the instructor wants students to Apply their skills in making ethical and social issue decisions, she or he might implement role-playing[33]. Role-playing gives a stakeholder's

perspective to each student in a particular context. Unlike case studies it does not allow them to know what the other participants are going to do, making it more realistic and fluid as the scenario develops naturally in response to the role players and the instructor governing the scenario.

The downside to this approach is that all the participants need to be committed to their role or the entire exercise could become sidetracked. A participant not fulfilling their role decreases the immersion and depth to which the students could explore the issue and will also only allow students to experience making realistic decisions in one role. In addition, it requires a great deal of time and effort to set up the role-play and get the students involved by providing the details and rules [15]. Role playing often benefits extroverted students who are more comfortable performing in front of others. It is also hard to reset a scenario for students to try a different approach or to easily switch roles. Already completed role plays will tarnish what learners will think and do for subsequent plays so that perhaps not all actors are playing naturally.

Serious Game as Solution for Application, Evaluation and Creation Skills

These drawbacks mean we need some educational tools that could be used alongside these other approaches so that learners would be able to develop Apply, Evaluate and Create skills in Computer Science ethics and social issue. Video games and simulations excel at exercising Application skills and serious game designs can add Evaluation and Creation goals to a video game, making it a more comprehensive pedagogical tool. Video games can be compellingly realistic and immersive for the player. Video games can be single player without requiring a moderator or involvement by other players, resolving the aforementioned issues of roleplaying. The game play can be oriented around trying to decide about trade-offs such as in Sim City [31] [35] or Civilization [15] [35]. These games allow players to perform in roles that they wouldn't have been able to experience otherwise such as being mayor of a city in the former and ruler of a

nation in the latter. The scenarios within the game can be reset on demand to allow learners to try out different choices and roles. Games with ethical gameplay mechanics have the advantage over other mediums of being able to both help players understand ethical dilemmas and make choices about them but also allowing them to explore [31].

There are many video games that include ethics and social issues mechanics and all of these have three layers: the narrative layer, the interaction layer and the design layer [35]. The narrative layer defines the context around the player including the plot, settings and characters. At the interaction layer the player is able to make ethical decisions that impact the game. Finally, there is the design layer where the ethics of the game designer influence the narrative and interaction of the game depending on what the designer values. The biases that the game designer brings to the game are impossible to avoid [35] and must be understood by the designer to create a balanced experience for players.

In all ethical dilemmas, including those that occur within an interactive layer of a game, there are three components: the choice that a person has to make, the decision that the person commits to, and finally the result of the decision the person has made [35]. For example a CYOA (Choose Your Own Adventure) novel is a game where there is a gameplay mechanic following this pattern. The novel describes a choice the player has to make, the player makes a decision by turning to a corresponding page in the book for that choice, and then the players reads the result of the decision they made [13] [24].

CRPG (Computer Role Playing Game) is another genre of video games that has explored trade-offs in making ethical or social choices. Examples in this genre include games such as the *Ultima* series [31] [35] [37] [38], *The Witcher* series [31], the *Mass Effect* series [31] [35], the *Fallout* series [31], the *Baldur's Gate* series [31], the *Dragon Age* series [35], the *Elder Scrolls*

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series [8] and the *Knights of the Old Republic* series [31] [35]. The origin of CRPGs is in translating the pen and paper experience of playing games such as *Dungeons and Dragons* to a video game [5]. The main game mechanic that players use to make ethical and social decisions consists of conversations with NPCs (non-playable characters). These NPCs are computer controlled avatars in the game world that the player's avatar dialogs with. The majority of the choices available to the player are contextual choices where NPCs reveal to the player details of the current context (i.e. narrative). After a player has received enough information to understand the context they are in, they are given pivotal choices which further the narrative of the game and often end with the player committing to an action.

Ethical dilemmas are also added to games in other genres to add to their depth. There is the interactive drama game *Heavy Rain* created by Quantic Dream [27] where the player influences the narrative of the game by controlling different actions of the characters in the game but it seems more like an interactive movie and does not contain any of the usual RPG mechanics. The first person shooters *Bioshock* [31] [35] by Irrational Games and *Call of Duty* [1] where the ethical dilemmas are represented through the story of the game and trade off decisions the player makes through the gameplay mechanics. The interactive novel *Radical Dreamers* by Square Enix [30] where most of the game is represented via text that the player can influence by controlling their avatar's actions. Finally, there is the game series *Phoenix Wright* where the player is a defense lawyer and spends the game collecting evidence and presenting it in court [12].

Within the interactive layer of a game there are three possible ways the game can respond to player input: it can react in a static way, where the player experiences an ethical scenario through the narrative layer but has no impact with her/his decisions; in an adaptive way, where the player

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makes ethical decisions which affect the narrative layer but the player doesn't affect the interactive layer in an explicit way; or a systemic method, where the underlying game mechanics are altered, such as player statistics [31] for example causing NPCs to attack or join the player's party or enabling or disabling dialog options based on the player's reputation. Out of the three possible ways that the ethics system interacts with the gameplay mechanics, adaptive systems allow the most ambiguity in their scenarios from player's choices. Static systems don't allow player choices to affect the narrative at all so whatever choices they make the game continues on. Systemic games give a direct result to the player often increasing or decreasing directly an ethical "meter" that keeps track of their good or bad deeds. This ambiguity found in adaptive games can be used to add depth to their experience of ethical issues [31].

One of the classic examples of a game that is static but does use ethics and social issues as a main aspect of the narrative layer is *Final Fantasy IV*. In this game the player begins as a soldier named Cecil working under the orders of his king to fight against other nations and take their valuable crystals with magical properties. When Cecil questions the king about an attack, he is stripped of his rank and sent to deliver a package to a village. Unbeknownst to him, the package contains monsters that proceed to destroy the village leaving behind a sole orphan crying for her mother. Cecil's crisis of conscience complete, he abandons his king and protects the young orphan from the same soldiers he previously commanded. While there are many ethics and social issues contained within the narrative of the game, none of the outcomes are alterable by the player's actions defining it as a static experience of the dilemmas. The player has no input about questioning the king, going to the village or abandoning the king. The player's avatar decides all of this for them.

An example of a commercial game that adds depth to its ethics using the adaptive approach is *The Witcher* [31]. Playing as Geralt, the protagonist of the game, players are exposed to the difficult ethical dilemma of either attacking or defending a witch. The choice is a dilemma because Geralt discovers the townspeople have been buying poisons from the witch, using them to kill other townspeople, blaming her entirely for their killings, and want her dead as a punishment. The witch herself argues that she was just providing a service and that the townspeople didn't need to purchase the poisons for use on their victims. After the player makes his/her decision, the game delays many hours to present the consequences to the player based on his/her choice. If the player sides with the townspeople and kills the witch, she isn't available to aid Geralt in a quest where the player needs her supernatural advice to free an innocent girl's ghost and the ghost is afraid of Geralt with the witch's blood on his hands. If the player sides with the witch it leads to a direct confrontation with the villagers requiring the player to kill them all and then face a confrontation with the law many hours later. Neither decision alters how the NPCs see the player or changes a meter moving the player closer towards good or evil, valiant or cowardly. The net result from making the choice is a narrative change and a slightly different battle that is quickly resolved leaving an ambiguous result.

The biggest drawbacks of adaptive systems such as *the Witcher* is that players will react negatively if there is a large difference between the player's expected choices and the actual choices that the game designer decided to offer them. For example if the designer doesn't consider a solution that the player feels should be available or there is a difference in viewpoint between the player and the designer [31] they might feel a loss of control and not consider themselves responsible for the actions of their avatar.

The earliest example of a systemic CRPG that explicitly represented and required ethical behavior as a part of gameplay is *Ultima IV: The Quest of the Avatar* [36]. In this game the player identifies a virtue that corresponds to a particular class of character (warrior, bard, paladin etc.) and is tested throughout the game with ethical dilemmas to determine if they are following the virtues. For example in the endgame the player releases several children who then attack him just like monsters do throughout the game. The normal approach to such a confrontation would be to attack the children but this would obviously be contrary to many of the virtues that the player is meant to follow. Making ethical decisions throughout the game alters variables that the player has been working towards the entire game such as not running away from fights increases the valor statistic but harming those who are not deserving of battle decreases the justice statistic. There are several non-violent and virtuous solutions to this situation such as using a spell to make the children sleep. Zagal finds this game notable because

> "• It attempts to make the player feel personally invested or responsible for the decisions they make in the game.
>
> • It encodes an ethical system and requires the player to learn it and follow it in order to succeed.
>
> • It provides players with dilemmas or situations in which their understanding of the ethical system is challenged." [36]

Games with ethical mechanics (static, adaptive or systemic) suffer from several common design problems. There is an open question about whether players can actually feel guilt in a game [31]. Without this feeling of guilt they may choose based on what seems to be the interesting choice instead of what it might do to their avatar and other stakeholders in the scenario. Exploring ethical problems through choices based on what appears to be interesting might not be a valid form of exploration of ethical issues because players might not be reflecting on the choices they are making [31]. Zagal also warns game designers that players need to know

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why they are making the choices they are [38]. Without this reflection players will also make ethical decisions without understanding or caring about the consequences.

Additionally, as the game designer increases the number of choices available to the player, the number of gameplay outcomes that designers have to conceive of and test increases at a combinatorial rate [31]. An easy solution to this problem is to limit all decisions to two options of clearly good and clearly evil choices. Unfortunately, it is not interesting to players to have such clear cut binary choices [14] [35] [31]. Players often prefer choosing ethically the first time they play and only some of them return to try out the evil options [35]. They are also trained to maximize their in game rewards and can ignore the ethical dilemma underlying their decisions by only looking at what choice would give the biggest reward [35]. For example in the narrative for the game *Bioshock* [31] [35] players have to decide whether to sacrifice little girls for "in game" currency and abilities or to let them go [31]. Sadly there are no negative consequences to making the "good" decision of freeing the girls since their "creator" will reward the player with an equal amount of resources if players choose the obvious "good" path. By making the choices neutral in resources it removes the sacrifice the player has to make to do the right thing. This choice is also presented to the player several times so that they only have to try making the "good" choice once to understand that there are no drawbacks to either decision. Making both the error of having an obvious binary choice and making that binary choice balanced removes the motivation for the player to consider the two options carefully.

One other possible solution to the negative effect of explosive growth can be including subquests within the overall narrative that resolve in a small number of ways decreasing the number of choices in the larger narrative but still exploring those ethics and social issues [31]. For example in the CRPG *Baldur's Gate* [31] each of the NPCs that the player can recruit into

their party has a subquest to perform before they will join the player. All of these NPCs have an alignment of lawful, neutral or chaotic and good, neutral or evil resulting in 9 different possible combinations (e.g. lawful good, lawful neutral, lawful evil, chaotic good etc.). Depending on their alignment the choices and rewards of the subquest will correspond to that alignment. For example one of the "lawful good" NPCs, Dynaheir, can be rescued after being kidnapped and taken to the Gnoll Stronghold. The player meets a "neutral good" character Minsc and a "lawful evil" character Edwin who both want to head to the Gnoll Stronghold for different purposes. Minsc wants to rescue Dynaheir and then both of them will join the player's group with a gain of party reputation for doing good works. Edwin wants to pay the player a sizable sum at this point in the game to assassinate Dynaheir and then he will join the player's party as the most powerful sorcerer in the game. Finally, if the player waits 10 days (in game) Dynaheir will be killed automatically at the Gnoll Stronghold, Minsc will attack the player's party if they have him in their party or talk to him after and Edwin has disappeared. All of these choices are unrelated to the main quest and can be bypassed entirely by not talking to the characters involved. Players can recruit Dynaheir, Minsc and Edwin by saving Dynaheir and convincing Edwin to join them but the three will remain in constant conflict verbally. All of these player choices will affect the systemic mechanics of the gameplay raising or dropping the player's reputation and it is impossible to keep everyone happy. Each of these NPCs comes with different abilities and rewards for helping them. This subquest is a good example of making a complex set of decisions for players without creating added complexity for the main quest in the game and has suitable choices for a player role playing anywhere on the alignment spectrum from "lawful good" to "chaotic evil".

All design by definition uses constraints to create something and so the game designer has to be careful about how s/he motivates players to make ethical decisions within a game [31]. A designer's bias will emerge within any game and s/he must be careful to structure the reward system around the objectives that they desire the player to achieve [31].

Creation of User Generated Content

There are many games where the game developers have polished and then released the tools that game designers used to create the game (such as *Neverwinter Nights 2* [9]). This enables players to create their own content. This game in particular allows players to create new dialog trees within the toolset that ships with the game so that players can write their own dialog trees in scenarios they have designed.

If learners are given similar tools for a game they could exercise their own Creation skills by creating ethical dilemmas that their peers could try to navigate. By providing a strong group of ethical dilemmas for learners to first play and then having them design their own ethical dilemmas a rich collection of scenarios could be harnessed for current and future learners to play. Each game would embed the designer's perspective and bias giving the learner playing the game a unique perspective on an ethics or social issue while practicing their Application and Evaluation skills. Meanwhile, designers would gain experience with Creation skills on an ethics or social issue.

Existing commercial games can't be used directly for teaching ethics and social issues in Computer Science because they don't cover relevant issues or occur in a realistic setting. For example *Mass Effect* [31] [35] takes place in a science fiction universe with aliens and far more advanced technology than we have today creating a setting where a modern day IT professional would seem out of place. Instead a new game has to be developed to support the context learners will find themselves in during their careers. The design of the new game needs to navigate a

delicate balance. If the game only provides fun and no teaching potential, then it will be less effective than the other pedagogical tools mentioned above, such as case studies and role playing.

Instead we want to create a serious game: a computer game that has an alternative purpose than just providing fun to the player [22]. We have explicit pedagogical objectives beyond the natural ways that games help learners to learn effectively [17]. In particular we want to support development of learner's cognitive skills at Bloom's Application, Evaluation and Creation levels.

Serious Games for Ethics and Social Issues Skills

A serious game is a game designed for more than just the purpose of entertainment. In the context of our research it refers to a game that is designed both to entertain and to teach. James Paul Gee [17] presents many of the reasons why games are so effective at enabling learning to learn. Games are effective at keeping beginners trying until they are able to get competency in a topic and at keeping experts motivated for further mastery. Games also distill topics to the essential elements so that learners can understand the necessary complex relationships in systems. They allow players to explore different paths to solving problems. They encourage learners to explore roles, ideologies, worldviews and problem solving techniques that they wouldn't experience in other mediums without risk of negative social repercussions [34] [32].

Both instructors and learners benefit from using a serious game. The advantage for instructors using a serious game is that they don't have to moderate the experience. As FitzGerald and Groff describe:

> "…since the computer manages the structure of the experience (the rules and logistics of the game) the teacher is free to facilitate student thinking and development, whereas with non-digital games, a teacher can be quickly overwhelmed with game management and logistics." [24]

Learners can also experience the learning content as many times as they require without the instructor having to monitor each experience. However, instructors can still find out what the learners have done and what choices they have made. Further, the content remains the same for all learners and can be improved and enhanced each year. Learners benefit because they can play at their own pace at their leisure. They can play independently of other learners enabling them to benefit regardless of how seriously their peers take it. The game can help them evaluate their play automatically through feedback mechanisms which can immediately inform and develop their learning.

Board Games about Ethics and Social Issues

The first type of games that have been used to teach ethics and social issues are board games. For example *The Ethics Challenge* [7] (for teaching ethics in engineering) and *Do the Right Thing* [2] (for teaching ethics in accounting) are two different board games that have been developed and used to help teach ethics and social issues to students.

The Ethics Challenge [7] was originally created by the Lockheed Martin Corporation to help them train their employees about ethics issues and was also used in a university engineering course. The motivation behind using it in the university class was because "Student responses were random with uninformative results about student knowledge. After the test, our students commented that the questions were too abstract and vague for them to answer. They suggested that more practical, real life questions, would be a better way to check their knowledge in ethics."[7]. To play *The Ethics Challenge* teams of students take on the role of a Dilbert character moving around the board trying to collect the most tokens. There are various traditional board game mechanics to move tokens randomly amongst the teams but the educational mechanic is that the instructor reads out a card that has an ethical dilemma with 5 possible answers and the different teams are allowed 5 minutes to discuss what they want their

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final answer to be. Each of the answers are assigned different token values by the game designer based on how ethical the designer thinks they are for that scenario.

Do the Right Thing [2] is a board game to help accounting students learn how to respond to ethics and social issues. As the teams move around the board they can land on "Take a Chance" or "Truth or Consequence" squares.

Landing on the "Take a Chance" square gives the team a scenario with 4 different answers that they discuss for 5 minutes before making a decision. Each answer is assigned, just like in *The Ethics Challenge*, a given amount of tokens based on how ethical the game designer thinks it is. After assigning the points, there is an instructor led discussion reflecting on the merits of the different answers.

The "Truth or Consequence" square asks the team to consider and respond whether a scenario is ethical or unethical. The creators of *Do the Right Thing* state "that board games, as an experiential pedagogical tool, are effective because they: (1) provide an enjoyable learning environment that enable students to learn by doing, (2) are easy to implement, (3) require no homework or grading, and (4) engage students in active learning that is retained." All of these benefits are just as applicable for digital serious games as they are for board games.

These board games are a good resource for helping students Apply their ethics and social issue knowledge by discussing and giving answers to the scenarios. They can have Evaluate objectives built into the natural flow of the game through discussion of the benefits and drawbacks to the answers.

However, there are also several downsides to using board games as a tool as well. There isn't currently a board game that targets computer science ethics and social issues. Board games don't support a player's ability to explore a different ideology, role or worldview without being judged

by the group that they are playing with. Unlike serious games run on a computer or game system, board games still require: instructor moderation to succeed, class time to play the game and significant preparation on the instructor's part to scaffold meaningful discussion to achieve Evaluate goals. Some of this instructor preparation might be wasted on scenarios that aren't reached by players in the time allotted. Included in this preparation effort is instructor reflection on why certain points are assigned to a given answer in case there is disagreement between the designer's assignment of points and the players' expectations. There is also the possibility that if it is always clear what answer should be given to maximize points for every scenario this may indicate that the board game is trivializing or ignoring difficult gray issues that a student may encounter in their career.

Games For Change About Ethics and Social Issues

There is also a genre of serious games called Games for Change [34] [32] that try to use game mechanics to help educate players about a particular ethics or social issue. They have the goal of motivating players to educate themselves further about the issue to succeed in the game, send messages to politicians expressing their concern, join a social movement or donate money to a cause.

For example there is a game called *Darfur is Dying* [11] [25] where the objective of the game is to bring awareness about the dangers that people were exposed to every day during the conflict in Darfur, Sudan to motivate players to become active. In the first half of the game the player takes on the role of a man, woman or child attempting to gather water for the rest of the family while avoiding being captured by the militia and being abused, raped, kidnaped or killed. In the second half of the game the player is trying to help a community to survive by meeting basic needs in a refuge camp of food, water, shelter and health meanwhile being attacked intermittently by the militia harming these basic needs.

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Peacemaker [35], another game for change, invites the player to take on the role of being the leader of either Israel or Palestine. The player sets policies for their own country to either achieve peace or further conflict. In the game the other country's leader wants peace but there are factions in both countries that only desire war and conflict. The game uses actual news footage and pictures to respond to the player's choices to ground it in reality and states that its objective is to challenge the player's assumptions about the issues of the region.

The Apply objectives for these games are similar to the needs of a tool for a Computer Science ethics and social issues class by giving the player choices to make about an ethics or social issue in a real life context. Unfortunately, none of these games that I am aware of cover the issues that a computer science graduate will need to deal with in their career. They are also so singularly focused on a particular issue that their game play will not generalize to the multiple issues covered by a ethics and social issues course requiring a newly designed game for each issue.

