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Student Perspectives on Learning and Teaching Data Ethics Through Speculative Game Design

Nisha Devasia, University of Washington, ndevasia@uw.edu
Andrea Figueroa, University of Washington, afigue@uw.edu
Sarah Evans, University of North Texas, sarah.evans@unt.edu
Bernease Herman, University of Washington, bernease@uw.edu
Cecilia Aragon, University of Washington, aragon@uw.edu

Abstract: From our smartphones to our social media, artificial intelligence (AI) algorithms are becoming ubiquitous in our everyday lives. However, the conveniences that they bring come alongside many potential social and political harms. It is imperative that members of the public develop data ethics literacy to interpret AI's harms and benefits daily. The immersive and transformative nature of games may enable a wide range of people to explore complex ethical concepts in AI and data science through the lens of speculative design. In this project, we focus on the learning process of a diverse group of students from two universities as they embark upon a process of game design to teach ethical thinking in data science/AI. Through qualitative analysis of semi-structured interviews, we apply a speculative game design framework to identify aspects that aid student learning.

Introduction

We interact with artificial intelligence and machine learning algorithms (AI/ML) multiple times every day – when we use facial recognition to unlock our phones, when we scroll social media, or when we tell our voice assistants to turn off our lights. However, the general public is often unaware that they are interacting with algorithms which may propagate data privacy issues. Given the pervasiveness of AI/ML in our lives, it is important that users understand its many risks and potential ethical concerns, such as algorithmic bias (Buolamwini & Gebru, 2018), misinformation, and discrimination (Mehrabi et al., 2022). Traditional computer literacy education currently does not address AI/ML's sociopolitical effects and fails to provide students with the skills to make informed choices about their individual usage of AI/ML enabled technologies (Touretzky et al., 2019). A more nuanced understanding of their human impact is needed in computer science and data science education (Aragon et al., 2022; Herman et al., 2020).

Given that AI/ML are complex topics for beginners to conceptualize, research in AI education has emphasized interest-driven learning: educational experiences that tap into students' personal passions and hobbies (Long & Magerko, 2020). To this end, games are often positioned as a salient approach to engage with students growing up in the digital age. More than 90% of children over 2 years old play video games (Alanko, 2023), and the games industry is one of the fastest growing markets in the world. Games are effective vehicles for creative learning (Koster, 2013), and have the unique quality of encouraging the user to give direct answers to questions posed through the choices they make in the game. Their sandbox-like nature especially suits them to engaging with complex problems: games can function as thought experiments that model such problems by situating them in simulated worlds (Schulzke, 2014). Speculative design, "an approach to design in which designers create a product or object connected to an imagined scenario" (Barendregt & Vaage, 2021), is a tool commonly used to engage in thought experiments. This approach is especially useful when considering "wicked problems" (Rittel & Webber, 1973), which lack defined aims or solutions, and defy definitive formulations. Notably, speculative design shares key traits with game design, such as prototyping as a method of inquiry, and using fiction to represent alternative futures (Auger, 2013).

Coulton et al. (2016) present a framework for using games as a method of speculative design, which allows designers and players to explore alternate presents and plausible futures. The framework suggests using the following elements: *plurality, plausibility, mimesis (enactment) and diegesis (narrative), iteration,* and *the avoidance of reductionism*. Plurality implies that different worldviews should be incorporated within the design process and the game itself. Plausibility means that game scenarios should enable players to connect familiar elements of daily life with authoritative sources of data. Mimesis involves the player enacting the game through play, while diegesis is presented through cutscenes and character dialogue. Although iteration is a common design practice, Coulton et al. emphasize including all participants in the process and the need for reflection time. Finally, complex societal problems cannot be reduced to solutions addressable though minor behavioral changes or overly simplistic goals. In this work, we build upon this framework and draw from previous research that positions students as *designers* of games (Baradaran Rahimi & Kim, 2019; Kafai & Burke, 2015; Tan &

Kim, 2015). The game development process forces the creator(s) to set the rules that govern players' choices and follow through with the repercussions of their decisions. Gualeni described the process of self-transformation through game design, in which "designers inevitably self-fashion themselves in ways and in directions that are analogous to those that they intended to elicit in the recipients of their work" (Gualeni, 2015). Designing an educational game requires that designers become familiar with the topics the game aims to teach and the best ways of teaching it, which requires critical thinking skills and a deep understanding of the subject matter (Gee, 2008). Designing games allows for deep personal reflection and provides a space to form opinions on complex issues (Schwind & Buder, 2012). Furthermore, considering the recent framing of several issues surrounding AI/ML's impact on society as wicked problems (Holtel, 2016), combining educational game design with a speculative approach also allows for divergent exploration of this impact.

