“It’s Not as Bad as Using the Toaster All of the Time”: Trade-offs in a Scratch Game about Energy Use

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Abstract: Young people can represent and understand complex systems by designing games. The work we report is from a Scratch workshop focused on understanding trade-offs associated with energy use in relation to climate change. One participant’s work illustrates the potential for game design to support understanding of complexity and, in particular, the mutually constitutive nature of conceptual understanding and the contextualized activity of game design.

Introduction

Many informal programs, resources, and games are devoted to solving problems related to energy conservation and climate change. However, climate change is hard to learn, particularly understanding its systemic causes and implications. *Agency* is critical to how we develop our initial notions of causality (Carey, 2009). Through early agency-related experiences, we learn that we can have an impact on the world in direct and centralized ways. However, our impacts upon nature are often decentralized – the outcomes of collective actions are emergent (Grotzer, 2012). Being in the role of game designer can provide a powerful context for young people to engage with understanding complex systems in science (Kafai & Ching, 2001).

This paper explores how girls designed games in the visual programming environment, Scratch, to teach others about energy conservation, focusing especially on trade-offs associated with energy conservation. We define girls’ understanding of ‘trade-offs’ as how many places in their lives they make trade-offs, what values are implied when they choose, what alternatives are available, and how to make reasoned decisions. Given this definition, we attempt to capture the mutually constitutive nature of conceptual understanding and contextualized activity (Barab et al., 2010). Because trade-offs are integral to decisions related to conservation, and hence to the impacts of climate change, the concept is key in advancing understanding. Specifically, this study sought to address the question: *What particulars of the workshop learning environment support participant understanding of the human, social and environmental trade-offs associated with energy use?*

Methods: Participants, Design and Procedure

Six girls, aged 11 and 12, participated in a 3-day workshop where they created an initial Scratch sketch on climate change, brainstormed game design ideas, learned about trade-offs, built games, tested peers’ games, and presented to their families. All participants had programming experience ranging from one week to over two years. Researchers as participant-observers led the workshop, using a design research approach, providing just-in-time support related to procedural, conceptual and consequential content (Barab, Gresalfi & Arici, 2009). Data were collected in the form of audio-recorded think-alouds, user tests and presentations, Silverback recordings of game creation, storyboards, notes and photographs. Recordings were transcribed and coded using a grounded theory approach (Glaser & Strauss, 1967).

Results

Of the six participants, Amelia’s story most clearly illustrates how grappling with trade-offs in the context of game design can lead to a deeper understanding of the complexities of energy conservation, as well as an opportunity to realize that understanding in a multi-faceted design. Amelia originally framed the choice her game player would make as a simple one involving saving energy. The consequentiality of trade-offs became evident when Amelia grasped (via another girl’s insight) that trade-offs necessitated “multiple right answers” and took the insight much further as a design challenge. Amelia now understood that conservation requires weighing and prioritizing different outcomes. Equally important, it involved developing additional game moves and a more complex game structure overall. Amelia’s story illustrates the mutually constitutive nature of her conceptual understanding of trade-offs and the contextualized activity of design to incorporate those trade-offs. In this sense, the concept materially transformed Amelia’s design, and grappling with the programming deepened her understanding.

By Day 3, Amelia’s game presented the player with a simple choice related to which appliance (toaster oven, microwave, stove, solar oven) was the most “environmentally friendly” (i.e., used the least amount of energy). Julie, an instructor, asked her to think about trade-offs, and she explicitly restated that the trade-off would be convenience:

Amelia: Um, well I just said the one that's most environmentally friendly. So I think that would be correct. Definitely it's not the most- [Julie: - most convenient -]

Amelia: -yeah, way to do it. But it's definitely the best for the environment.

Julie: So are you still sharing that information about how long it takes?

Amelia: Yeah […] If you click on the objects it pops up, and it says like, "I will take 2 to 4 hours to cook your toast but I use no energy. And then so like the toaster pops up and it takes 2 minutes but uses a lot more energy. So each of them has it, so like 7 minutes, and then the stove 3 minutes.

Julie: […] Will the player know, thinking about the learning goal for a minute, will they learn about trade-offs or will they just learn about the energy? What will they learn from those times?

Amelia: Probably that if something's environmentally friendly, it's not always the most convenient.

Later Amelia was urged to think about energy use choices *in terms* of trade-offs. She did so by explaining that the flower - which she kept as a visual metaphor for environmental health – would indicate score: 'So like if your flower is drooping, it means you did really bad.' Amelia began to think about constructive messages that people can take away from a game about trade-offs. Instead of the 'correct answer/positive message' design she was using before, she began to incorporate trade-offs, some related to time/convenience and some to the health of the environment:

> Well, I mean it really, it really depends on how much you use them [a toaster versus a solar oven.] Maybe if you have. I know like I wouldn't do this, but you could if you wanted to. So if you took a solar, if you used a solar oven, and maybe you could get up early in the morning and put your toast in and then go back to sleep - […] but like if you use the solar oven some of the time, and then the toaster like a little, it's not as bad as using the toaster all of the time.

In the end, Amelia implemented her idea about balancing the trade-offs by incorporating it into a script that provided advice to the player before s/he begins to play the game: 'If you use a toaster some of the time and a solar oven some of the time, you don't have to give up electricity altogether but you could still make a difference…' This suggests that the player can choose to have their cake and eat it too! In constructing player choices among "conditions, actions and outcomes," Amelia "narratized the to-be-learned content" (Barab et al., 2010, p. 19).

Conclusions

Amelia demonstrated imagination, persistence and engagement in negotiating both conceptual and procedural content that produced complex game play (Barab, Gresalfi & Arici, 2009). For her, design functioned as inquiry using model building. Game design and model building share the virtues of requiring explicitness and iterative design-analysis-revision, incorporating input and output elements, and involving causality. A critical trade-off that arises in this connection is the learner's fluency with the modeling language and its metaphors. Amelia shows that representation of ideas about a system can be developed so that the focus remains on the system and its hypothesized behaviors, the questions and answers rather than the tool.

References

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