Educational Serious Games About Ethics and Social Issues

TLTS (Tactical Language Training System) [22] is an example of a serious game for learning. It is used by the military to train soldiers in the language and culture that they will encounter in the field. Traditionally, this has been done through the use of actors and physical sets, but it is very expensive to implement, as are roleplaying activities to illustrate ethics and social issues in class. *TLTS* was designed as a system to overcome these difficulties by having scenarios that soldiers would work through by not only having the game respond to their choices, but also analyzing the spoken natural language and body language they used in their interactions. This was implemented using a commercial video game engine integrated with complex speech recognition and a human psychology modeling system. This means that *TLTS* had more requirements for their system than we do for the teaching of ethics and social issues. We do not

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have the complexities of interpreting language from players and translating that into something the game can respond to. We don't necessarily need to represent body language as an aspect of culture requiring high fidelity graphics. The advantage we have in the ethics and social issues domain for Computer Science students is that we can concentrate on the difficult choices and not add the complexity of state of the art game engines and artificial intelligence processing. Nevertheless, *TLTS* it is a good example of using a serious game to teach in a difficult domain through difficult choices.

Interactive narrative *AEINS* [20] [21] uses a Socratic discussion to help students aged 9 to 12 learn ethics. *AIENS* generates a continuous narrative using production rules and a student model to keep the stories relevant to the user. Learners are asked questions to fulfill the requirements for creating a teaching moment such as inviting along a certain number of friends. The system has one of the NPCs suggest an unethical thing to do, such as shoplifting, and the learner either agrees or disagrees to perform that activity. If they don't agree, the story continues until the next teaching moment. If they do agree to perform the unethical action with the NPC, a different NPC acts as a Socratic agent by disagreeing with the player's action and discussing it with them.

This approach is not without drawbacks. First it is a passive activity where the player is reading for most of the time without having to make any decisions and waiting for the story to get to a moment where it requires the player's action. *AEINS* misses opportunities to motivate players by using game design that views the player as a more active participant. Secondly, the ethics goals are more straightforward with basic ideas such as honesty or respect being important concepts that hopefully, university students have been exposed to and understand. Learners are only corrected when they choose incorrect behavior and then enter a discussion with an NPC. Learners can "game" the system by placating the NPC and thus move onto the next teaching

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moment without reflection about their decision. This discourages learners from experimenting with risky choices and experiencing the consequences of their actions. When the ethical issues become more complicated, such as trying to balance a trade-off between security testing and meeting a strict deadline, it is important for the learner to be able to make risky choices if they see the benefits outweighing the potential risk. Simplifying each option into "good" and "bad" does a disservice to adult ethical reasoning where more complex trade-offs occur.

Winter and McCalla [36] created a text based game where students made ethical choices and received consequences based on those choices. Student behavior in the choices revealed patterns in play that could be identified as different ethical stereotypes. This work could be extended by adding a video game interface and doing further analysis on learner behaviors. The scenarios that the game presented had very few choices. There were no feedback mechanisms for helping learners Evaluate the choices that they made beyond narrative consequences and there was no opportunity for learners to create their own scenarios.

There are some serious games related to helping people learn to make ethical choices including *TLTS*, *AEINS* and a text based game. However, these games have the drawbacks of not covering the issues and settings that Computer Science students will encounter in their professional careers and they don't challenge students at the upper levels of Bloom's Taxonomy. So a new serious game has been developed called *Conundrum* to meet these challenges.

CHAPTER 3
CONUNDRUM SYSTEM

A proof of concept serious game called Conundrum was designed to attempt to meet the requirements outlined in the previous chapter. Conundrum has three components learners interact with: the game play module, the flashback component that allows players to review their decision sequence after each game is played, and the Act Editor that allows the game content to be created and edited.

These three systems are designed to support the Bloom Taxonomy categories Apply, Evaluate and Create [3] .The game play is responsible for helping learners to achieve Application educational goals, the flashback is designed to help them Evaluate their game play and the Act Editor is designed for them to be able to create their own Acts enabling them to achieve educational goals at Bloom's Creation level.

Conundrum Game Play

The game play of Conundrum is meant to challenge students to make relevant ethical and social issue decisions with realistic trade-offs and consequences, giving them an opportunity to use their Application skills [3]. There are many design goals for Conundrum. Conundrum's NPCs have to give the player sufficient context to understand the trade-offs in the choices they make but not so much that they are acting with perfect information. Ideally there would be no tutoring at the time they make choices (as CYOA [6] does) but instead any pedagogical feedback will be after the fact at the conclusion of the scenario. The narrative should deliver consequences to the student's avatar and NPC stakeholders so that students can understand the direct

ramifications of having selected a particular trade-off. Being a game and not real life, however, it would be useful to allow students to replay any sub-scenario so that they can experiment with other decisions and their consequences. Instead of fellow players Conundrum is designed with a cast of NPCs that remain in character and thus allow the player to experiment with a scenario as many times as they wish with some consistency in character behavior.

Figure 1 - Contextual Choice with One Thought Bubble Highlighted and Two Hidden

The setting in which Conundrum embeds a player (the "learner") is the context of a Computer Science professional. Instead of being an elf or starship captain as in a typical CRPG or CYOA the player is instead a system administrator, application programmer or a project manager. Also unlike the standard CRPG there are no "combat" or other gameplay mechanics, only dialog with NPCs and making choices.

In Figure 1 you can see an example of a contextual choice in Conundrum. Contextual choices are those that give the player information about the setting their avatars are in but doesn't further the narrative by having them make a decision. The player is on the left hand side (with the skirt and the long hair) while the manager for the player represented by an NPC is on the right hand side (in the tie and pants). The NPC has just asked the player "Alright which alternative did you want to know more about?" In response the player can ask one of three possible questions about the context they find themselves in, with "Ask if the project might be done on time with double shifts" being considered right now. The other two options are asking "…if the client could be convinced to deploy the system after the security testing…" or if the player "…could get the client to postpone the security testing until after the deployment."

If they do choose to find out more about double shifts by clicking on the thought bubble, the NPC will tell the player (in Figure 2) "The likelihood that the testing will be done on time is very small. You can try to push your team to finish it by the deadline if you think that is the best choice." From this the player can either ask for more details from the manager or indicate she wants to try double shifts by selecting the choice "I've decided I want to try finishing the project with double shifts." This choice is a pivotal choice that alters the outcome of the scenario by having the player committing to a choice that will alter the outcome of the scenario they are in.

Figure 2 - Pivotal Choice with One Thought Bubble Expanded and One Hidden

Similarly, when the player selects this choice they see the result in Figure 3 where their avatar has told the NPC manager that "I've decided that I want to try finishing the project with double shifts." The game branches from here depending on the choice the player has made. Having the game interact with the player in this way allows the learner time for reflection, considering the different options. This should be practise for the learners in the necessary skill of

gathering requirements and understanding the social and physical environment in which the

software they are building will be embedded.
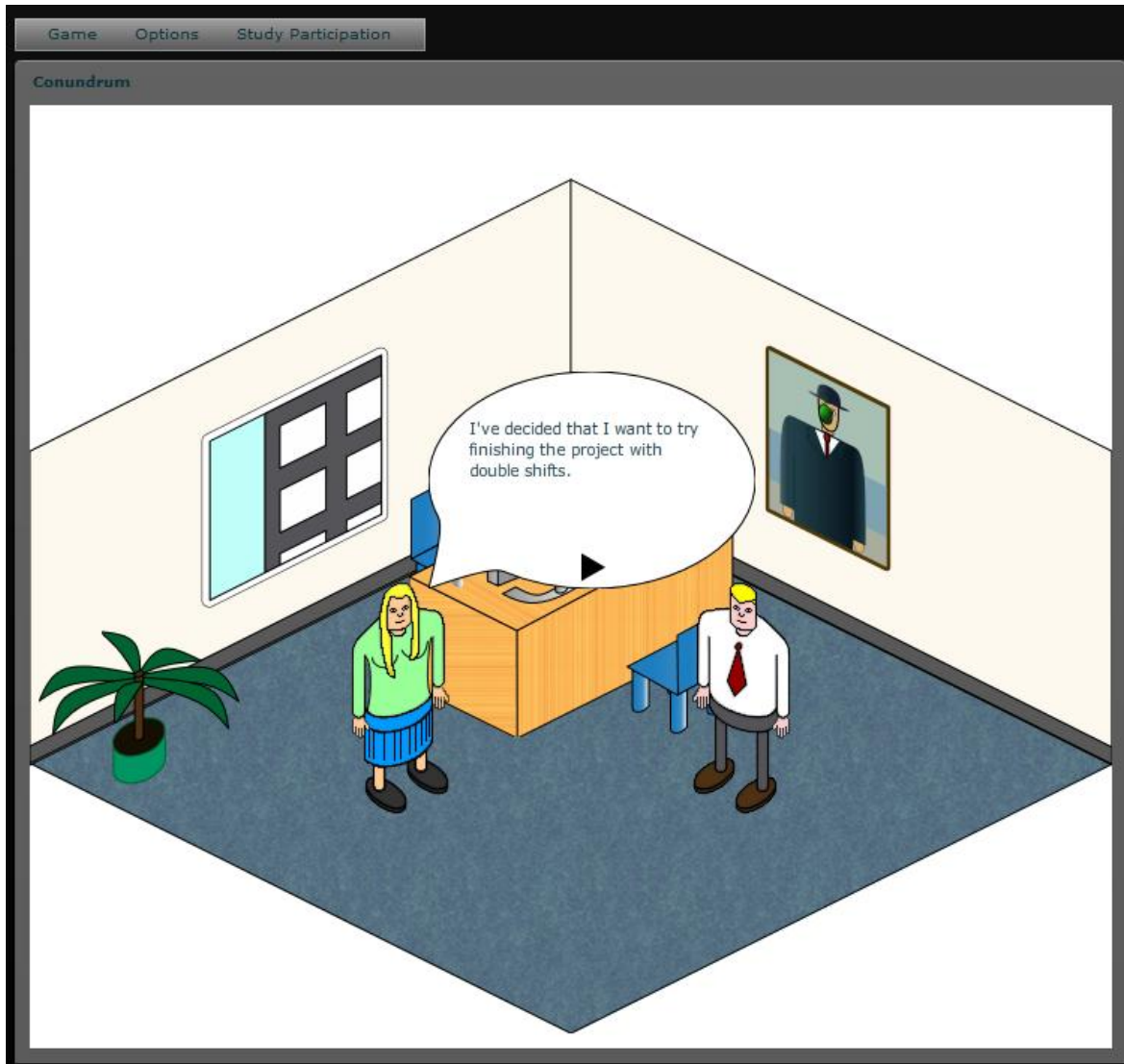
Figure 3 - Result of a Choice

The content in Conundrum is broken into three abstraction levels: Acts, Scenes and

Dialogs (Figure 4). An Act covers all the choices students are able to make around an ethical or

social issue. In general video game terminology this would be a level or a stage. Using the word

"play" or "game" to describe a single play through of an Act can quickly become confusing so I will be using the MMORPG (Massively Multiplayer Online Role Playing Game) term "instance" to describe a player's single travel through an Act. In an Act's graph there are far too many nodes and edges for the author to keep track of, so each Act is broken down into Scenes, coarser grained encapsulated sub-scenarios.
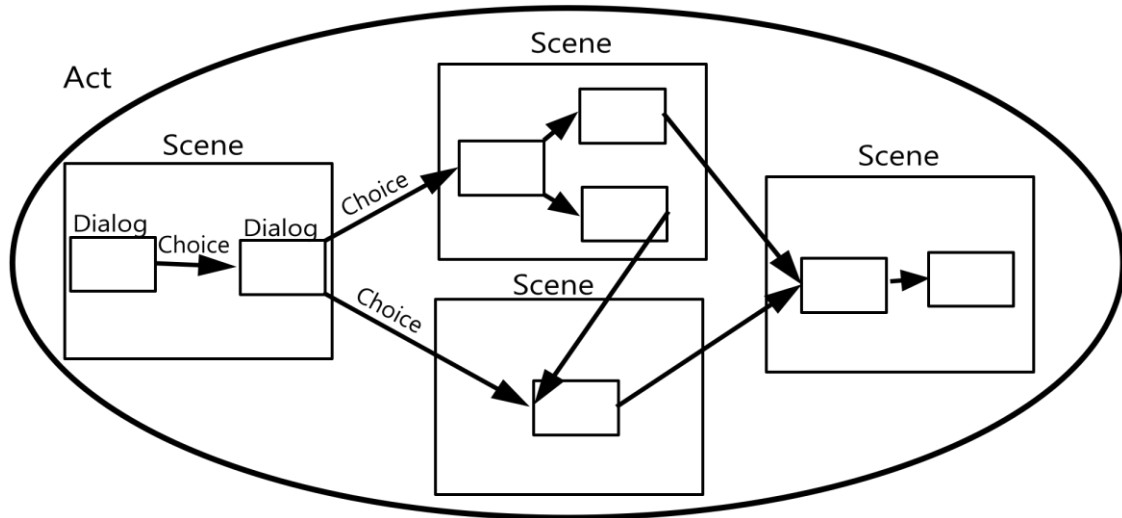
Figure 4 - Relationship Between Acts, Scenes and Dialogs in a Conundrum Act

All Acts begin with an initial Scene. Edward Packard, the conceiver of and one of the original authors of CYOA books, said that planning an outline for one of the books "look like a tree lying on its side with many branches and limbs. If you can imagine every branch, limb and twig of that tree as a page you get an idea of how an outline is done. My outline would be called a flow chart in computer terms."[26] The Act is a tree or flow chart in Packard's terms. The Scenes are the branches and the Dialogs are the twigs. Scenes allow the author of an Act to encapsulate Dialogs into a grain size of their choosing, where the Dialogs within one Scene are independent of those in all other Scenes. All the Dialogs of an Act could be in one Scene or there might be only one Dialog per Scene. To be most effective the Scenes should be graphs of Dialogs that cover the options available in a particular context, but designed to prevent the Act

from growing at a combinatorial rate [31]. For example there is a Scene in the Act Security vs. Deadline called Discuss Alternatives shown in part by Figures 1 through 3. This Scene allows the player to discuss with his or her manager the possible avenues out of a difficult situation. The Scene ends when the player has indicated they have decided on one of the possibilities with their manager.

Scenes can lead to the end of the Act, another Scene or many other Scenes. When a Scene starts a title comes up indicating the beginning of the Scene to let the player know they are going into a new context. The title is usually linked to what is going to occur within that Scene.
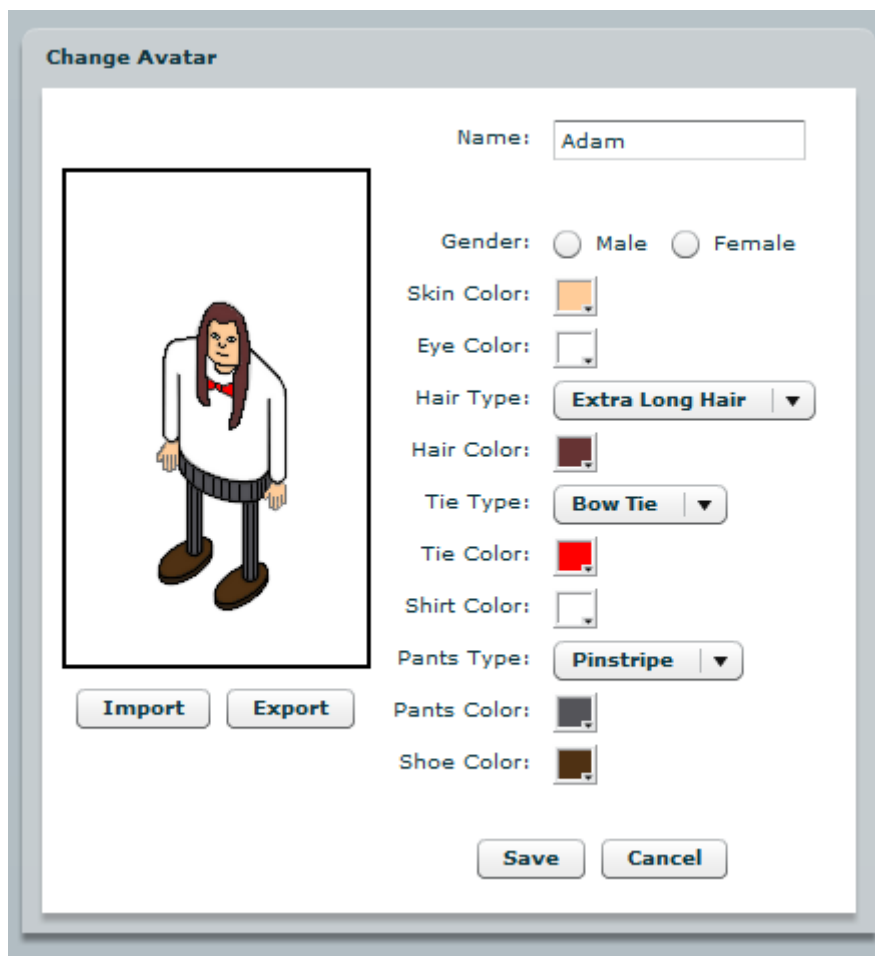
Figure 5 - Customizable Avatar System in Conundrum

The Dialogs that make up a Scene are themselves made up of one or more choices (up to a maximum of 4). These choices are presented to the player in the Act. Each of these choices has a result such as another Dialog, another Scene or the end of the Act.

Through play testing we determined that players had trouble identifying their own avatar, often confusing it with NPCs. To overcome this issue we also use the CRPG concept of customizable avatars as shown in Figure 5. By allowing the player to change their avatar they are able to recognize it quicker and are less likely to mistake their avatar for an NPC or vice versa. This should also allow the player to identify more with their avatar as they are able to customize it to suit them, perhaps to reflect some of their own characteristics.

A great deal of the gameplay in Conundrum is modeled after CRPGs and CYOAs with the essential gameplay kept intact but embedded in a setting of Computer Science ethics and social issues to encourage learning.

Acts Designed For Play in Conundrum

There were four different Acts designed for the "original" Conundrum: Security vs. Deadline, Conflict of Interest, Intellectual Property and Computer Crime. They were each designed with three distinct parts in the first rule of thumb that seemed to have been a role model for learners when they were designing their own Acts.

> Rule of Thumb 1: It is often useful to divide the Act into three parts: introduction, action and denouement.

There is the *introduction* where the player is introduced to the environment, NPCs and the conflict with several different options given. The player then makes a decision and enters the second part, called the *action*, trying to resolve the conflict. Finally there is a quick *denouement* at the end of the Acts to wrap up what the choices meant leading up to this ending. Even though each of the four Acts follows this basic structure, they each have their own graph structure

ranging from complex in Security vs. Deadline to simple in Computer Crime. This graph

structure controls how much freedom each player has to affect the overall outcome of the Act.

Security vs. Deadline

Introduction to the Security vs. Deadline Act

Security vs. Deadline was the first Act designed and it's the most complicated Act in number

of pivotal and contextual nodes (see Figure 6). It was the most motivating in terms of the average

amount spent playing it and it also resulted in the most times being played out of all of the Acts.

Three Different Paths

It was designed with a three way split right at the start (Figure 6). This was crafted to motivate

players to examine the trade-offs involved in their decision making and to wonder about other

possible outcomes.

The parenthesized numbers in Figure 6 after each pivotal choice represent the number of

players who made that choice during actual play. As can be seen in Figure 6, two of the paths

were explored by participants, including trying to recover from going over a deadline either by

using double shifts ("Double Shifts" in the diagram) or trying to talk the client into extending the

deadline ("Extend Deadline" in the diagram). The third path of skipping some security testing

("Omit Security" in the diagram) was ignored with one player reporting on the post-test

questionnaire that it sounded too risky. This choice will need to have some incentives added to it

in future versions of Conundrum so that the players will consider it a viable option. Although

there was one path that was unused by students, it is encouraging that many of them returned to

try out some of the other paths they hadn't taken. This leads to the first rule of thumb learned

through the playing of Conundrum.