To explore this approach of designing educational games about AI/ML data ethics, we conducted a two-year long interdisciplinary study with students from two institutions (Byun et al., 2022). The instructors had expertise in data science, library science, and AI. Students ranged in age and experience from dual enrolled high schoolers to graduate students. The stated goal of the project was to collaboratively design games that teach critical and ethical thinking about data ethics in AI/ML and the effect that such technologies can have on our society. This paper explores the research question: What are the constraints and affordances of learning through speculative game design across two academic institutions? We contribute to the less studied area of *making* rather than *playing* games for learning (Kafai & Burke, 2015), and build on Coulton's framework of games as speculative design to gather insights into students' learning processes.

Methods

The goal of this project was to design ethical games with a diverse group of students from two institutions. A listing describing the project was advertised through the University of Washington, and a researcher from the University of North Texas distributed the posting through student groups on campus. Sixteen students across both institutions from a range of college programs with interests in gaming, learning, data science, and/or research signed up to participate. Structured as a Directed Research Group (DRG), the course met weekly for 1.5 hours over two quarters or one semester, depending on the schedule of the student's home institution.

Directed research groups

Directed research groups (DRG) are a decentralized learning experience that model the student-as-collaborator relationship (Larson et al., 2009; Turns & Ramey, 2006). They are intended to engage undergraduate and masters students in various phases of the research process, and were created in response to calls for more opportunities in undergraduate research, in accordance with the standards set by the Boyer Commission on Educating Undergraduates, the Council on Undergraduate Research, and the National Conference for Undergraduate Research (Hu et al., 2008). DRGs are normally led by doctoral students and faculty members, who mentor and empower students to both participate in and conduct their own research. DRGs encourage diverse collaboration among students and between students and academic leaders, emphasizing exploration and diversity as fundamental to research. This format draws inspiration from project-based learning (PBL) pedagogy, which de-emphasizes lecture-based content transmission in favor of interest-driven learning frameworks. Furthermore, research has shown that applying knowledge to real-world problems supports deeper learning than lecture-based learning (Miller & Krajcik, 2019).

The first academic term of the DRG was designed to establish a common base of knowledge for participants in data science, AI, ethics, research, learning, and gaming, as well as to design an initial prototype of a game by the end of 6 months (1 semester or 2 quarters). Students engaged with the material on various levels: 1) assignments and readings curated by the instructors, 2) self-directed meetings with a small group to work on a video game addressing a specific ethical issue in data science or AI/ML, and 3) weekly class time where students and instructors met over Zoom to participate in lectures, large group discussions, and joint exploration of serious games. Teaching materials included case studies of biased algorithms which resulted in actual human harms, immersive game design mechanics, and game studies literature on narrative elements. Students combined the technical learning from the data science lectures with techniques learned from game design to create multiple iterations of their game within each group (see Figures 1-4 for examples of student work).

Participants

The participants consisted of 10 students from the University of Washington and 6 students from the University of North Texas. These participants expressed interest in joining the group based on the description and were selected based on their background and skills in topics such as gaming, education, data science, and research, with emphasis on recruiting underrepresented students. The group consisted of 9 undergraduates and 7 graduate

students. Two of the undergraduates were part of an accelerated program in which they finished the last two years of high school and the first two years of college concurrently. The majority of the students identified as members of groups underrepresented in STEM, including women and people of color (see Table 1).

Table 1

Demographic Information of Participating Students in the DRG.

	Gender	Ethnicity	Student Status
Univ. of Washington	M = 3 F = 7	White = 4 Asian = 6	Domestic = 9 International = 1
Univ. of North Texas	M = 4 F = 2	Black = 1 White = 1 Asian = 4	Domestic = 4 International = 2

Figure 1

Storyboards from a Prototype Fake News Game.