Rule of Thumb 2: When your sole gameplay mechanic is making choices, you need to make those choices compelling to your players or you will expend energy creating unnecessary content.
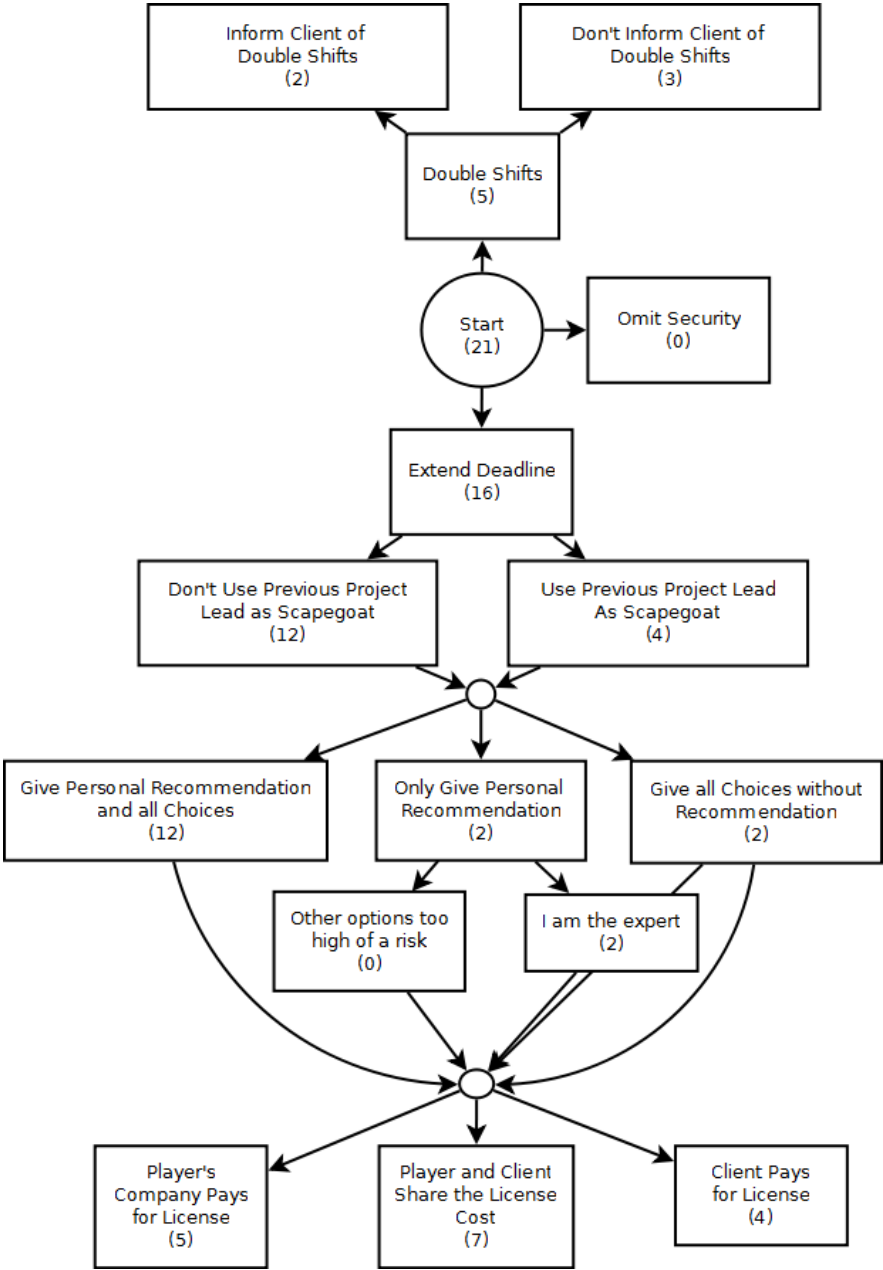
Figure 6 – Number of Pivotal Choices Made by Players in the Security vs. Deadline Act

One student reported that it was the assurances of the NPC manager that convinced her/him to try the risky option of double shifts and that normally she/he wouldn't have considered it a viable option.

> Rule of Thumb 3: It is very important to craft the language of each Dialog of the Acts to encourage players to explore every branch.

Nevertheless, there is still the hard work of convincing students to make choices that challenge strong preconceived notions about certain issues. For example there was a student who stated that under no circumstances would double shifts or neglecting security by deploying without testing be options.

<u>Sub-Issues</u>

Security vs. Deadline was also designed to have sub-issues covered within two of the three major paths that didn't impact the Act overall but would lead to local consequences.

> Rule of Thumb 4: Using sub-issues increases the feeling of depth in the Acts without increasing their size combinatorially [31].

While trying to convince the client to extend the deadline, players were exposed to three sub-issues and if they had tried to convince the client to postpone the security testing until after deployment they encountered two of these sub-issues.

The first sub-issue was the player attempting to improve his/her reputation with the client by trying to convince them that it was the previous project manager who was to blame. This was to highlight the risks of using other co-workers as scapegoats regardless of whether they were at fault. If the player chose to use the former project manager as an excuse, this would backfire as the client was a good friend with the previous project manager who had helped to secure the contract for the company in the first place. Only a quarter of the time (4 out of 16 plays) was this option chosen.

The second sub-issue gave players the opportunity to explain their reasoning about the solution they thought would be the best for the client. A player could choose to give all of the recommendations without a suggestion, thus allowing the client to choose the solution they liked best. The player could also only give the choice they believed to be the best without giving any other options or reasoning for the decision. Finally, the player could give to the client all three of the possible options, but also recommend one as the best choice. Three quarters of the players (12 out of 16) decided to take this last route and give the options along with the recommendation; the others tried out the other 2 options (2 for each option).

The third and final sub-issue had more of an impact on the outcome of the Act. It was a discussion between the player and the client about who was to pay for a licence to keep the client's systems operational in the limbo period between when the software was supposed to be delivered and when it was actually delivered. The best option was for the player to offer for her/his company to pay for the licence with their manager congratulating them on cementing the relationship with the client at the cost of the licence. The player was also able to suggest sharing the cost burden of the licence with the client, leading to an unhappy, but still cooperative, client. Finally, if the player suggested that the client pay for the license they would threaten to sue for breach of contract. There wasn't quite an even split across all possible outcomes but it came close, as can be seen in Figure 6.

Security vs. Deadline was by far the most complicated Act for both the pivotal nodes and context nodes. The following usage data must be taken in context of the fact that this Act was released right at the beginning of the study with Conflict of Interest so players had more time to experience these two Acts compared to the later Acts Computer Crime and Intellectual Property.

Even so, this Act has more nodes, both pivotal and context, and more sub issues that were related to the overall theme of the Act, so it isn't surprising that players spent more time in this Act.

User feedback indicated that depth in the Acts was important to keep player interest, and the use of sub-issues is a manageable way to add this depth without a combinatorial explosion in the size of the graph [31]. One participant actually played both major paths (double shifts and trying to get the deadline extended) at least once but also tried out all possible permutations of the sub-issues to see what would happen in each. Another couple of players were intrigued with the sub-issue of who would pay for the licence and replayed the choices in this sub-issue to find out the different results. Although only three of the players were fascinated with the sub-issues, it still seems to be an appealing way to increase the complexity of the Acts without necessitating a greater increase in complexity of the graph structure for the Act. This would seem to be one good rule of thumb for creating Conundrum Acts.

Conflict of Interest

The central issue of the Conflict of Interest Act (Figure 7) is the player deciding if it is worth the risk to take a bribe for a decision already made, at the risk of future credibility. The design of the Act consists of binary choices starting with whether to take a bribe or not, and the choices after that elaborate a difficult conversation with the player's supervisor. Conflict of Interest was the second Act designed and released to the students at the same time as Security vs. Deadline in correspondence with the course syllabus. This Act is the second most complicated Act, being simpler in design than Security vs. Deadline in the number of pivotal and context nodes.

As shown in Figure 7, around half of the time players tried to take the bribe (and mostly getting away with it with some consequences) and the other half of the time they didn't take the bribe. Feedback from the Act confirmed that students understood the main issue at stake. One of the players when asked why s/he didn't take the bribe "Why didn't you choose to benefit from a

choice you have already made?" answered "If it came out that I took a bribe it would ruin my credibility as a leader. It doesn't matter that I already decided it. It could easily be misconstrued."
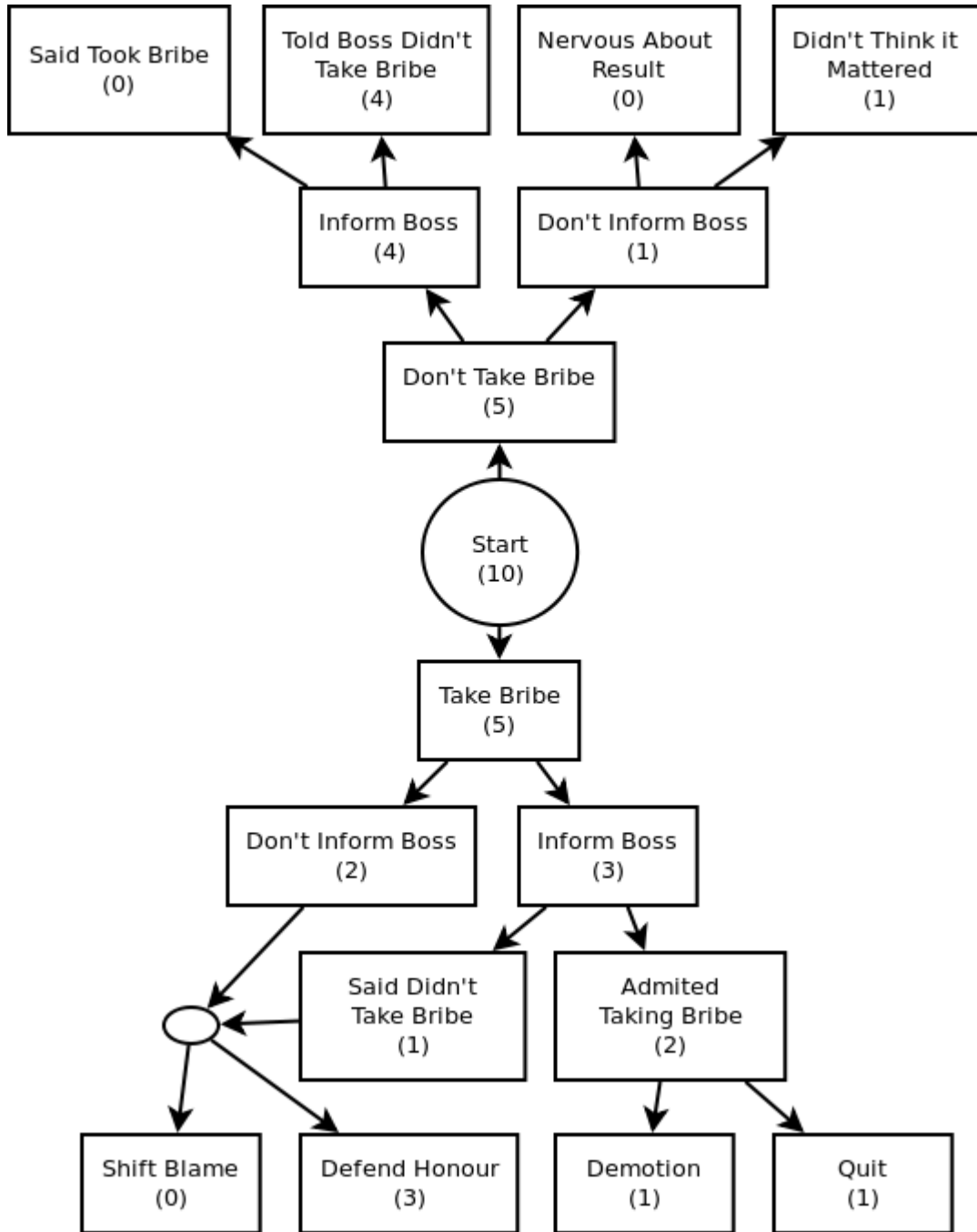
Figure 7 – Number of Pivotal Choices Made by Players in the Conflict of Interest Act

Two novel Act rules of thumb emerged from playtesting Conflict of Interest. The first of these is rule of thumb 5.

> Rule of Thumb 5: The avatar of the player can talk to themselves as a way of making a decision.

The avatar talked out loud about the different possibilities when there were no NPCs in the room and then decided on a course of action. This rule of thumb was actually used by the participants in their own Acts as a method of moving the plot quickly along.

In the first design of this Act the player was offered a bribe by a male in the shadows of their office's parking lot. Female play testers didn't feel comfortable with this and felt that they should be given the option to flee the briber. I changed the bribe character to be a well-dressed female to compensate for the threatening nature of a mysterious man accosting them in the parking lot and they reported it removed their reservations about it. This leads to the second rule of thumb coming out of Conflict of Interest.

> Rule of Thumb 6: Playtesting is the only way to reveal how players will react to the choices you enable them to make in the game [16].

In future versions of the Act it would also help the Act in terms of depth by having the boss take the bribe you aren't willing to and having the player need to deal with either confronting their boss about him taking a bribe after he overrides your decision or letting it work itself out.

Intellectual Property

Intellectual Property (shown in Figure 8) is actually both about using a rival's IP to gain a market advantage as well as trust in employees being a major concern when industrial espionage is a possible threat. The main NPC the player interacts with is a rogue employee who leaves the company for a rival company and then offers to give the player the rival's source code to accept him back. The NPC's dialog is written in such a way to make him appear untrustworthy and

arrogant. There are two major sets of subsequent choices that lead to four possible outcomes.

The player can either take the employee back or not. If he is taken back the player can either use

the source code and get busted by the rival company later on or not use the source code and be

burdened by the employee. If the player doesn't take back the employee they can either warn

their competitor about his activity leading to the second best outcome or wait for the competitor

to use the player's source code and sue them leading to the most successful outcome. As Figure 8

shows, over half of the players warned the competitor about the troublesome employee.
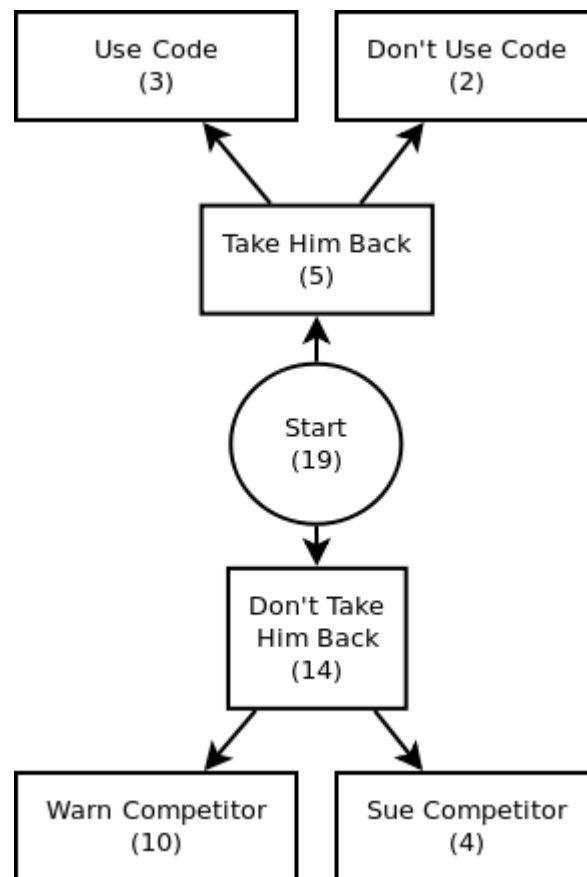
Figure 8 – Number of Pivotal Choices Made by Players in the Intellectual Property Act

This Act in hindsight illustrated the problem with having an end goal that was good, but not

the optimum outcome. Many of the players seemed to stop at warning the competitor assuming

that this led to the most lucrative outcome for the player's company when in fact suing was the

most successful outcome. This illustrates the problem of how to challenge players to explore all of the space without making all of the "non-optimal" outcomes negative ones. A possible solution would be to have alternative endings where only good results are shown when every other option is exhausted, thus rewarding the players for exploring the entire space hopefully not depressing them before they have an opportunity to explore all of it. Letter grades or scores could be assigned to each of the endings to clarify how good the ending they got was or the endings could be designed more like CYOA where there is often only one good ending with several other disappointments but this would take out the important and useful ambiguity of some of the Acts. In fact since this is a video game it could be edited to give negative results until all of the other possibilities were exhausted to motivate students to try out all of the possibilities. There could also be a reward system that would grade the players on their choices.

Computer Crime

Computer Crime (Figure 9) starts with the mystery of who has compromised the company computers and is using them for illicit purposes. The player has to a make a difficult decision about how to regain sole control of the computers for the company by resetting their root passwords, trying to catch the perpetrator in the act, or deleting and reinstalling all of the company machines. After this choice the three branches converge when it is discovered that a difficult employee was abusing the machines just because he could.

Computer Crime is a linear Act with no real variation in the outcome of the Act with one major pivotal choice at the beginning and then a dialog between the player and the employee. This allows for a longer Act than one that branches including a reintegration of all paths after the initial decision, a sort of consolidation so that all game plays allow the player to make the important decision, see the result, and finally have a conversation with the troublesome employee.
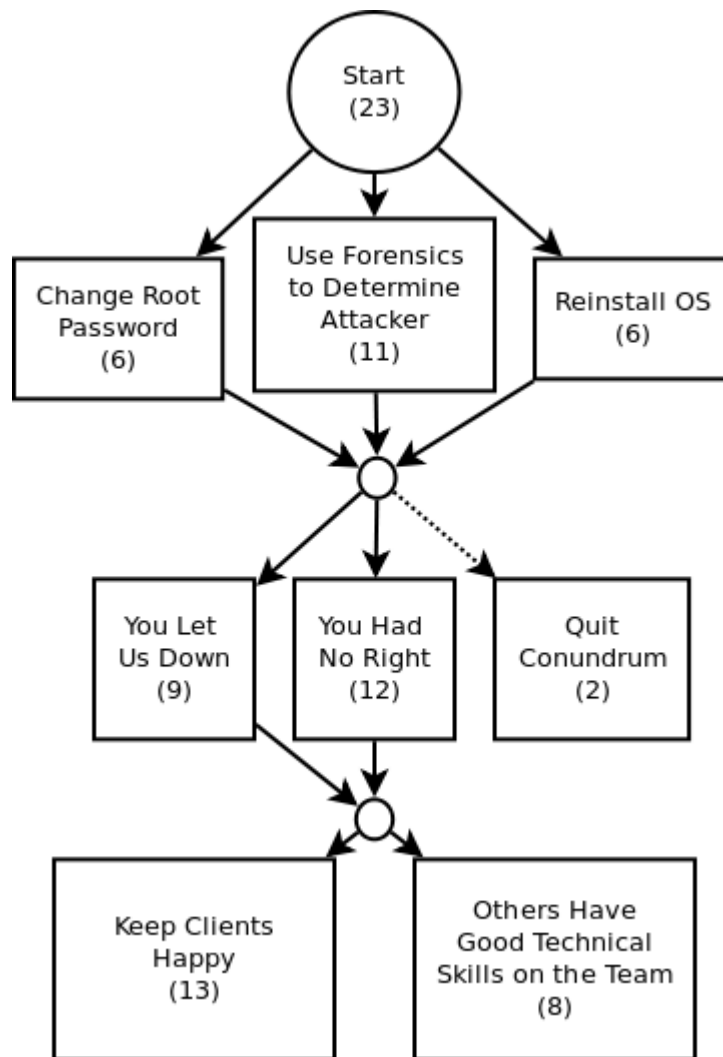
Figure 9 – Number of Pivotal Choices Made by Players in the Computer Crime Act

After it has been determined that someone has compromised the player's company computers, the initial choice is how drastic a solution to take to return control of the company's machines to their administrators while disturbing the company's productivity the least. The options the player has from the least drastic to the most are: should the player change the root passwords on all the machines and hope that is enough to stop the perpetrator (6 times played), should they use forensics to try to determine exactly who has gained access and how (11 times played), or finally

should the player reinstall all of the operating systems on all of the servers to make certain there is no compromise (6 times played). These different actions are arranged in such a fashion that they start off as least disruptive to the company's function and get gradually more disruptive but more likely to result in a successful outcome.

Regardless of which path players decide to take, the end of the Act is the player having a frustrating dialog with an employee who thinks his technical prowess puts him above reproach. It should be noted that this is the only Act where one player actually quit before the end of the Act. In particular it looks like the player wanted to know what happens depending on what initial choice is selected, so they first chose one option and played until the end, then they chose the second option and quit, and finally tried the third option and quit, without finishing the dialog with the annoying employee.

The character of the rogue employee was designed so that he would be smug and ignorant of the principle that all computer scientists will have to face: just because you have the technical prowess to perform something doesn't necessarily mean you should do it without thinking of the consequences to yourself and others.

The Computer Crime Act unlike the rest of the Acts is structured to be linear. Players intuitively know or discover which Acts are more linear with less branching or fewer nodes and spend less time on them. There are some pivotal choices but each of these flows into the same sink before continuing onto the next possible pivotal choice. The only game plays where someone quit right after making a choice was this Act. This participant played the initial interesting choice of determining whether to change root passwords, deploy forensics or reinstall everything, quit the game and then returned to try the rest of the options. In no other game play

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did people play a little bit of an Act until a pivotal choice and then quit. This evidence supports

the only Rule of Thumb in Computer Crime.

Rule of Thumb 7: Choices need to have actual impact in the game or else players may

become demotivated.

Table 1 – Rules of Thumb for Conundrum Acts

Rule of Thumb #	Description
Rule of Thumb 1	It is often useful to divide the Act into three parts: introduction, action and denouement.
Rule of Thumb 2	When your sole gameplay mechanic is making choices, you need to make those choices compelling to your players or you will expend energy creating unnecessary content.
Rule of Thumb 3	It is very important to craft the language of each Dialog of the Acts to encourage players to explore every branch.
Rule of Thumb 4	Using sub-issues increases the feeling of depth in the Acts without increasing their size combinatorially [31].
Rule of Thumb 5	The avatar of the player can talk to themselves as a way of making a decision.
Rule of Thumb 6	Playtesting is the only way to reveal how players will react to the choices you enable them to make in the game [16].
Rule of Thumb 7	Choices need to have actual impact in the game or else players may become demotivated.

Flashback

To further enhance the learning experience we added what we call a flashback sequence

for each instance so that players would be able to practise their ethics and social issues

Evaluation skills [3]. So after a player has finished playing an instance they are taken to a

flashback. The flashback sequence gives the player a controllable instant replay for them to

review their game play. It is like a comic strip of the game the player just played where they can

focus on only one panel at a time and each panel represents choices the player made or dialog

between stakeholders. This is a good way to scaffold learner reflection on what they have done.

Figure 10 is a flashback to the dialog in which the player engaged in the Security vs. Deadline Act. If the player wanted to move to the Dialog or choice that came before this current slide they would press the back button in the lower left corner of the current slide. If they wanted to advance the Act they would press the next button in the lower right corner of the slide. The player can spend as much time as they wish reflecting on any slide, and they can also quit at any time.
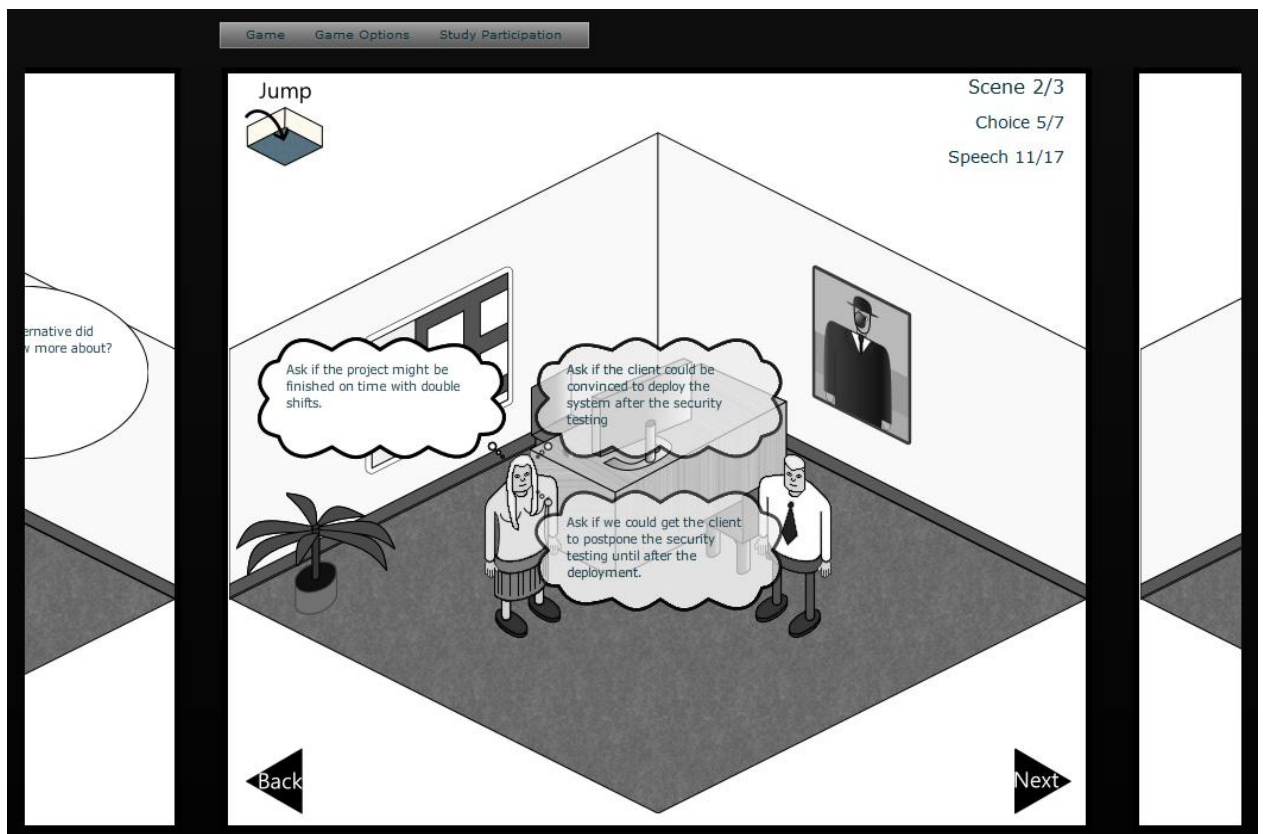
Figure 10 – Flashback with Dialog Options

You can see the choice the player made was "Ask if the project might be finished on time with double shifts." because that thought bubble is filled in with a white background and not a translucent one like the other choices "Ask if the client could be convinced to deploy the system after the security testing." and "Ask if we could get the client to postpone the security testing

until after the deployment." By allowing players to review their play they can be reminded of the choices that led to the conclusion of the Act. It also causes them to once again see the choices they could have made and reflect on where they might have led. If the player is curious enough about the possibility of an alternative choice, there is a Jump button in the top left corner of the central panel that, when clicked, takes the learner into a new game starting at this exact location in the Act. This allows them to quickly explore the Act as they navigate to different choices in the flashback and choose alternative branches to explore. The jump option, allowing the player to actually experience the consequences of other choices, provides an even deeper kind of reflection for the player.
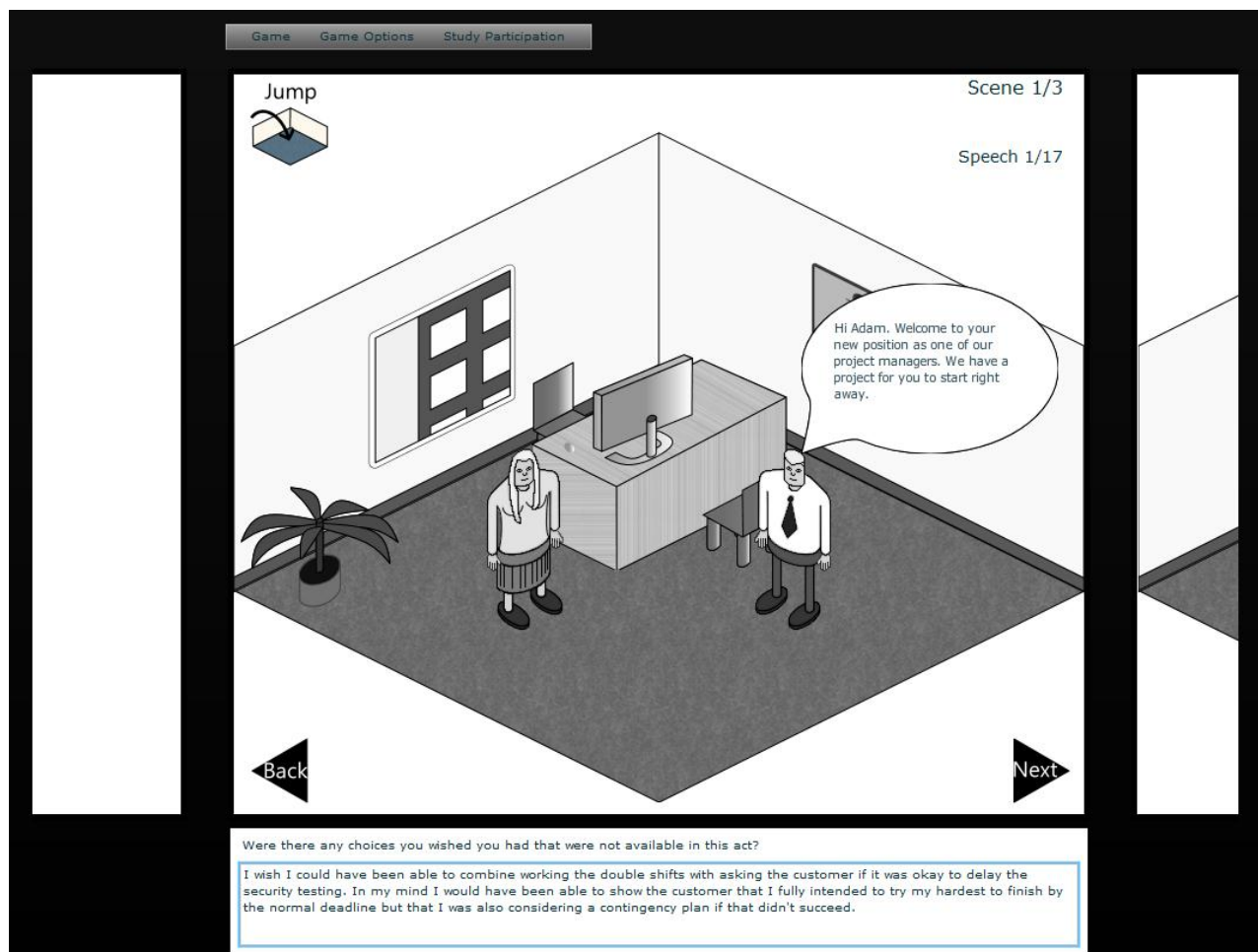
Figure 11 - Flashback with Question

Shown below the central panel in Figure 11 is a dialog box where players can be asked to Evaluate their play through using a probing question (which must, of course, be added in advance by the Act designer). The current Acts in Conundrum use this functionality to both ask general questions about the Act or specific questions about the current choice displayed. This capability was designed to allow the Act creator to challenge learners about how they make ethical and social decisions. The question box itself pops into view whenever the player arrives at a Dialog where there is a question, to make sure that the learners notice it.

The gameplay and flashback capabilities of Conundrum support both Application and Evaluation levels of Bloom's cognitive taxonomy for ethics and social issues. The third level of Bloom's taxonomy supported by Conundrum is Creation [3] through the Act Editor.

Act Editor

The earliest versions of Conundrum required direct editing of very long XML representations of the Acts. This required considerable time and effort to both build and alter an Act. For example making a change to a Dialog required exhaustive work to make sure that another piece of the Act did not depend on it. Also if errors began to creep into the text of the thought or speech bubbles one would have to systematically scan through the Act XML. It was also difficult to visualize the choice structure of the Act as it became more complex and the branches became more numerous. Also maintaining a list of unique ids for each of the Dialogs became cumbersome as two Dialogs in different scenes might be very similar but due to previous choices would ultimately have different results. The Act Editor is meant to help overcome these difficulties for the Act designer shown in Figure 12.
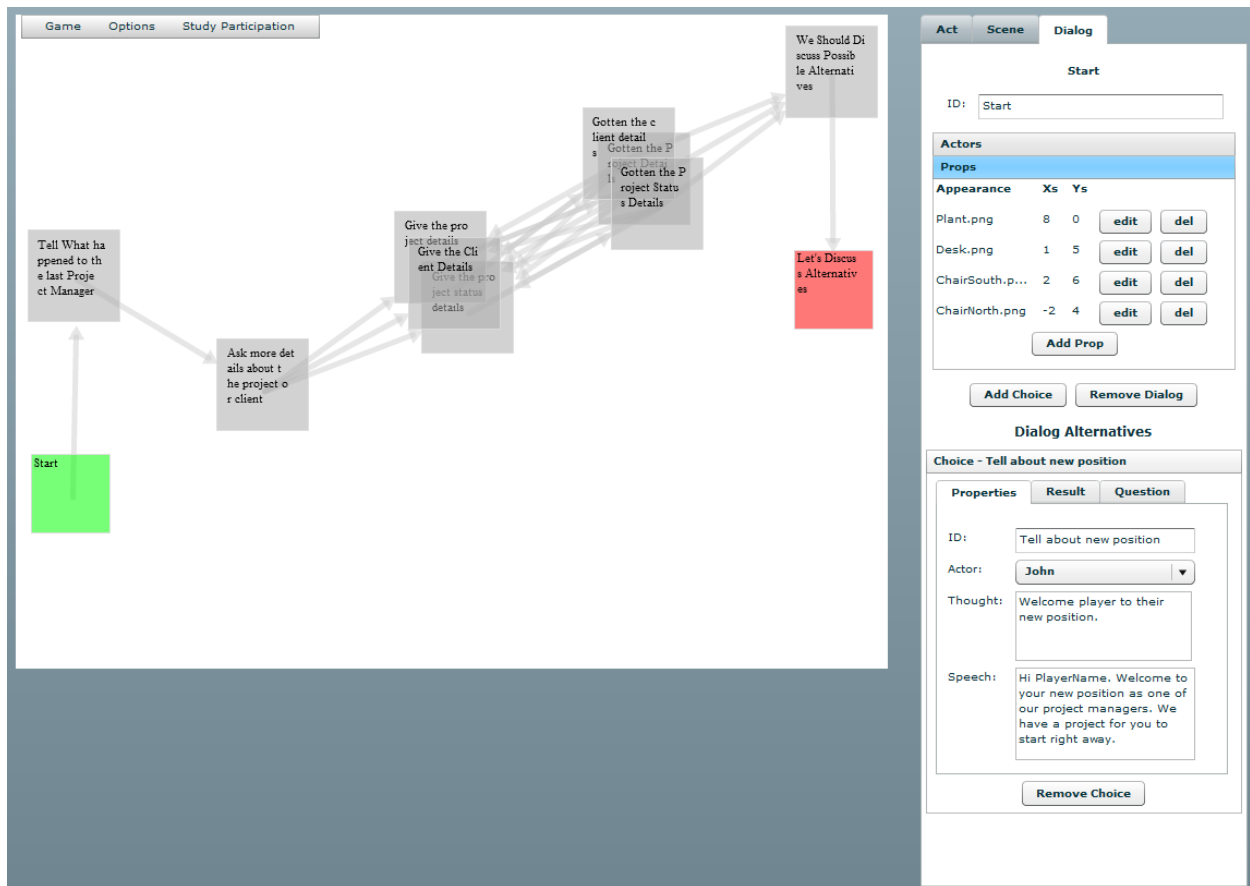
Figure 12 - Act Editor Choice Design

The graph based visualization on the left hand side of the Act Editor shows the designer

their Dialogs in the current Scene as boxes and the choices between these Dialogs as arrows

connecting them. Only one Scene is shown at a time and it is easy to create new connections that

are maintained and verified by the Act Editor. Conundrum Acts are graphs and so support

Dialogs that can lead back to a previous Dialog (i.e. graph cycles are allowed and shown). There

is a small physics based simulation underpinning the visualization allowing the Act designer to

move the Dialogs around with the edges acting as springs to keep them together allowing the Act

designer to organize them in the space depending on their purpose and not lose essential

connections. The start and end Dialogs for the Scene are color coded as green and red

respectively to clearly distinguish them from other choice nodes. Dialogs in the Act are attached to a particular NPC or the player's avatar.

The Act Editor allows a designer to create the setting for an Act using a graphical preview shown in Figure 13. The designer starts by creating actors that represent the NPCs the players will be interacting with. Different appearances are helpful for each NPC so that the player can keep track of each stakeholder involved in the Act. For each Scene that an Act designer creates she/he can specify the background for the setting. For example to represent a Scene taking place in the player's office, conference room, garage etc. they would choose a different image. She/he can also specify what and where the props of the setting (such as chairs, desks and plants) will be and also where the NPCs and the player will be standing or sitting in these new settings.
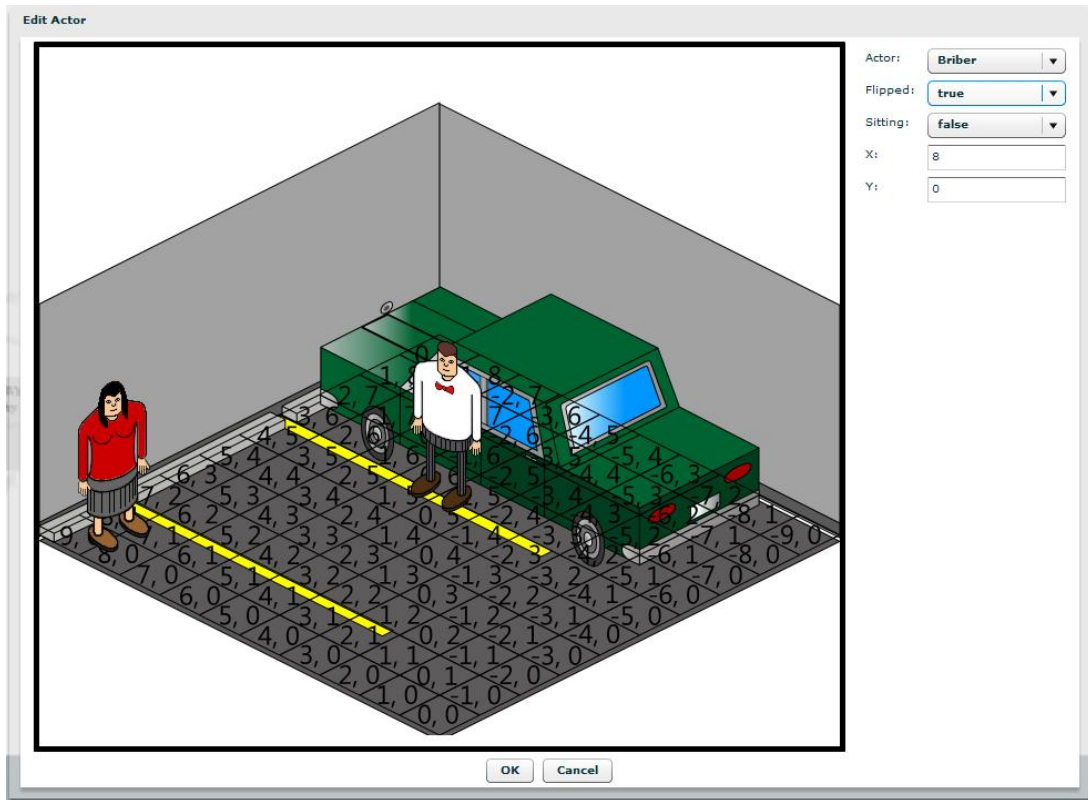
Figure 13 - Act Editor Actor Placement

Also if the Act designer uses the text "$PlayerName$" anywhere in the text for an Act, it is substituted for the name the player has assigned their avatar. This way authors can create a Dialog that refers to the player directly by name.