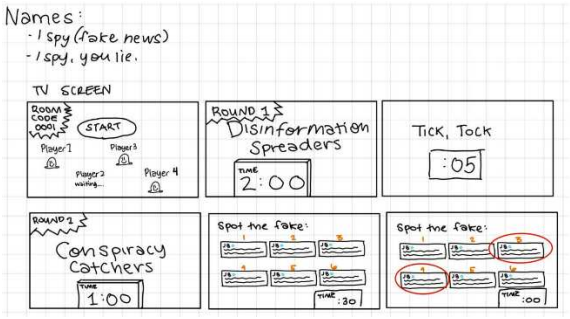
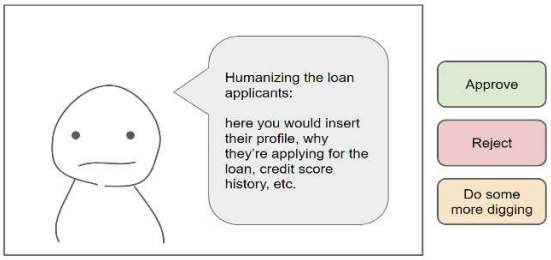


Figure 2

Paper Prototype for Misinformation Game Mechanics.

Figure 3

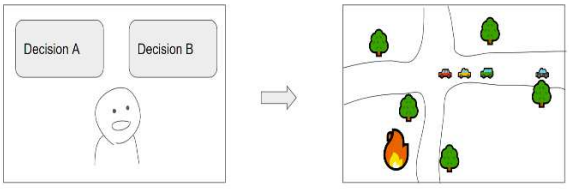
Storyboard from Prototype Game about AI in Banking.



Clashing incentives: bank teller has an obligation to their employer, but also a moral compass to follow and a need to help others.

Figure 4

Game Flow for Making Ethical Decisions In-Game.



Mayor of town is presented with a unique dilemma, with 2 tough options and pros/cons for each.

Once decision is made, cut to scene that shows the outcome. Gameplay develops accordingly.

Interviews

We conducted semi-structured interviews with each participant in a one-on-one setting, ranging from 7 to 30 minutes. Based on the research questions for the overall project, these interviews focused on student perspectives on data ethics, the experience of collaborative design, and their own relationship to the field of data science. Interviews were conducted virtually the week after the end of the first quarter and recorded and transcribed for later analysis. Examples of questions included:

- What were your expectations when you signed up for the DRG? How has the experience been different than you expected? In what ways has the experience been what you expected?
- Have any of your ideas changed around the topics of big data, ethics, research, learning, and gaming?
- What DRG activities have you enjoyed the most/least? What has been most/least useful?
- Do you identify with STEM as part of your studies and career?

Analysis

The first and second author each independently performed a round of inductive coding on the interview transcripts to find emerging themes (Merriam & Tisdell, 2015). After developing an initial set of themes, we reanalyzed the transcripts with a focus on said themes. We focused on insights that spoke to what specific elements of the DRG helped students learn and why those particular elements were the most conducive to their learning.

Findings

Among the interviews, different themes emerged about how the DRG elements impacted students' learning. We organized our findings around which activities and aspects students found the most helpful, applying Coulton et al's framework and including suggestions the students had on how to improve the DRG in future iterations.

Group organization

> *"It's more like an interactive class, where each one of us gets an opportunity to express our ideas and come up with new things."*

Guided discussions among both the entire group (the entire class and teachers) and the smaller groups (project groups of 3 or 4 students) were crucial to the students as they shared their views, heard different perspectives, and formed opinions on both ethical and technical topics. Educators must take care to not be reductionist when teaching about ethics; for example, believing that there is a "correct" or "preferable" solution to an ethical question. As Coulton et al. remark, 'preferable' should be a question the designers ask of themselves within the design activity rather than an aim of the design. The DRG structure greatly facilitated this self-exploration and group discovery, with students asking questions of each other and listening closely to diverse viewpoints. As Schwind and Buder point out, allowing time for reflection within the groups enabled students to thoughtfully consider opposing perspectives rather than "select[ing] information that confirms their prior perspectives".