Just as in WRPGs (Western Role Playing Games), it makes sense to organize Acts by the choices that will dictate the outcome of the Act. I give these types of choices the name "pivotal choices" to distinguish them from the contextual choices that lead the player to better understand the context they are involved in. If the pivotal choices have been decided by the Act designer before using the Act Editor it only takes a couple of hours to move from an initial design idea into a playable version of the Act. To enable fast prototyping of creating Acts by default all choices have the result of ending the Act so that the Act is always playable even if an ending has not been designed yet or one of the choices not fully fleshed out. In this way the Acts can be iteratively designed through play testing [29] from the very start so that player input can be integrated into the design.

Building an Act requires deep thinking about one or more ethical, social and technical issues, as well as devising a context to explore the issues and the possible player responses to choices in a particular context. Allowing learners to design and build their own Acts using the Act Editor thus allows them to explore ethical and social issues at Bloom's Creation level. The Act Editor was designed to be easy enough to learn that students in an ethics and social issues course could reasonably be expected to use it to build their own Acts as a course project taking a few weeks at most.

CHAPTER 4
EXPERIMENT AND RESULTS

Experiment

Taking cues from video game industry design practises Conundrum was designed from the ground up with playtesting [16] to improve its chances of being effective. This meant a few prototypes were developed and thrown away to ensure that both the concepts for the game engine and the Acts were sound. During this iterative process necessary functionality was discovered and introduced into Conundrum. In the end four Acts were designed for students in a senior computer science social issues and ethics course to experience based on different topics from their syllabus including juggling security and deadlines, dealing with the perception of conflicts of interest, the perils of intellectual property and employees engaging in computer crime.

A study was then carried out at the University of Saskatchewan from February until April, 2010 to evaluate the Conundrum proof of concept prototype. The target participants for Conundrum were the students in the CMPT 408 – Ethics and Social Issues class. They were recruited in class (participation wasn't mandatory and they were able to use the complete system without participating in the study). Conundrum was integrated into the overall class in a few different ways. Students were introduced to Conundrum through a tutorial Act to help the students understand how to play Conundrum and to use the flashback. After that a sequence of Acts over several weeks were released that were pertinent to the issues being covered in class with release dates shown in Table 2. The topics covered by Conundrum were Security vs. Deadline, Conflict of Interest, Intellectual Property and Computer Crime. Later in the term the Act Editor was used by students to create their own Acts as the class project.

Table 2 - Release Dates for Acts

Act Name	Release Date
Tutorial	January 26th, 2010
Security vs. Deadline	January 26th, 2010
Intellectual Property	February 2nd, 2010
Computer Crime	February 9th, 2010
Conflict of Interest	February 23rd, 2010

Data Collected

The data that we have for Conundrum comes from three questionnaires (Appendix A) and captured usage data. There was a demographic questionnaire, a before use questionnaire and an after use questionnaire. Before the participants used the system they were required to decide whether they wanted to participate in the study and could change their status at any time. If they indicated that they wanted to be involved with the study, then they were asked to fill out both the demographic and before use questionnaires and their user data was captured. If they chose not to participate only record keeping data was captured by Conundrum to enable them to play the game and none of it was analyzed for research purposes. Of the 14 students who decided to participate in the study all of them filled out both of these questionnaires.

During the last couple of weeks of the study we asked the participants to fill out an after use questionnaire to help us understand where Conundrum succeeded and failed. Out of the possible 14 participants only 9 of them filled out the after use questionnaire.

Game Data

Conundrum was designed from the beginning to capture the activities of the players as they played the game. Captured events include starting or ending a game, starting or ending an Act, or starting or ending a Scene to give context to the smaller events. Thought bubbles were designed on purpose to expand or shrink as the users hovered over them so that the duration could be recorded as they read and considered each choice. We wanted to detect off-task behavior such as

checking email so that durations would remain meaningful. Such off-task behavior is called a "pause" in the game. Conundrum was able to detect when a student changed to a different tab in their browser or another application on their computer. It was also able to create another event when the student resumed playing Conundrum. You can see examples of these events in the game data in Appendix B. This, of course, does not capture other off-task behavior such as leaving the computer running Conundrum while engaged in some activity elsewhere.

There needed to be a cleaning process for the game data to eliminate noise. We rejected any games that were saved after players had played the last Act and had moved on to edit their own Acts so we could avoid capturing play that might be aimed at understanding Conundrum and not at understanding social issues. A total of 96 different "save games" were created by participants before the cutoff date. Of these 96 save games 15 of them were empty and didn't have any relevant data. Save games were considered empty and excluded from the study if there were no pivotal choices made and/or no time spent in the flashback.

An example of a save game being excluded is illustrated by one participant's instance of Security vs. Deadline. The participant loaded the save game they had played previously at the beginning of the Act, made a choice to "learn more about the client" and then quit. Perhaps the student wanted to review the details of the client but more likely they were testing the jump functionality.

Of the remaining 81 save games I also omitted those of the tutorial Act. There weren't any ethical choices to make in the tutorial, only information on how to use Conundrum's functionality. There were 8 tutorial Act instances played leaving a remaining 73 actual save games from which to extract and process data. 7 of the participants chose to dive right into playing Conundrum without trying out the tutorial Act.

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Flashback Data

The events recorded for the activities during the flashback are similar to the ones recorded for playing the game. There are events to record when the flashback starts; when the student moves onto the next slide in the flashback; when they move to the previous slide; when they jump into a Scene, Dialog or choice; and finally when they end the flashback. Unlike the game data, save games with no flashback data have still been kept and analyzed.

Act Editor Data

Detailed log data like that captured during game play and flashback use was unavailable for student actions undertaken during their use of the Act Editor due to ethical considerations. As a result the durations of precise activities are unavailable. What is available is the final version of each student Act, including its topic, the number of nodes it has, its graph structure and the endings it has.

Results

Given the data we were collecting and the objectives of the study, we were searching for evidence of participants having achieved Bloom levels of Apply, Evaluate and Create. The evidence for achieving Apply goals is in how they had played Conundrum. The evidence for Evaluate levels is if they showed that they had reflected on the choices they had made playing the game. Finally, the evidence for having achieved Create objectives is if they have created a novel Act in Conundrum with a deep and relevant ethics or social issue with enough challenge for the player.

Participants Achieved Bloom's Level of Apply

I define achieving Apply goals within a computer science ethics or social issues course as the learner exercising their ethics and social issue knowledge including making informed decisions about ethics and social issues. Within the context of Conundrum, evidence of this would be the learner making deliberate choices within Conundrum based upon what they have learned in the course across a variety of issues represented in each of the Acts. We don't have a direct measure of what they were considering in their minds at the time when they made their choices in Conundrum but a good proxy for this information is whether they spent more time than is necessary to just click through the Acts and that they played several Acts so that they were exposed to several different ethics and social issues. I consider learners to have achieved Apply goals if they have played at least 3 different Acts and spent at least 9 minutes playing Conundrum (3 minutes per Act).

Based on these criteria there were two distinct groups that played Conundrum, those that didn't exercise their Application skills and those that did. There were four Conundrum players who failed to experience what Conundrum had to offer and didn't really achieve Application goals (Table 3).

Table 3 - Participants Who Failed to Achieve Application Goals

Participant	Total Time (Mins:Secs)	Games Played	Play Activity
Participant 5	05:14	3	Played Computer Crime Act three times
Participant 12	08:04	3	Played Intellectual Property Act three times.
Participant 17	07:19	2	Played Intellectual Property Act twice
Participant 22	05:56	1	Played Computer Crime Act once

They all spent less than nine minutes playing the game and all of them only played a single Act. Only two of these participants left feedback in their post-test questionnaire and only one left actual feedback to the questions that I had asked. This makes it impossible to determine the specifics of why three of the participants didn't succeed in practicing Application skills. For the participant who did answer the post-test questionnaire the common thread throughout this participant's complaints about Conundrum was that there were not enough consequences to the actions made in Conundrum. In other games such as RPGs that they had played the time and effort invested in playing their character motivated them to protect their avatar and feel the gravity of making ethical and social decisions. They did appreciate that Conundrum exposed some of the ethical consequences to their actions for the decisions they had made, but they just didn't feel immersed because their avatar would have no real long term consequences because the Acts were over too quickly compared to a traditional RPG that lasts for many hours.

There was a group of 10 participants that seemed to achieve Application goals; they played at least three different Acts once and/or had much longer play times. They all spent over nine minutes playing and many of them played some Acts more than once. Participant 16 was different in that s/he only played two different Acts but spent a great deal of time playing them and carefully making her/his decisions. Although s/he may not have experienced as many of the issues as other participants did, her/his deliberate play suggests that s/he was serious about

making choices carefully. I don't think it was an inability to play games because s/he reported as being "Good" at video games and listed Call of Duty, a popular first person shooter, in her/his list of games played, a game that requires making ethical decisions and having excellent reflexes compared to Conundrum.

Table 4 - Participants Who Achieved Application Goals

Participant	Total Time (Min:Sec)	Games Played	Play Activity
Participant 4	09:41	3	Played Security vs. Deadline, Intellectual Property and Computer Crime all once.
Participant 7	13:39	4	Played Security vs. Deadline once, Intellectual Property twice and Computer Crime once.
Participant 11	14:01	3	Played Intellectual Property, Security vs. Deadline and Conflict of Interest once.
Participant 19	16:33	5	Played Intellectual Property twice and Computer Crime, Conflict of Interest and Security vs. Deadline all once.
Participant 20	17:51	9	Played Security vs. Deadline four times, Intellectual Property once, Computer Crime twice and Security vs. Deadline twice more.
Participant 6	17:11	6	Played Security vs. Deadline and Intellectual Property once. Played Computer Crime four times.
Participant 21	17:49	8	Played Intellectual Property and Computer Crime three times, and Security vs. Deadline twice.
Participant 16	21:26	2	Played Security vs. Deadline and Computer Crime once.
Participant 15	25:22	10	Played Computer Crime and Security vs. Deadline once, Intellectual Property three times, Computer Crime once more, Conflict of Interest once and Computer Crime three more times.
Participant 9	40:02	14	Played Security vs. Deadline four times, Intellectual Property and Computer Crime once, Conflict of Interest five times and Security vs. Deadline three more times.

Given these results this is an indication that the proof of concept Conundrum is effective at helping participants achieve Apply objectives without the drawbacks mentioned about role

playing (extra effort required of the instructor to mediate, non-participitory students ruining the experience for the others and favouring extroverts over introverts).

Participants Achieved Bloom's Level of Evaluate

Reaching the level of Evaluate in Bloom's Taxonomy for an ethics or social issues course involves reflecting metacognitively on ethics and social issue knowledge including how to make decisions about complex issues. In the context of Conundrum this would be reflecting on the choices made about the issues covered by the Acts. The flashback sequence was designed to help players reflect once a play through of an Act is completed.
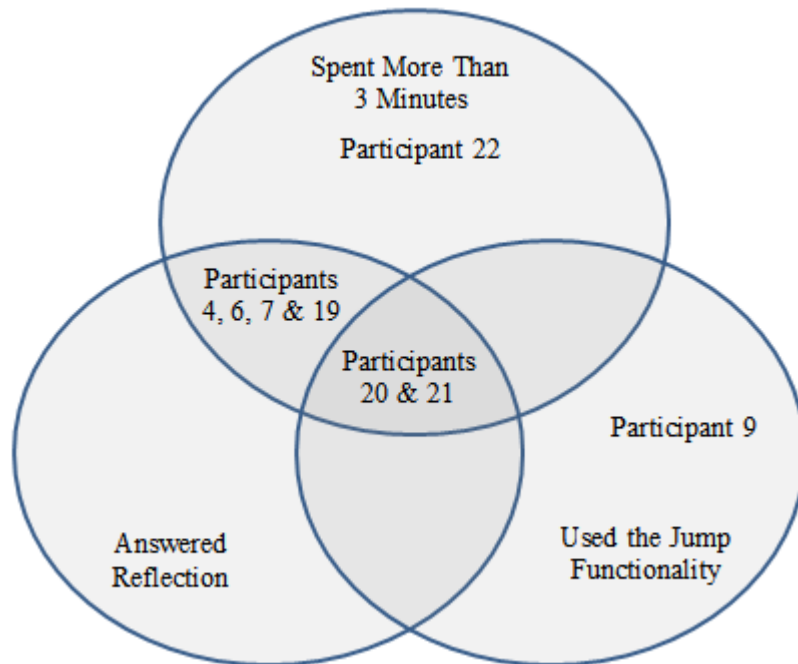
Figure 14 - Evaluation Goals Achieved by Participants

We cannot measure directly if they are reflecting on their choices outside of Conundrum. However, we can measure how long they spend looking at the flashback showing that they are revisting and thinking about the options that were available in the Act. I considered 3 minutes to be a long enough demonstration that they were reviewing their play through the Flashback.

There were also reflection questions that were asked in the Flashback sequence as a overt method of trying to encourage players to reflect on their play. The reflection questions were targeted at getting players to think either about a particular choice they had made or more generally how the Act concluded. Finally, the last evidence that showed that a player was participating in Evaluate activity was if they had used the Jump functionality to try out some of the alternatives to the choices they had made.

There were fewer participants who demonstrated Evaluation skills (8 show in Figure 14) than those who showed evidence of Application (10) of their ethics and social knowledge. 7 of the 8 players exercised evaluation skills by spending more than 3 minutes using the flashback system. 6 of the 7 who spent more than 3 minutes were spending some of that time filling out the reflection questions. The remaining 1 of the 8 players (the one who didn't spend 3 minutes in the flashback) exercised Evaluation skills using the jump functionality. 2 of the 8 participants used both the jump functionality and flashback (for longer than 3 minutes).
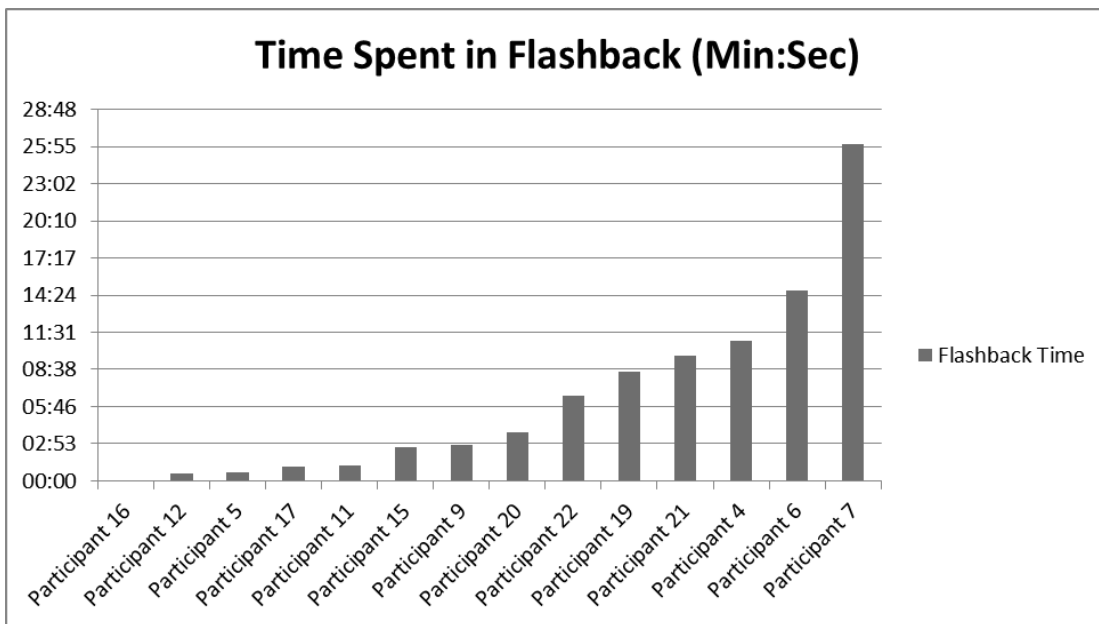
Figure 15 - Time Spent Using the Flashback System

Flashback Usage

As can be seen from Figure 15 there were a variety of uses for the flashback sub-system, ranging from not using it at all to using it for over 25 minutes. Only Participant 22 achieved Evaluation goals but didn't demonstrate success in Application goals (played only 1 game for almost 6 minutes) making her/him an oddity compared to the other participants and worth discussing individually. S/he only played one game of Computer Crime and was the most minimal user of Conundrum in terms of number of plays. For the twelve and a half minutes s/he spent playing Conundrum six and a half of those minutes were spent in flashback activity. None of this Evaluation time was spent answering the questions for the Acts or using the jump functionality. Instead s/he just spent the time looking at the results from this one instance. S/he only started playing right before it was time to start designing her/his Act which might account for the lack of plays and s/he may have played more in depth if given more time. S/he was also the only player to demonstrate Evaluation goals but not to answer any questions or use the jump functionality.

Flashback Questions

During flashback usage questions asking learners to reflect about a choice they made in the game would pop up from the bottom of the screen. Participants were not required to answer these questions before proceeding with the rest of the flashback or starting a new game. There were 6 players who answered questions in the flashback. Participants 4 and 19 only stated that if they had more perfect information about the details of the scenario or easier choices they might have made different choices but didn't really reflect all that much about the choices available to them.

Player 6 answered the questions in such a way to suggest that s/he was emotionally involved in the Acts showing that Conundrum has the potential to affect students emotionally [31]. There was one NPC called Jude in the Intellectual Property Act who was designed to be very arrogant

and unlikable. Player 6 referred to this character as a jerk twice while answering the flashback questions and when asked "Do you feel this was a fair ending considering the choices you made?" s/he answered without relation to the question, "I don't have any feelings for Jude". None of the other participants responded to the flashback questions in this way, but Conundrum had succeeded in achieving an emotional response from her/him with this character design which is encouraging given that this NPC was designed to model working with difficult and potentially unethical coworkers.

Participant 20 answered one of the Act reflection questions in an interesting way that revealed her/his strong beliefs about working overtime. S/he believed that overtime was never the correct thing to do and felt the Act suggested that skipping the security testing was unacceptable so that limited her/his options in Security vs. Deadline to talking to the client to get an extension. A result like this would be useful from the instructors' perspective because it would enable the instructors to understand some of the more fundamental beliefs of their students and allow such beliefs to be explored more in depth during class time.

Participant 21 cited one of the external readings (in the course) about patent trolls and their role in industry while answering a question in the Intellectual Property Act. S/he mentioned that although these companies do seem predatory, sometimes patents are the only thing protecting larger companies from stealing all of the ideas of new companies. This was an important demonstration of the player using ethics and social issue knowledge that they had acquired from the course being recognized as useful for Applying that knowledge in a difficult choice that they needed to make.

Using Jumps

There were three players who took advantage of the jump functionality and used it to determine what would happen at the end of the Act if a different final choice was made. All three

used the jump functionality on the Act Security vs. Deadline Act with Participant 9 and 20 using it to check to see what ending happened when the player paid, client paid or both shared the payment for a license of the software the client is currently using to bridge the gap in time while the player completes their software. Participant 21 first made a choice that resulted in the second best ending by offering to share the cost of the software license which leaves the manager of the player congratulating the player for keeping the client but warning that she could have lost the client with the bold move of suggesting to share the license cost. This ending may have motivated her/him to try to achieve a better ending. Participant 9 also used the jump option in the Conflict of Interest Act to see what would happen if s/he accepted a demotion instead of quitting when caught accepting a bribe. Therefore, participants used the Jump as designed to quickly jump to an interesting pivotal choice to try out another possibility, thus exercising their Evaluation skills.