Small groups

> *"I really enjoyed the small groups. I'm usually not a group person, I prefer working alone…but in our smaller groups I just really enjoy the idea sharing that happens there."*

Students spoke extremely positively of the small group discussions, with nine of them explicitly stating that it was the most useful aspect of the DRG organization. The ease of expressing one's own opinion was mentioned repeatedly in the interviews. This echoed Coulton's emphasis on inclusivity within the actual design, specifically the focus on democratizing the design process and encouraging the inclusion of all voices, not just those who are in the position of privilege or who agree with the dominant societal narrative. The DRG consisted of students from different educational levels, with age differences of five years or more. Younger students stated that they sometimes felt unqualified to express themselves effectively in the large group meetings, due to their perceived lack of experience. The more intimate setting promoted engagement, and allowed less-experienced students to openly share their views. Students repeatedly stated that they benefited from the open sharing of ideas and iteration that occurred within the smaller groups. The structure of the small groups ensured that the diverse group of students participating in the DRG saw each other as peers.

Large groups

> *"This is by far the most engaged discussion I've had so far in terms of a remote context."*

Large group discussions offered students numerous advantages that enhanced the learning experience and fostered a sense of community among participants. One student described the large group discussions as "more like an interactive class, where each one of us gets to express our ideas and come up with new things." Coulton points out that linking authoritative data sources (expert views from instructors) with both narrative discussion (diegesis) and student lived experience (mimesis) enables more effective exploration of complex societal issues. The three students that identified the large group discussions as the most useful aspect of the DRG stated that they felt their input was actively listened to and the interaction felt receptive and reciprocal. One student noted the sense of community and engagement that was promoted when instructors encouraged students to speak and to have their cameras on. Moreover, large group discussions allowed students to explore a wide range of perspectives, allowing participants to discover both commonalities and differences.

Diversity of thought

> *"It's crazy how…we can all come up with such interesting and different ideas. Coming from industry, where they harp so much on being diverse, you never really see it in action. But seeing [diversity] come to fruition and an actual diverse group, it's really neat."*

From physical geography to personal identity, the students and faculty that participated in the DRG were a striking example of diversity and intersectionality in action. This relates strongly to Coulton's framework element of plurality. The three instructors were women in STEM, bringing together 1. a Hispanic senior faculty member from the University of Washington, a large public university, 2. a Black early career data science researcher from the

same institution, and 3. a junior faculty member at the University of North Texas, a designated Hispanic-Serving Institution (HSI) in the American south. The two graduate teaching assistants were Hispanic women. The majority of the students identified as underrepresented in STEM. Three students were international, bringing non-American viewpoints to the discussions. The students spanned a wide range of specializations, including psychology, mechanical engineering, and business, with most majoring in human-computer interaction.

Students stated explicitly that the diversity in experience enabled them to generate a wide range of innovative ideas. By embracing a variety of perspectives, students found their collective brainstorming sessions to be particularly enriching. One student said: "I really love my teammates' ideas and how differently they were thinking, and how that made it really interesting to meet up with them." Another emphasized the collaborative nature of the discussions, stating: "We all try to come up with ideas together and try to take something from each person's ideas." The diverse environment fueled an equally diverse list of game ideas (see Table 2).

Table 2
A List of Game Ideas that Students Devised by the End of the First Academic Term.

	Game Idea
Group 1	Players experience a day as a hacker. Players receive info on their phones that they must keep private from other players. Teams must decide if they can trust the information they've received and at what time to share it. Inspired by Bomb Corp.
Group 2	Players experience the flow of using AI to approve banking loans. The win condition involves collaborating with the AI rather than letting the AI make all the decisions on its own.
Group 3	Players roleplay as the mayor of a fictional town and have to make difficult ethical decisions to progress the game. Players are shown the effects of their actions upon the citizens of the town.
Group 4	Players engage in a family-friendly Jackbox-style game to both roleplay as a misinformation spreader and a receiver.

Self-transformation

Several students reported that participation in the DRG had changed their personal beliefs or everyday actions. As Coulton mentions, the merging of mimesis, which often includes empathy, with narrative diegesis enables powerful and potentially life-changing personal exploration through game design. We identified two themes among these responses which were particularly salient to our understanding of what students took away from their experience.