During the post use questionnaire one of the participants intuited the purpose of the flashback sequence by responding that the aspect they most liked about Conundrum was "not being able to know if you made the right decision till you consider all the factors in each scene together... specially the flashback feature."

A majority of all the participants used flashback to exercise their Evaluation skills by examining what happened during their play, answering questions about the particular choices they made or using the jump functionality to try an alternative path through the Act. This shows that Conundrum is a pedagogical tool for enabling learners to practise their ethics and social issues Evaluation skills but needs modifications .

Participants Achieved Bloom's Level of Create

The highest level of complexity in Bloom's Taxonomy is Creation skills. Achieving Create goals in an ethics or social issues course involves synthesizing ethics and social issue knowledge

into new products that help students learn more deeply about their knowledge. So in the context

of Conundrum achieving Create skills is creating a new Act about a relevant ethics or social

issue that is covered in depth including multiple problems and solutions (i.e. paths with different

endings based upon what the player choses to do). Conundrum was designed to enable students

to create their own Acts through a tool called the Act Editor. This allowed them to use a

graphical structure to create new conversation trees so that they too could explore their own

ethical issues through creation.

Students worked in groups of 2 to create their own Acts, as part of the course requirements.

Eight of these groups (out of 9) agreed to allow me to examine their Acts after the course was

complete and the marks were allocated. Table summarizes some of the characteristics of the

Acts created by each of these 8 groups.

I identified four criteria to examine the groups' Acts to determine which were the most

complex, and to see if they were well designed enough to stimulate Creation skill learning. These

four factors were: (i) the number of nodes in the Act, (ii) the number of possible endings a player

could get, (iii) the complexity of the Act structure with a linear Act being the least complex and a

vastly branching Act being more complex, and finally (iv) whether the issue was a relevant, deep

and novel ethics or social issue. From these criteria three levels of complexity emerged in the

design of Acts showing a range from the simplest of Acts, to those of middle complexity and the

most complex outlined in Table , above.

The Simplest Acts

There were two groups (Group 1 & Group 2) that created the least complex Acts and did not

demonstrate Creation pedagogical goals due to their choice of topics. Both of these groups

picked issues that are very weakly social or ethics issues. Both of the groups chose very similar

themes to their Acts: the choice of either open source vs. commercial software (Group 1), or

cheaper and harder to train software vs. more expensive and polished software that their

employees were already familiar with (Group 2).

Table 5 - Player Created Act Details

Group	Nodes Count	Endings Count	Effectiveness of Ethics or Social Issue Topic
The Simplest Acts			
Group 1	69	11	Not really about an ethics or social issue, it is about technical trade-offs in commercial vs. open source software with a slight piracy angle if commercial software is chosen as the solution.
Group 2	57	7	Have to decide how much money to spend on a graphics engine for a game vs. how much time it takes to train developers.
Middle Complexity Acts			
Group 3	29	4	Setting database defaults can get the player in trouble. Nothing novel, copies Security vs. Deadline Act with talking to client.
Group 4	42	7	Player would benefit from using some of the code he wrote for work on a home project. Company tries to claim app as its own.
Group 5	37	4	The opportunity presents itself to use a competitor's source code to gain a market advantage. If the player decides to whistle blow it could ruin the player's life.
Group 6	115	4	Industrial spy paid to sabotage company by using company resources as a bot-net. Player must monitor employee activity but if there is too much monitoring the employees get mad.
Most Complex Acts			
Group 7	47	11	External hacker ruining company productivity but it appears that it is various employees. If the player jumps to conclusions she/he has to deal with sinking employee morale.
Group 8	126	9	Bullying in the workplace leads to the bullies leaking a mocking video that goes viral. Players experience multiple perspectives by taking on the avatars of a fellow employee who can or cannot participate in the bullying, experiencing it as the one being bullied, and acting as the boss trying to stop the bullying or as a lawyer trying to protect the company from a civil suit due to the video going viral.

Group 1 did include a sub-issue of piracy attached to choosing the more expensive software

that would have been interesting if explored more fully. The number of nodes for these Acts was

inflated due to their arbitrary branching around how expensive things were, not due to any

complexity in decision making as would be necessary for higher levels of Bloom. The player

would have to struggle with undertrained and unproductive employees or budgets spiraling out of control. Both of these Acts had similar endings of either spending too much money on software and hardware, thus bankrupting the company, or missing deadlines since the cheaper solution was not sufficiently suitable.

Middle Complexity Acts

There were four Acts whose complexity (according to criteria (i), (ii), (iii) and (iv)) makes them similar to the Acts produced originally for Conundrum except Security vs. Deadline. By creating these Acts four groups demonstrated that they exercised their Creation skills in ethics and social issues. There were many issues that these Acts covered including database defaults angering customers (Group 3), developing software at home using company software libraries (Group 4), whistle blowing because the company is going to use stolen competitor's source code (Group 5), and an external hacker ruining company productivity and employee morale (Group 6).

Group 3's Act explores the dangers of setting database defaults on behalf of a client. This is a good social or ethics issue to use as a Conundrum Act. However, the team that created the Act based upon database defaults failed to mention during it what exact defaults were contentious or how they would affect the customers to make them angry. This resulted in the Act lacking a driving motivation for why this issue needed to be fixed.

Group 4's Act starts with the player having a great idea for an application that would make her/him a lot of money outside of her/his job. The player realizes that using some of the standard libraries available at work inside of this application would greatly shorten the development time. It is also slow enough at work that the player has the opportunity to develop their application at work as well and has to wrestle with the notion of abusing company time on top of the resources. Of course, using company resources and time gets the player in trouble as they are risking their

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job and the application might be claimed by the company to be their intellectual property, as well, once the lawyers get involved.

Group 5 had a very small number of nodes in the graph compared to the other student Acts but they were used very effectively to expose some of the human consequences of whistle blowing. These consequences include the player's spouse leaving them if they do whistle blow and also being blacklisted from being hired by other companies in the future. If they decided not to whistle blow the player could end up in severe trouble stuck in court as a personal defendant in their competitor's lawsuit. If the player isn't careful with the lawsuit they will lose their spouse just as easily as if they had blown the whistle.

Group 6 is the last and most complex Act in this middle complexity group. It explored the risks of a possible workplace witch hunt. The player is a brand new system administrator for a company when suddenly the company's source control repository gets corrupted over and over again with all indications pointing at an employee. The player can take harsher and harsher actions to stop employees from corrupting the repository including firing them but it turns out to be an external hacker harming productivity and framing others. If the player has been too vigilant then employee morale suffers and future productivity will as well considering some of the star programmers were implicated.

The students building these four Acts achieved basic Creation-level pedagogical goals but didn't reach the same level of complexity as displayed in the next two Acts.

Most Complex Acts

There are two Acts that are far larger in terms of criteria (iii) than any of the Acts created for Conundrum and demonstrate an advanced level of Creation knowledge of social and ethics issues (criteria (iv)). They both have a surprisingly similar number of nodes and endings compared to the other player generated Acts (criteria (i) & (ii)). Where they separate themselves

is that they are each essentially composed of more than one Act. In the first one, Group 7's Act, there are two separate Acts as the player tries to balance monitoring employees that makes them unhappy versus trying to catch an industrial spy. Group 8 has four different Acts wrapped into one that allow players to explore bullying in the workplace from the perspectives of the different stakeholders involved in the bullying.

In Group 7's Act, the player is a brand new system administrator who needs to decide the level of monitoring he/she should institute to ensure that employees are performing work instead of goofing off. For the first Act the player chooses to make the monitoring too high, then employees start to complain and the player's job is on the line. In the second Act s/he instead employs a lighter version of monitoring, a new issue arises of someone using too much of the network. It turns out that one of the employees was paid by a competitor to deliberately sabotage the player's company by installing a bot net and making it look like the company was complicit in attacking others to discredit them and distract them with a court case.

Group 8's Act was the most complex, and epitomizes the ideal Creation goals of a Computer Science ethics and social issues course. The ethics and social issue is relevant; the content of the issue is based on a true story. The number of nodes far exceeds the number of nodes in the Acts in the original Conundrum and is more than four times greater than some of the student-generated Acts. Group 8's Act has a complex graph structure that is easy for players to navigate and novel in its design. It is really 4 Acts in one as the player gets to experience the situation from four different perspectives and roles.

The player starts off in the role of an employee who is witness to and can participate in the bullying of a new employee. This new employee is being bullied because he has blue skin and a distinctive way of talking due to an accent that is represented in the dialog. Whether the player

bows to peer pressure or not, her/his fellow employees have bullied this poor blue skinned

employee and have posted the results on a streaming video website which has gone viral.

The unique structure of the Act begins here with a hub of choices where the player can choose

from multiple roles resulting from this situation. The player can experience what it is like to be

the victim where all of their thought bubbles are standard text but their speech is modified with a

fictional accent as they try to deal with bullies. The player can be the prosecutor on behalf of the

victim trying to set precedents with the case to prevent this happening in the future. There is the

option of being the boss of the victim trying to stop the other employees from harassing this new

employee and dealing with the fallout when it becomes a serious lawsuit. Finally, the player can

be the ISP who has the video of the victimization on their service and is being sued for

contributing to the bullying by hosting this video for millions of viewers. This structure makes

the Act's design novel and highlights subtle complexities through the different roles. It is an

excellent example of how getting students to design their own game can serve their

understanding of the issues at the Creation level of Bloom's taxonomy.

Generally, apart from the two low-complexity Acts, the Conundrum authoring environment

has allowed students to explore social and ethical issues at the Create level of Bloom's

taxonomy.

Additional Results from the Conundrum Experiment

Participant Details

When participants used the system for the first time and agreed to participate in the study they

were presented with two questionnaires (Appendix A) that gathered details about them. The

demographic questionnaire targeted general information about them and their work and school

experience. The "before use" questionnaire asked them about their video game experience.

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Analyzing the answers to the questionnaires indicates that the sample of students for our proof of concept prototype have appropriate characteristics for the study. In particular the participants represented a good spread of ages (21-28), most had previous course experience related to computer science ethics and social issues (taking courses such as Political Science, Religious Studies, Philosophy, Sociology, Business and Women and Gender Studies) and most (10 out of 14) were not required to take the class as part of their program, implying they were motivated already to be interested in ethics and social issues before using Conundrum. Although females were underrepresented (at 3 learners out of 14) this is unfortunately typical for Computer Science classes. 2 students were pursuing the general honours degree program and 7 were pursuing the 4 year program, meaning that they were taking the ethics and social issues class as an elective. The remaining four students were pursuing four year software engineering degrees which do require taking the ethics class. Of these four software engineering students three of them had taken other courses related to ethics suggesting an interest in ethics and social issues. However, the remaining participant that was required to take the class but reported no previous ethical experience turned out to be the heaviest user of the system (Participant 9) in terms of time spent and number of games played. This means that we have a good diversity in terms of age and most people didn't need to actually take the class, and those that did either spent a large amount of time in Conundrum or had taken other ethics and social issues classes.

Conundrum is Equally Suitable for Novice and Expert Gamers

A major goal for Conundrum as a pedagogical solution is that it would be accessible for those who are unfamiliar with video games and don't use them regularly as a leisure activity. Based upon participants' self-reports, they can be divided into two different groups: novice and expert gamers. For the purpose of this thesis I will define novices as those who reported that they either

play 0-1 hours per day or report themselves as not very proficient. Expert gamers are designated

as those who report that they play 1-3 hours per day and are proficient. It was a fairly even split

of participants with 6 novices and 8 experts. Therefore, we have a good complement of heavy

and light gamers. Table describes the Conundrum play of the novices. Table does the same for

the experts. In the tables the first column is the Number of Plays (over all Acts), meaning the

number of instances that a participant played Conundrum Acts. The Time Spent Playing

Conundrum is the total time spent in the gameplay component of Conundrum making decisions

among the choices. The Time Spent Reflecting in Flashback column is the combined amount of

time that learners spent looking at the flashback sequence, making jumps into different parts of

the Act and answering reflection questions. The Total Time Spent in Conundrum is the sum

between the time spent playing and reflecting in Conundrum. Considering there is a good

mixture of novice and expert gamers and the averages aren't too far apart this seems to indicate

that not too much will need to be changed for Conundrum to accommodate gamers and non-

gamers alike. It should also be noted that in the post-test questionnaire none of the participants

complained about the Conundrum interface being inaccessible to them.

Table 6 – Novice Gamer Gamplay Statistics

Participant Number	Number of Plays	Time Spent Playing Conundrum	Time Spent Reflecting in Flashback	Total Time Spent in Conundrum
Participant 4	3	00:09:41	00:10:51	00:20:32
Participant 6	6	00:17:11	00:14:43	00:31:54
Participant 12	3	00:02:41	00:00:11	00:02:52
Participant 15	10	00:25:22	00:02:39	00:28:01
Participant 16	2	00:12:16	00:00:00	00:12:16
Participant 19	5	00:16:33	00:08:27	00:25:00
Average	4.83	00:14:51	00:06:13	00:21:04
Total	29	01:29:07	00:37:15	02:06:22

Table 7 – Expert Gamer Gameplay Statistics

Participant Number	Number of Plays	Time Spent Playing Conundrum	Time Spent Reflecting in Flashback	Total Time Spent in Conundrum
Participant 5	3	00:05:14	00:00:39	00:05:53
Participant 7	5	00:13:39	00:26:06	00:39:45
Participant 9	13	00:40:02	00:02:47	00:42:49
Participant 11	3	00:14:01	00:01:11	00:15:12
Participant 17	2	00:07:19	00:01:08	00:08:27
Participant 20	9	00:17:51	00:03:45	00:21:36
Participant 21	8	00:17:49	00:09:43	00:27:32
Participant 22	1	00:05:56	00:06:38	00:12:34
Average	5.5	00:15:13	00:06:30	00:21:44
Total	44	02:01:51	00:51:57	02:53:48

Participant Game Experience

Out of the 14 participants that responded 10 actually had some experience with CRPGs and their ethical components including both experts and novices. The CRPG games listed include Bethesda games *Fallout 3* [35] [38]*, Morrowind* [8] and *Oblivion* [8], the BioWare games *Baldur's Gate* [31], *Knights of the Old Republic* [31] [35], *Mass Effect 1 & 2* [31] [35], and *Dragon Age* [35], and Black Isle Studio's *Fallout* [31] where the ethical decisions take place in conversations with NPCs and result in players making ethical choices.

Games students reported playing in other genres besides CRPGs were *Heavy Rain* created by Quantic Dream [27], *Bioshock* [31] [35] by Irrational Games *Radical Dreamers* by Square Enix [30], *Phoenix Wright* [12], and *Call of Duty* [1]. One participant also reported playing *Sim City* [31] [35] (an urban planning game) as an ethics and social issue game but there are no ethical mechanics besides what the player attributes to their own actions (the player can destroy the city with natural disasters but this is not blamed on the player). One participant felt that role playing

in a drama course led to insights into ethics and social issues. The participants seem to have a wealth of experience of games with ethical and social issues components.

Summary of Results

There were many good results from this experiment about the effectiveness of a serious game to aid learners in experiencing ethics and social issues. When using Conundrum, there was strong evidence that learners achieved Apply and Create levels of Bloom's Taxonomy by playing and designing Conundrum Acts. There was weaker evidence that learners achieved Evaluate goals of Bloom's Taxonomy by using the flashback sequence after playing.

The participants who played Conundrum were typical Computer Science students. Players had played a wide range of video games from a variety of genres with some aspect involving ethics and social issues. Both novice and expert video game players were able to experience Conundrum with little difference in activity between the groups.

CHAPTER 6
CONCLUSION AND DISCUSSION

Conclusion

Computer Science ethics and social issues is a difficult subject to teach but it is extremely important that computer science students understand how ethics and social issues can affect themselves, the people around them, and society at large. Current methods of teaching this subject using ethical frameworks, presenting expert testimonials, case studies and role playing do a good job at enabling students to practise the lower levels of Bloom's taxonomy: Knowledge, Understanding, Analysis and Application. However, for the Application, Evaluation and Creation levels of Bloom, essential to more deeply understanding social and ethical issues, something else is required. Serious games, where students can be immersed in realistic situations with ethical and social dimensions, make their own decisions, evaluate the consequences of their decisions and create their own dilemmas, will fulfill such a need.

Conundrum is a serious game designed for these requirements. It was tested in a proof of concept experiment held in conjunction with a Computer Science professional ethics course at the University of Saskatchewan. Conundrum was accessible to both video game novices and video game experts and there didn't seem to be any difference in how accessible the game was to them. Video games in general have used ethical dilemmas for many years to add depth to their play and the vast majority of the learners who played Conundrum had experienced at least one of them.

This thesis has also described the pedagogical success Conundrum had helping students to practise Apply, Evaluate and Create skills of Bloom's Taxonomy. In particular the game play enables learners to practise their Application skills by making good and bad decisions in a safe

environment that gives them feedback about how they are doing. The majority of players played more than 9 minutes of gameplay and experienced more than a single Act demonstrating their ability to Apply ethics and social issue skills. Scaffolding has also been added to the post-play experience so that learners can practise Evaluation skills on the gameplay they have just performed enabling them to Evaluate their ethics and social issue decisions in a single play through in Conundrum. A majority of players demonstrated using Evaluation skills through playing the flashback for long enough, answering reflection questions or Jumping to particular parts of the Act. Further, game design tools that are easy to use allowed students to achieve Creation goals by having them create their own game content. There were three categories of Acts ranging from least to most complex created by the learners. In the least complex Acts, issues were explored that weren't really ethics or social issues in Computer Science and these issues were treated quite shallowly. There were the middle complexity Acts whose topics were ethics or social issues and whose graph complexity was as good or better than the three simpler Acts designed for Conundrum. Finally, there were the advanced Acts designed by the student groups that were more complex than almost all of the Conundrum Acts prepared for them.

Future Research

Due to Conundrum being a proof of concept prototype there are several potential avenues of research leading from the design of Conundrum to new opportunities for instructors and students. There is the potential for development and usage of an open learner model for instructors and learners. New Acts could be developed for Conundrum to support learners in other domains than computer science ethics and social issues. There are multiple dimensions that Conundrum could be augmented to support social interactions between players. Finally, Conundrum could be altered to explore static or systemic ethics systems instead of adaptive.

Develop and Deploy a Model of Student Participation in Conundrum

One of the weaknesses of the proof of concept is that instructors and learners don't have feedback about their progression through the content available and how they are approaching the content. Ideally, it would be useful to have metrics that are automatically calculated and presented to both instructor and learners using Conundrum. Based upon the proof of concept study there are 4 useful metrics including: (i) how many issues learners have been exposed to (the breadth of the issues), (ii) how in depth they have approached the issues, (iii) that they have spent enough time on the issues and (iv) that they have spent some time reflecting on the Acts.

 (i) Breadth - Number of Issues a Participant has Explored

The first metric for student participation in the system is the proportion of Acts that a student has experienced from beginning to end. A higher proportion indicates an exposure to many issues. So the higher percentage this number is, then the more the participant has experienced issues through Conundrum. There were 4 Acts available in Conundrum so a player could achieve a breadth score of 0%, 25%, 50%, 75% and 100% depending on whether they finished at least one play through of, respectively, no Acts, 1 Act, 2 Acts, 3 Acts or all of them. Figure 15 shows the proportion of Acts the players have completed.
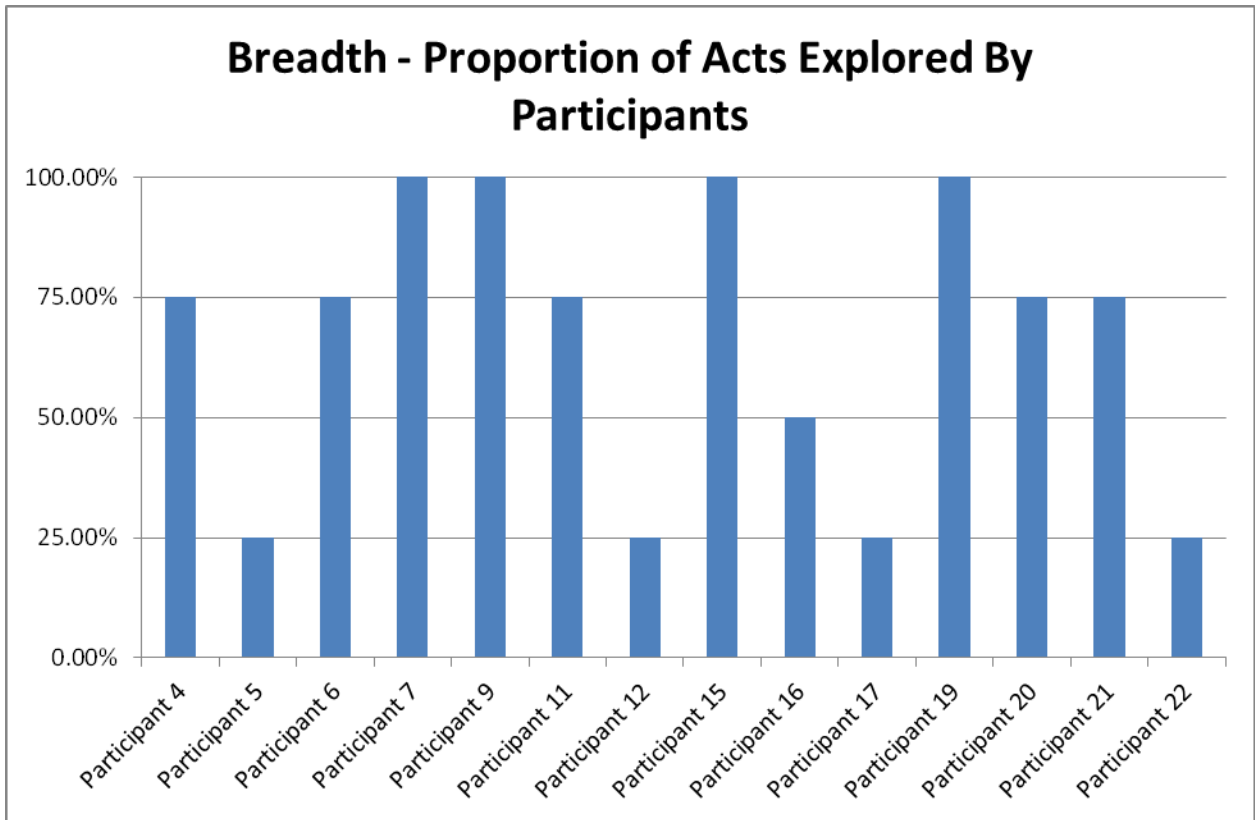
72

Figure 16 – Breadth – Proportion of Acts Explored by Participants

(ii) Depth – Number of Choices a Participant has Explored

In contrast to the breadth across Acts, a second effective measure of participation of students in the system is the depth a participant has explored various pivotal choices within a single Act. The depth is defined to be the proportion of pivotal choices explored by a participant within an Act. This shows a player's exposure to the many facets of an issue that are explored in a Conundrum Act. So a participant who has not played an Act will have a depth of 0%. If a participant has only made 1 of the 3 pivotal choices within the Act then 33% will be his or her depth. Finally if a participant has explored all pivotal choices within an Act then s/he will have a depth of 100%. Shown in Figure 17 is the depth score of each Participant in each Act. For example Participant 5 was able to explore all of the pivotal choices for the Act resulting in a

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score of 100% for Computer Crime but failed to play any of the other Acts resulting in a depth
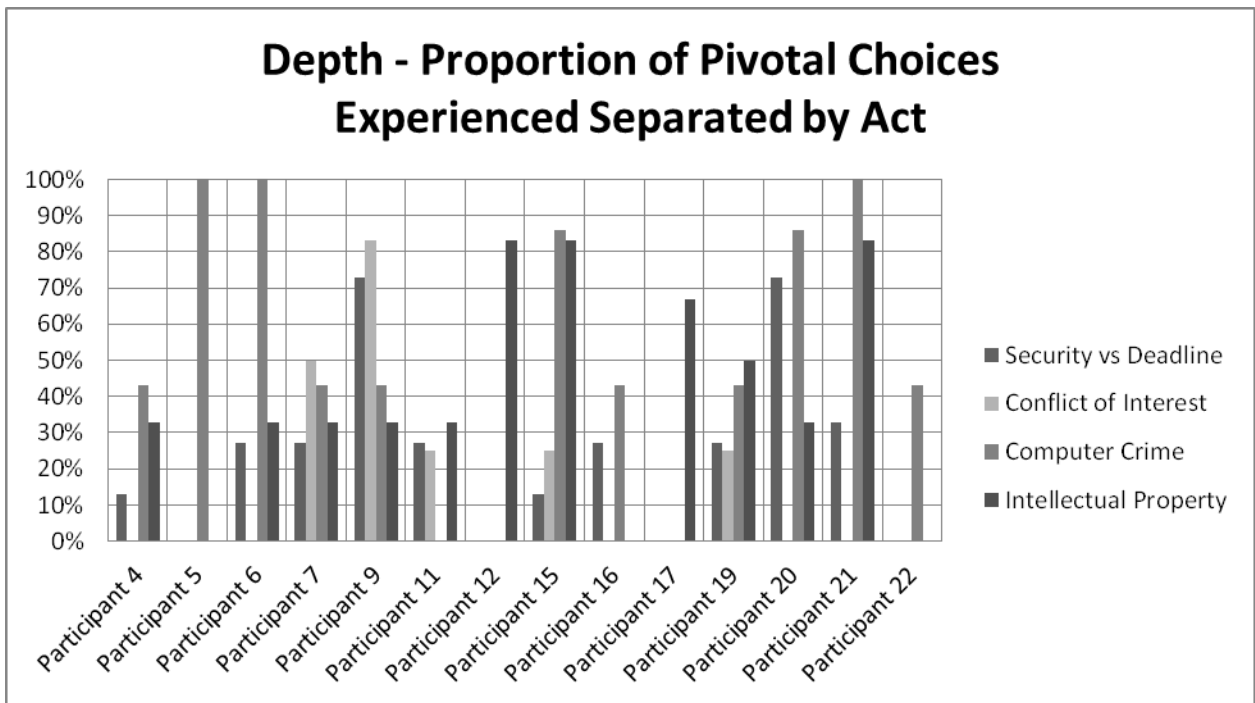
score of 0% for the remaining 3 Acts.

Figure 17 - Depth Percentage Separated by Act

The maximum value of depth (Figure 18) across all Acts for each participant is a measure of

how deeply a participant has explored a single issue (in contrast to the breadth across all issues

discussed above). A maximum is chosen because we want this metric to indicate how well a
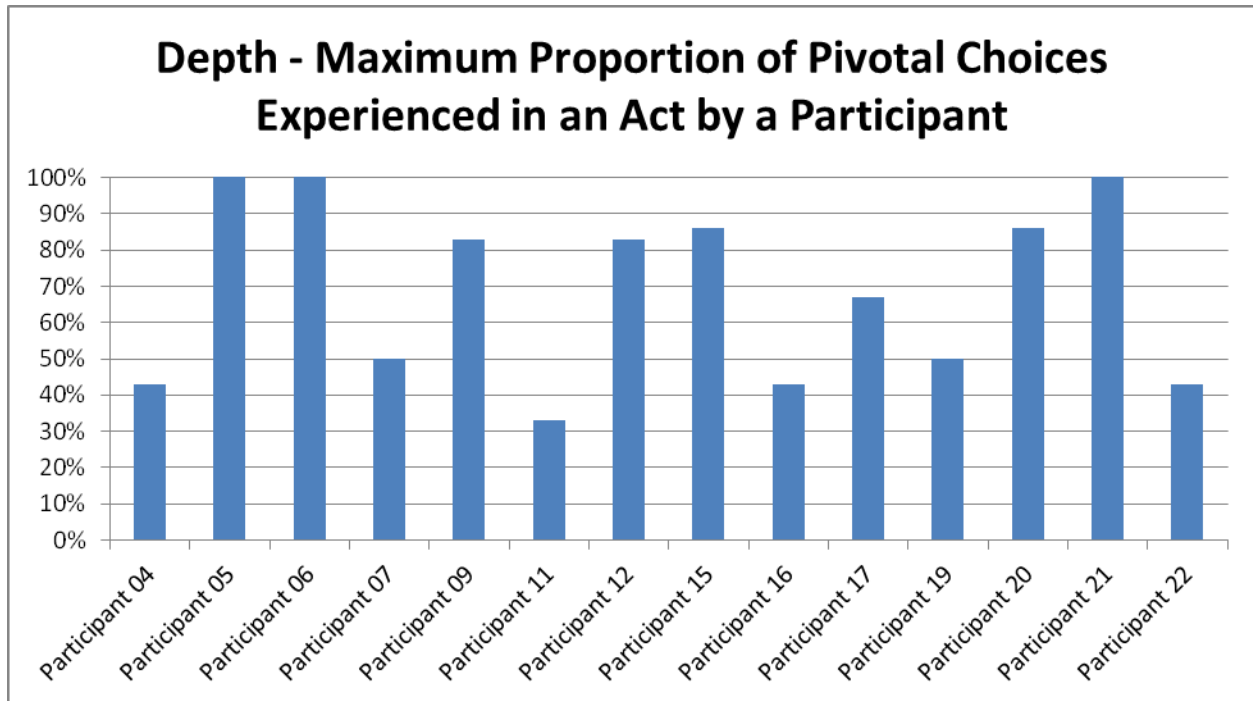
player has explored a single Act.

Figure 18 - Percentage of Max Depth Explored by Participants

(iii) Relative Usage of Conundrum by Time Spent Playing and Reflecting

Relative usage (Figure 19) is the ratio of the time spent by a participant divided by the most active participant (in Conundrum this includes both game and flashback time). Relative usage is used to both filter out those who are just randomly click and to acknowledge those who spend more time thinking about the choices they are making. For example if two players have the same breadth and depth relative usage would show who was taking longer to examine their choices. This would be trained over time so that it would include old participants of the system so that it would more accurately reflect their participation particularly in smaller groups and when the year first starts and everyone hasn't really participated all that much. So for this sample Participant 9 rates at 100% because s/he used the system for the longest and Participant 5 who only played the one Act is down at the bottom at just over 10% of Participant 9's usage. This metric is useful to determine whether or not a learner simply clicked through the different options without reading and contemplating their choices.
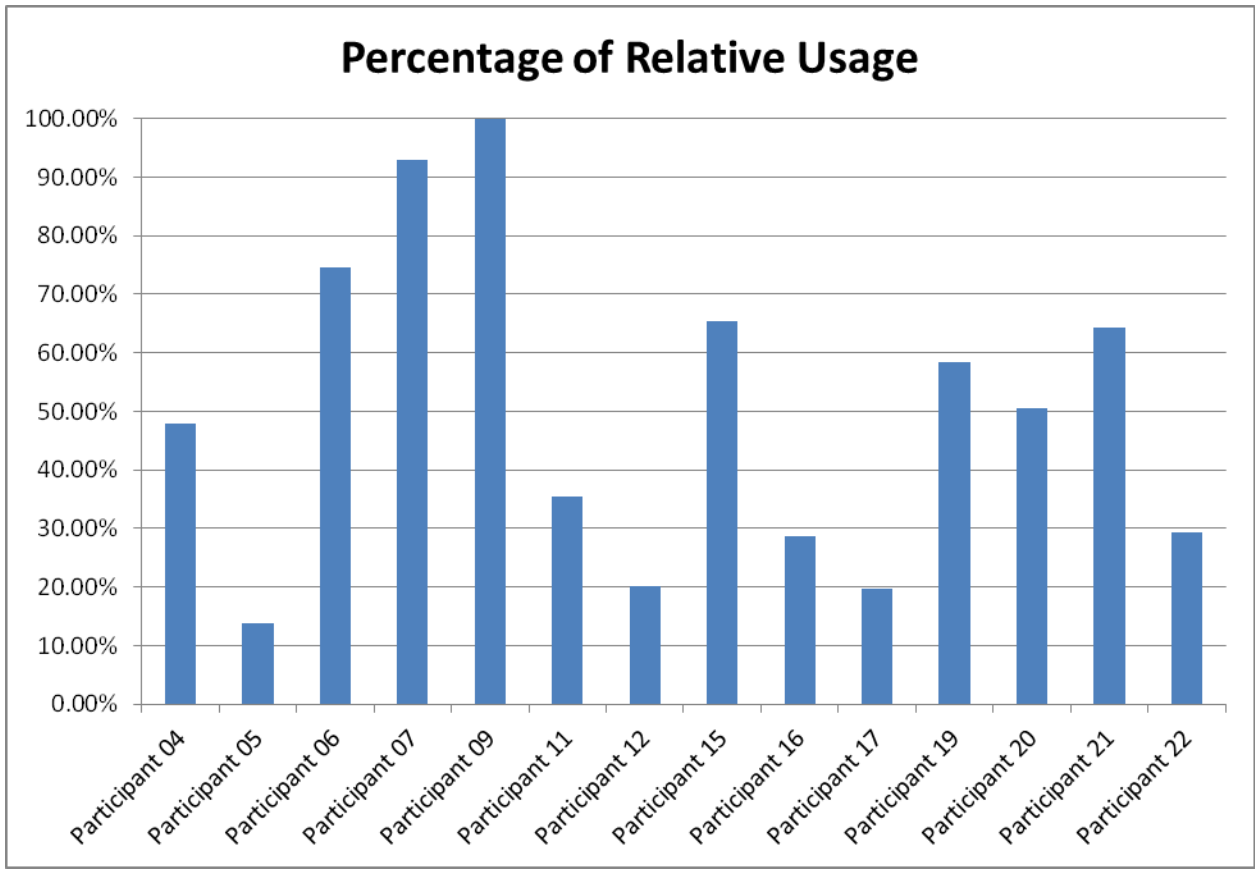
75

Figure 19 - Percentage of Relative Usage

(iv) Flashback vs. Gameplay Proportion of Time

Another aspect of worthwhile student activity is for them to spend a significant amount of time reflecting about their play through the flashback and answering flashback questions. So the next measure is to see what ratio of the time spent in Conundrum was in the flashback sequence compared to the total amount of time (includes both game and flashback time). Figure 20 shows the ratio of time that each participant spent in the flashback compared to the total amount of time they spent (the only other time would be gameplay time). Participant 7 had the maximum score of 65% of his/her time spent in the flashback and Participant 16 had the least amount of time spent in the flashback with a score of 0%.
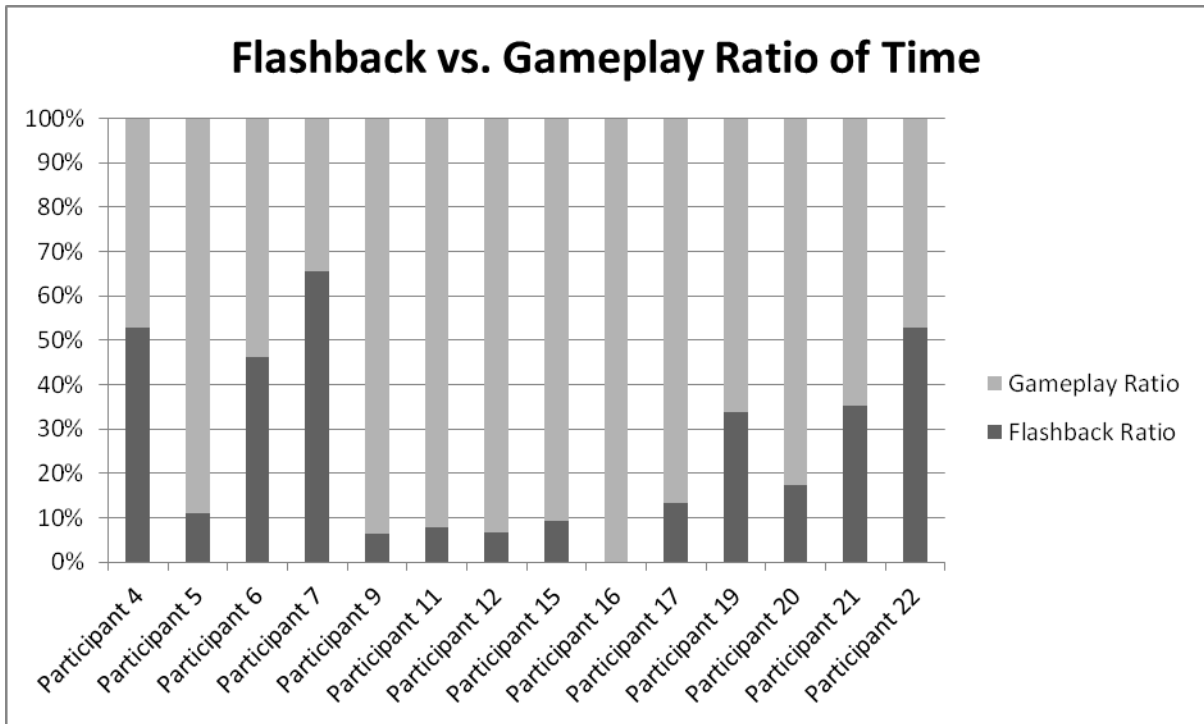
76

Figure 20 - Ratio of Time Spent by Participants in the Flashback Sequence

Allowing the Instructor and Learners to Visualize the Metrics: Opening the Student Model

Now that the four metrics are established the next step is designing a way that they can be visualized by instructors and learners so that they can understand their progress through the ethics and social issues available through Conundrum Acts. Combining all of the preceding metrics ((i) breadth, (ii) depth, (iii) relative time spent and (iv) flashback ratio percentages) together into a radar graph for each participant shows a proposed open learner model in Figure 21. These radar graphs show the percentage that each participant has achieved in each dimension giving the viewer a quick overview of that participant's activity. Each of the 5 lines on the graphs represents 20% out of a possible 100% for each dimension. For example Participant 16's relative time spent is half way between the 1st and 2nd line from the centre so his/her score is 30%. S/he didn't spend anytime in the flashback so the value of the flashback ratio is 0%. His/her depth score is two lines from the centre so that is 40%. Finally, his/her breadth score is

between the 2nd and 3rd line so it is a score around 50%. The major benefit of these visualizations is that the instructor can quickly discern a participant's scores in multiple dimensions and can compare one participant with another quite easily. Comparing Participant 16 with Participant 17 the instructor could see that Participant 16 spent more time overall, spent less time reflecting in the flashback, had a lower depth score and had a higher breadth score than Participant 17.
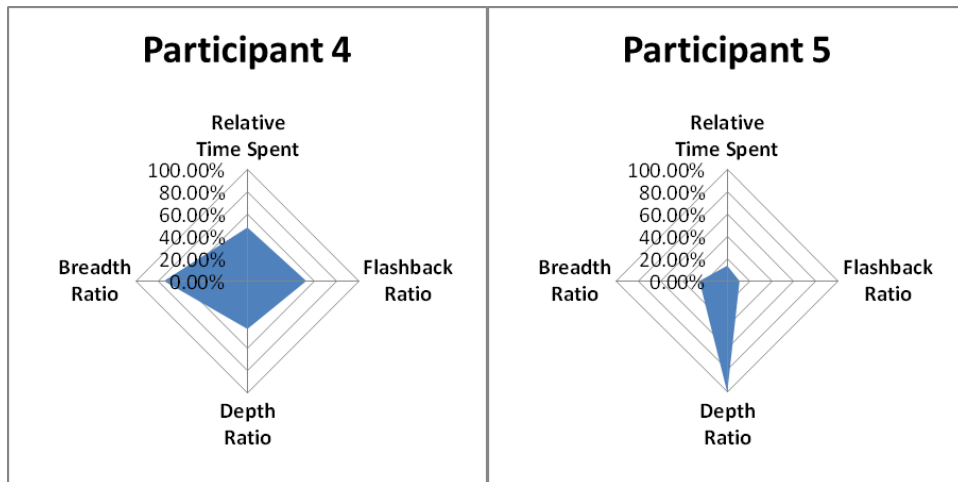
The instructor can draw many other conclusions from these radar graphs, many of which could form the basis for feedback to the students. Some of these are discussed in the remainder of the section. Participants 5, 6, 12, 17, 21, and 22 are depth players (players who are focusing more on exploring a single issue than on experiencing all of the issues). It would be beneficial to encourage these students to branch out and try other Acts next time they played so that they would experience a greater range of issues. Participants 4, 7, 9, 11, 15, and 19 are a group of students that focused more on breadth than on depth. The focus of potential rewards should be to lead these students to try out some of the alternatives that the Acts have to offer. Participants 16 and 20 were almost equal in breadth and depth making them unique cases where rewards should not be focused on increasing their breadth and depth scores. Instead in game rewards should be focused on encouraging them to spend more time playing or reflecting.