Increased understanding of data science and ethics

> *"Before, I didn't see a lot of risks of future technology because I was so interested in the positives. But now I see how it can be used in ways where you're like, okay we can still try to do this, but we need to have more control over it."*

Combining technical lectures, group discussions, and active engagement in game design to teach data science led to tangible changes in students' perspectives and actions. The lectures taught students how to be "a little more careful on what to download…[we] have to be more careful of what [we] do with each person's data and what [we] can use it for." This is a clear example of the blending of mimesis and diegesis. The discussion helped broaden students' perspectives on data science and ethics and had them confront the ways in which these topics affect their daily lives. As one student stated, "I didn't think too much about [data science]…but I realized that everything I do is affected by it and learning about bias and how that can create prejudice towards people was really eye opening." Students were also grateful for discussions in which instructors broke down real world examples of how data bias can affect others, which empowered them to explain these examples to non-experts in their lives. This relates to Coulton's theme of plausibility and the importance of co-designing with experts.

Deconstructing negative notions of games

> *"My insight of what a game is has completely changed."*

The introduction of learning games within the educational scope of the DRG, as well as students' active participation in both playing and designing games, were crucial to understanding the pedagogical potential of games. The majority of students in the DRG did not identify as gamers, either prior to or after the DRG. However, several students experienced a complete shift in their perceptions of video games, both recreationally and for learning purposes. Initially, some students held negative notions of both video games and their players. For example, one student stated: "My parents influenced me [to think] that only losers do that sort of thing." Others believed that gaming was meant solely for entertainment, not learning. However, because of their participation in

the DRG, the majority of students came to view gaming in a different light. They were more conscious of the intention behind games, and approached game design more thoughtfully. Furthermore, some students stated that their conversations about gaming outside of the scope of the DRG also changed significantly, and that they are spreading their newfound perspectives to family members and friends. This iteration and reflection demonstrate that profound explorations can take place within the process of speculative game design.

When asked which aspect of the project they were looking forward to the most, an overwhelming majority of students (15 out of 16) responded that they were excited to work on the game prototypes, see other group's game ideas, and test out their game. This underscores the appeal of game development as a creative and engaging activity, transcending traditional gamer demographics. The development process itself became a powerful catalyst for enthusiasm and involvement, making it a valuable tool for fostering innovative thinking across diverse groups.

Organizational complications

Coordinating students from two geographically disparate institutions led to some suboptimal methods of material organization. The following two subsections list student suggestions on how to improve the DRG.

Clarifying expectations

> *"My group is really good. I'm the only master's student in my group, all three of them are undergrads, so I think there was a tacit understanding that I was gonna lead. It just kind of happened that way, but I don't necessarily feel like I'm more experienced or anything like that, because we're all pretty much new to this field."*

The groups within the DRG were a mix of students from both institutions with varying degree levels, ranging from dual-enrolled high school students to master's students. However, master's students felt that there was an unspoken agreement in their groups that they were going to lead, even if they felt unprepared to do so. Furthermore, some master's students thought that they did not have as much experience with some of the topics as younger group members did. Although instructors stated at the outset of the DRG that more work was expected from graduate students, most of the graduate students did not interpret this as a call to leadership, and were under the impression that they would just have to do more assignments.

Centralizing communications

> *"At least the people I've spoken to, email is an announcement tool. [...] And then we also get so many emails [...] so that is an information overload. And then every single calendar invite is an email so everything is just like coming in. It's really hard to 'chat' with people through email."*

Students offered several suggestions on how to centralize the DRG materials and communications to serve their learning better. Originally, the primary form of group communication was email; messages were sent out weekly with group instructions and materials. However, because students received a plethora of different emails from their department, university, and scheduling tools, DRG related emails were often lost, leaving them unsure of what the deliverables were for the week. The additional overhead of the collaboration between two universities led to emails from unfamiliar domains being filtered or deprioritized. In addition, email communication between team members was thought unnecessarily formal, especially to students who didn't use it as frequently as instructors did. Many of the students resorted to using instant messaging tools to communicate among their small groups. Students self-organized to create a DRG Slack with specific channels for each different aspect of the game design, such as #programming, #art, and #data-science. They also suggested that the instructors upload all the materials in one place, such as Google Drive.

This decentralization of tools was a result of institutional restriction in place by software companies. While both campuses use Canvas as the primary learning management system (LMS), it was not possible to create a course shell for students and instructors in different universities. A Google Classroom was considered, but due to the University of Washington's Google license, students could not access it with their university emails. Having a common LMS would have enabled both discussion features and shared document management.

Discussion

In this paper, we investigated the process of learning through speculative game design across two separate academic institutions. We structure our discussion around the impact of collaboration between two universities on specific components of the process and the influence of collaborative design in speculative games. We tie

our findings to Coulton's framework for games as speculative design tools, as we found this framework to be particularly helpful in considering the research question of exploring the constraints and affordances of learning through speculative game design in a diverse and geographically separated context.

The primary affordance of collaboration across separate institutions was diversity in lived experiences. Most of the students from the University of Washington, a large research institution on the West Coast, were US students majoring in human-computer interaction. The students from the University of North Texas brought a larger variety of academic and personal backgrounds. Instructors accounted for diversity and intersectionality across group members when assigning the smaller design groups, and students spoke about how this positively affected the ideas their groups were able to come up with. However, the incompatibility of learning management systems and accessibility barriers in decentralized communication tools often made collaboration difficult across the larger group.

Students universally praised the affordances of the speculative game design process, particularly citing themes related to Coulton's elements of *plurality*, *plausibility*, and *mimesis (enactment) and diegesis (narrative)*. Students explicitly stated the diversity (*plurality*) of the group and its contrasting opinions helped them develop their own views. Diversity fosters creativity by encouraging the collision of different ideas and approaches. In the context of speculative design, where innovation is key, diverse teams are more likely to generate imaginative concepts that push the boundaries of traditional thinking. Varied viewpoints and lived experiences, especially with regards to technologies becoming as ubiquitous as AI/ML, are more likely to lead to holistic design solutions for more positive speculative futures.

Students' descriptions of how the DRG had tangibly changed their actions, from discussions with family members about games and the class material to the deconstruction of negative notions of gaming, were evidence of *self-transformation* as described by Gualeni. Self-transformation encourages adaptability and equips students with the ability to navigate uncertainties and contribute to dynamic design processes. This self-transformation was facilitated and augmented by the affordances of the group involving *mimesis and diegesis*. Students, as they ideated and designed their games, were able to enact stories that reflected everyday experiences in their own lives, but also used rhetorical techniques and narrative to elaborate and reflect on those experiences in a way that deepened their own understanding of the game topics. Through designing to teach others about these topics, the students themselves internalized the potential harms of unethical data use and learned to think more critically about how they interact with these technologies every day. The *plausibility* of these everyday scenarios strengthened their understanding of potential harms and ethical concerns. Finally, the *iteration* in the game design process fostered time for reconsideration of design elements and the accompanying deep reflection on personal beliefs. By unpacking issues and investing themselves in the storylines, students gained substantial insight into the dangers of *reductionism* when exploring complex societal issues.

Limitations

There were several limitations to this work. The size of the DRG was relatively small, with only 16 students and four groups. The data gathered is from the first period of the project and is representative of a snapshot of the entire game design process. The student group, although diverse, still lacked representation from key demographic groups. Although three members of the instructional team were Hispanic, none of the students identified as such. There was only one Black student and no representation from Native American or Pacific Islander students. Furthermore, the research team was not able to investigate how students' personal identities affected the ideas they contributed to the design process. We plan to address these limitations in future iterations of the DRG.

Conclusion

This project presents qualitative findings from a project involving a diverse group of students and instructors collaboratively engaging in a speculative design process involving games about artificial intelligence, machine learning, and data ethics. The goal of the project was to produce games that inform non-experts about current issues related to AI/ML and data ethics, as well as potential futures that AI/ML could create. Evidence of student learning was gathered as the students collaborated, ideated, and designed four games. We found themes building on the five elements of Coulton's speculative design framework, particularly as related to a diverse and geographically separated group and listed key affordances and constraints in this environment. Our findings reflect the effectiveness of co-designing games to address complex, intersectional issues such as data ethics, encouraging further exploration in speculative game design with diverse collaborative groups. Envisioning a wide range of futures necessitates a wide range of lived experiences and ideas.

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