The relative time spent is an important metric for the instructor to get a sense of whether the student actually spent time experiencing the Acts or only clicked on the alternatives as quickly as possible to finish their experience. Participants 5, 12, 17 and 22 didn't spend very much time relative to their peers and should be encouraged through rewards to spend more time in Conundrum.
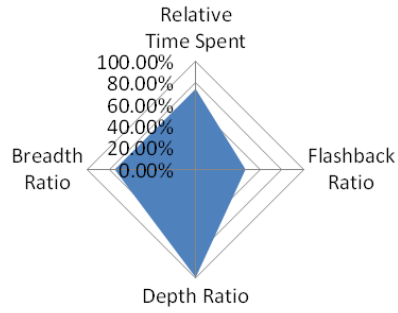
The players that exhibited a high level of reflection time through using the flashback compared to gaming time shown by the radar graphs are Participants 4, 6, 7, 19 and 22. The

instructor should find ways to channel the other participants towards answering more reflection questions and using the flashback to review their play.

These radar graphs are both useful for the instructors and learners in an ethics and social issues course. The instructor can assess the learner's created Acts by playing them and judging them relative to their peers, previous years and the basic quality of the Act. Conundrum Acts could also be assigned as homework and used as a point of discussion during class time as a way of assessing whether learners were actually playing and reflecting on the Acts earnestly. However, it would be useful to have a tool available in real time to facilitate the instructor being able to judge those learners who have put in the time to experience the Conundrum Acts. These radar graphs could be used to help instructors know how their students are progressing through Conundrum. It would also enable instructors to require students to attain a certain level of participation in the games by certain dates. The learners would benefit from having a good understanding of what is expected of them.

Participant 6

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth Ratio

Participant 7

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth Ratio

Participant 9

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth Ratio

Participant 11

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth
Ratio

Participant 12

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth Ratio

Participant 15

Relative
Time Spent
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%

Breadth
Ratio

Flashback
Ratio

Depth Ratio

Figure 21 - Relative Time, Flashback vs. Gameplay, Depth and Breadth Ratios for Each Participant

Using Conundrum in Other Domains

There is nothing about the design of Conundrum that constrains it only to be used for computer science ethics and social issues; it could be used for ethics and social issues for any domain where making choices and having dialogs is an important aspect of learning by doing. For example in an ethics philosophy class Acts could be created with NPCs representing philosophical figures such as Aristotle, Plato or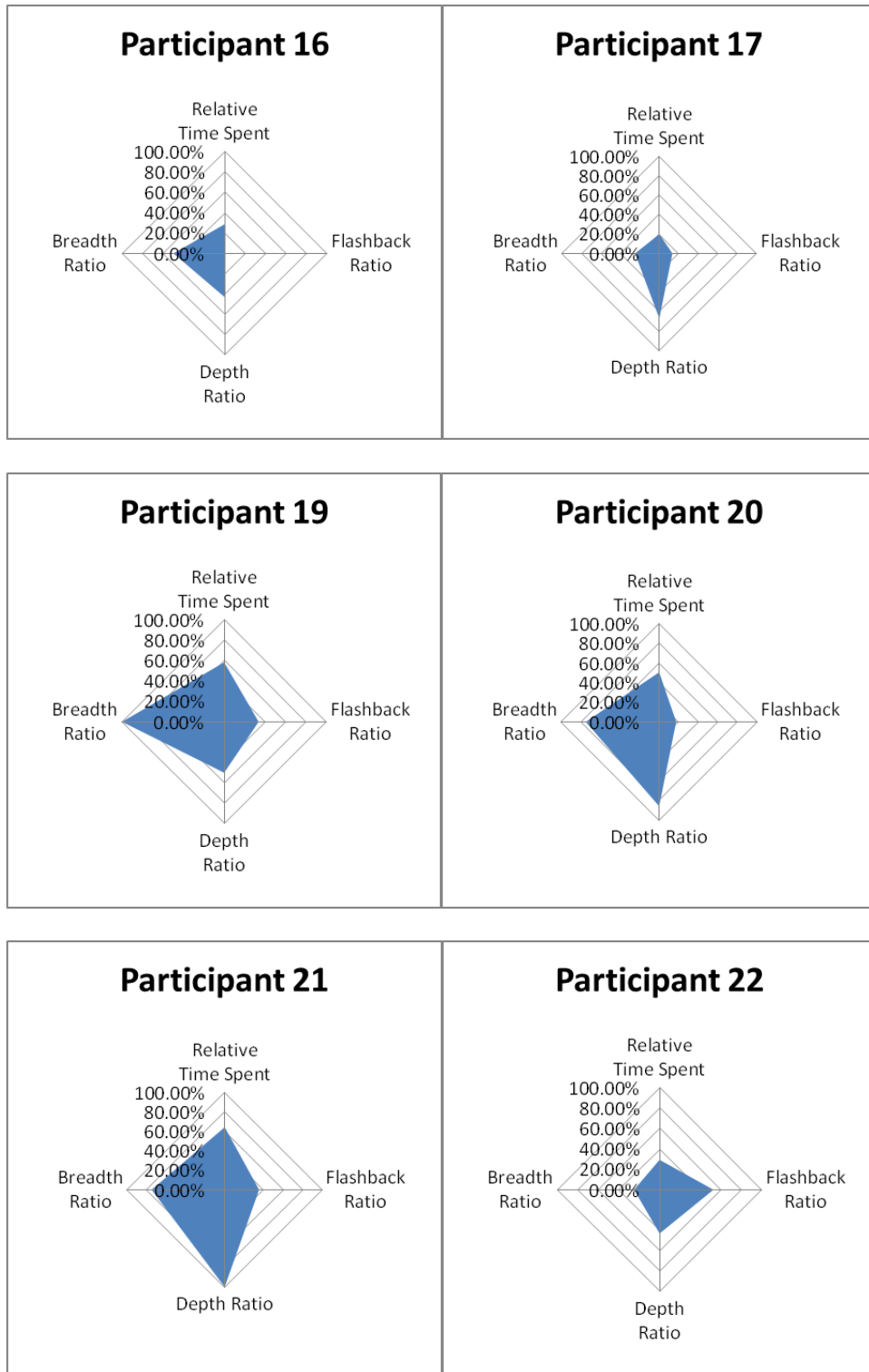 Nietzsche so that players encountering a difficult situation would be able to consult with these NPCs to aid them in making a decision with the side-effect of helping the players learn these philosophers' ethical frameworks. The instructor could even hide which of the NPCs represent which of the philosophers so that learners would be tasked in one Act to make decisions using Aristotle's teleological reasoning and would have to Know and Understand the philosophy enough to be able to Apply it in a real situation.

Socializing the Creation of Acts

The next area of potential future research for Conundrum is in adding social components that support the original game and learning mechanics. The first possibility is exploring the opportunity created by the ethics and social issues class being offered every year to a new group of students who create new Acts that could be used as learning content for future offerings of the course. Another potential way to increase the effectiveness of Conundrum is with aid from the instructor, Acts could be designed for discussion in the class based on real life case studies. There could also be a feature added to Conundrum allowing players to dynamically submit new choices to the author of the Act to augment all player's experience of that Act. The final component that could be added to Conundrum to facillitate social activity for achieving educational goals is creating multiplayer Acts that give different roles in the Acts to different players for them to interact around an ethics or social issue.

Crowd Sourcing the Acts

If Conundrum were available for the Computer Science ethics and social issues class over a number of years, and learners were willing to share their Acts with future students it would be possible to add their Acts to the collection available each year. It wouldn't take long before there were a good number of Acts covering many different aspects of the curriculum. It would be interesting for the instructor to assign the play of specific Acts for class discussion with twists such as certain students having to approach the Acts with different ethical frameworks as their guide and with specific Acts designed to illustrate issues with those ethical frameworks. Every game designed with an ethical component reflects the designer's biases in their values and beliefs[35]. Having a variety of the very best Acts designed by different students exposes players to different design biases giving them an opportunity to interact with different values and beliefs which is especially valuable if the player's beliefs and values contradicts the instructor's bias[35].

Translating Case Studies

It would also be interesting to create new Acts based upon actual case studies done in the class curriculum so that learners could first try to live with the difficult choices they would have had to make if they were a professional stuck in the real world situations illustrated in the case. For example, they could take on the role of an investigator in the Therac-25 case [23] and/or the role of the company making the Therac-25 as situtations started being reported to them of apparently malfunctioning equipment.

Dynamically Adding New Choices to Conundrum

It would also be an interesting assignment to ask learners to come up with alternatives to some of the problems faced in the Acts by having them add their own branches to the Acts. This might also help them to prepare for the creation of their own complete Act around an ethics or

social issue. This might also be a way to update previous years' Acts as issues, technology and society change over the years.

Participant 19 suggested adding an option in Intellectual Property to sue one of the NPCs directly instead of the company that hired him. This suggests that it would be useful to allow players to dynamically add to the Acts as they played them. I suspect that the majority of these new choices would be about circumventing the difficulty of making the difficult choices in the Acts but this feedback as well as playtesting demonstrates that different people bring interesting perspectives to ethics and social issues. Enabling players to participate in the creation process would greatly increase the quality of the Acts in Conundrum as well as exercising their Creation skills.

Imagine that a player comes to a difficult choice in the Act and wishes there was an intermediate approach between two options. There could be a way for the player to add a new thought bubble at this juncture that they could develop through to the end of the Act. Then the play could resume right where they were playing before creating this new branch, and they could finish playing this instance of this Act. There could be a submission process where the original author would be presented with the changes and then edit, approve or deny them.

Multiplayer Acts

Conundrum was not implemented with multiplayer features. However, it might be interesting to create Acts from different perspectives where some learners could play the manager, the employee, the client of a vendor, etc. This would allow them to experience the Acts from different perspectives under the constraints of the game. This would require lab or class time to get everyone playing at the same time and facilitate discussion but would be invaluable in helping learners realize that sometimes they need to work together with others to solve difficult ethics and social issues. This would also allow the Acts themselves to strictly inform the learners

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with different information from the different perspectives and with a simple in game chat mechanism to enable them to debate the issues and the choices while staying in character and preserving anonymity.

Static and Systemic Versions of Conundrum

There are three different ways that a game can introduce ethics and social issues. There is the static method where the ethics and social issue appears in the narrative layer but cannot be modified by the player [31]. The adaptive method allows the player to make ethical choices which change the narrative but have no other impact upon gameplay [31]. Finally, there is the systemic method where the player's ethical and social issues choices affect the underlying mechanics of the game which will alter how they have to play the game [31].

Conundrum was designed from the beginning to be an adaptive game where the ethical game mechanic was players making a decision from a group of choices and the narrative altering based on that decision. It would be interesting to compare the effectiveness of the Conundrum adaptive design with similar static and systemic alterations.

A static design of Conundrum would be easiest and it would be useful to prove that it is less effective to create Acts without any branching and to show that they are less compelling than those with lots of choice.

A systemic design of Conundrum would also be interesting, adding more traditional game play mechanics that would reflect the daily activities of being a Computer Scientist, but altering how the game is played based on the player's ethical choices. A student model could be introduced measuring aspects of a player such as the breadth of their exploration, and the depth of their exploration (the metrics discussed above), but also other aspects of the student such as demographic features, how much risk the player was willing to take, and perhaps even stereotypical types of behaviour such as playing extremely ethically (or unethically), etc. These

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dimensions could be used to systemically change the game. For example, if a player has historically chosen the safest course, avoiding risk at any cost, the game could remove safe choices to force the player into at least exploring some of the riskier options. This would expose the player to the benefits, drawbacks and sometimes necessity of risk. For an exact opposite player, who always decides to make risky choices, the Act could be modified to have subsequent choices where there is a safe option and an increasingly ludicrous option to help the player reflect on how much they are willing to risk. Alternatively, such risk taking players could be highly penalized (in game outcomes).

The Conundrum proof of concept prototype used commercial and serious games techniques to help players achieve the Apply, Evaluate and Create levels of Bloom's taxonomy. Major future efforts will involve creating open student models especially for use by the instructor, using student models to inform the gameplay, increasing the amount of content available to players, and enabling them to easily participate in the improvement of the available content.

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APPENDIX A
QUESTIONNAIRES

There were 3 questionnaires presented to participants using Conundrum. The demographic

and before use questionnaires were presented automatically to players after they had agreed to be

part of the study and gathered demographic, education and video game experience. The after use

questionnaire was presented to participants automatically in the last couple of weeks of the study

assuming they had agreed to be in the study to gather self reported information about

Conundrum.

Demographic Information

Please fill out this questionnaire.
Age:
Gender: Male Female
Year of Study:
What Degree are you seeking at the end of your undergraduate program?
Have you been in an internship or co-op program?
Do you have work experience in IT? If so how many years and what kind(s) of position(s) did you hold?
Have you taken a course that might impact your understanding of ethics or social issues? (eg. Religious Studies, Political Science, History, Marketing, Philosophy etc.)

Before Use Questionnaire

Video Game Experience

In this section you will be asked about your past video game experience.
Average Amount Spent Playing Video Games per Day
0-1 Hours   1-3 Hours   More than 3 Hours
How would you describe your video game proficiency?
Have you played RPGs (role playing games) with an ethical component before (e.g. Fallout, Baldur's Gate, Mass Effect, The Witcher etc.)? If so, can you give some examples?
Have you played other games with ethical components (interactive dramas etc.)? If so, can you give some examples?

Conundrum After Use Questionnaire

Conundrum Experience

In this section you will be asked about your experience playing Conundrum during this particular session with the game.

1. I found the lessons in Conundrum helped me understand concepts in my ethics class.

Disagree   1   2   3   4   5   Agree

2. The choices presented in each scenario seemed appropriate.

Disagree   1   2   3   4   5   Agree

3. I found Conundrum motivating.

Disagree   1   2   3   4   5   Agree

4. I found Conundrum immersive.

Disagree   1   2   3   4   5   Agree

5. I found Conundrum fun to play.

Disagree   1   2   3   4   5   Agree

6. I felt free to explore roles in Conundrum I wouldn't ordinarily play.

Disagree   1   2   3   4   5   Agree

7. I experimented with potentially risky choices.

Disagree   1   2   3   4   5   Agree

Describe which role you felt you were playing while playing Conundrum.

Did this game cause you to think and reflect about ethical issues?

Did this game aid you in your ability to analyze ethical situations? If so in what ways?

Was it fun to play? Why or why not?

Would you play this game again? Why or why not?

Would you recommend this game to a friend studying ethics? Why or why not?

What aspects did you most like about Conundrum?

What aspects did you least like about Conundrum?

What would you add to Conundrum?

What would you remove from Conundrum?

Any further general comments about Conundrum?

Appendix B shows example data produced by Conundrum including the report generated for
each participant's play session. This shows: the start and end time for the session, how long
the particpant spent playing, the amount of "pause time", which could be them switching to
a different tab in their browser or another application on their computer, and finally, a
report of the amount of time spent playing without pauses.

Events
Game Stats
Start Game Time: Tue Feb 23 2010 21:26:14 GMT-0600
End Game Time: Tue Feb 23 2010 21:31:51 GMT-0600
Total Game Time: 5 Minutes, 37 Seconds
Total Pause Time: 0 Seconds
Game Time without Pauses: 5 Minutes, 37 Seconds

There was also raw game data captured by Conundrum in XML format that recorded: the
start and end of the Acts, Scenes and Dialogs they played, whether they had any pauses
within their game play, which thought bubbles they hovered over with their mouses to read
the text of the choice, and finally, which choices they made.

Game Data

<event time="Tue Feb 23 2010 21:26:14 GMT-0600" type="Start Game" />
<event act="Act 1 Security vs Deadline" time="Tue Feb 23 2010 21:26:14 GMT-0600"
type="Start Act" />
<event act="Act 1 Security vs Deadline" scene="Introduction" time="Tue Feb 23 2010 21:26:14
GMT-0600" type="Start Scene" />

<event time="Tue Feb 23 2010 21:26:26 GMT-0600" type="Start Pause" />
<event time="Tue Feb 23 2010 21:26:26 GMT-0600" type="End Pause" />

<event act="Act 1 Security vs Deadline" dialog="Ask more details about the project or client"
scene="Introduction" time="Tue Feb 23 2010 21:26:28 GMT-0600" type="Start Dialog" />
<event choice="Who is the client" time="Tue Feb 23 2010 21:26:30 GMT-0600" type="Look At
Thought Bubble" />
<event choice="Who is the client" time="Tue Feb 23 2010 21:26:33 GMT-0600" type="Stop
Looking At Thought Bubble" />
<event act="Act 1 Security vs Deadline" choice="What is the progress of the project"
dialog="Ask more details about the project or client" scene="Introduction" time="Tue Feb 23
2010 21:26:49 GMT-0600" type="End Dialog" />

APPENDIX C
EXAMPLE FLASHBACK DATA

Appendix C shows example flashback data produced by Conundrum including the statistics

report generated for each time the flashback was used for each participant. This showed the start

and end time for the session, how long they spent looking through the various dialogs and

choices they had in the Act, the amount of "pause time", which could be them switching to a

different tab in their browser or another application on their computer, and finally, a report of the

amount of time spent playing without pauses.

Flashback Stats
Start Flashback Time: Tue Feb 23 2010 21:31:51 GMT-0600
End Flashback Time: Tue Feb 23 2010 21:34:22 GMT-0600
Total Flashback Time: 2 Minutes, 31 Seconds
Total Pause Time: 6 Seconds
Flashback Time without Pauses: 2 Minutes, 25 Seconds

The following is example raw XML flashback data including the events of: the participants
    starting a flashback, moving onto the next or previous dialog or choice, which choice they
    jumped into for a new play of the Act, it also recorded any time they spent away from the
    flashback in case they switched to a different tab in their browser or to a different
    application than their browser.
Flashback Data

<event time="Tue Feb 23 2010 21:31:51 GMT-0600" type="Start Flashback" />
<event choice="Tell about new position" time="Tue Feb 23 2010 21:31:54 GMT-0600" type="Flashback Next" />
<event choice="Start" time="Tue Feb 23 2010 21:31:55 GMT-0600" type="Flashback Next" />
<event dialog="Ask more details about the project or client" time="Tue Feb 23 2010 21:31:59 GMT-0600" type="Flashback Next" />
<event choice="Start" time="Tue Feb 23 2010 21:32:01 GMT-0600" type="Flashback Prev" />
<event choice="Tell about new position" time="Tue Feb 23 2010 21:32:01 GMT-0600" type="Flashback Prev"