

Reimagining Narratives, Rewriting Code: Computer Science and Math Identity Development in an Anticolonial Video Game

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Abstract

We designed an anticolonial video game with the goal to support players' Computer Science (CS) and Mathematics identity development. Drawing upon recent theories of CS and Math Identity (Cobb, Gresalfi, & Hodge, 2009; Gresalfi & Hand, 2019; Author & colleagues, 2019), we looked at how players' identity positioning shifted during gameplay, and which identities might have developed. We argue that one student had multiple identities surfaced, repositioned, and even developed (in the case of her identity as a gamer) through gameplay. Findings suggest that supportive interpersonal relationships and opportunities to rewrite important stories are two game elements which seem to promote identity positioning as one who imagines and wants to use CS and math for social good.

Motivation

Educational games have been studied for their affordances for learning; only more recently have scholars begun to explore the affordances for identity development. Identity has been shown to support students to meaningfully persist in STEM (Van Horne & Bell, 2017), to challenge and subvert the discipline using its own tools (Gutstein, 2013), or both (Pinkard et al., 2017).

Emerging evidence suggests powerful identity development may be supported by games (Barany, Talafian, Petrovich, Shah & Foster, 2019), but we need to study which specific elements support the identities we aim to support. We designed a game to explore how unique elements like an anticolonial narrative, exploring taboo social issues, building movements, and repurposing CS and math might provide support for students to develop a long-lasting, positive, productive CS and mathematics identity.

Theoretical Framework

We designed iteration 1 of our game with the Cobb, Gresalfi, and Hodge framework (2009) in mind because they name three observable indicators that may contribute to identity development. These are exercise of agency, distribution of authority, and production of math considered competent. We also wanted to explore “feeling of affinity” as another indicator.

It turns out that Cobb and colleagues' framework served us for design, but when we tried to describe *how* identity developed and which identities we were seeing during the study, it was not sufficient. We can suspect authority is distributed or think some of the math produced is considered competent, but how do we know this to be the case? Author and colleague's framework (2019) describes how material, relational, and ideational *identity resources* (Nasir & Cooks, 2009) connect to interest development. This framework helped us identify differences in interest and identity before and after the intervention. Hidi & Renninger's Four Phase Model (2006) and Azevedo's idea of *preferences* (2013) further helped us analyze when and how deeply interest was sparked, but these theories did not help us fully understand the mechanisms that caused the identity shifts we observed.

We turned to Positioning (Harré & Van Langenhove, 1999) as operationalized by Gresalfi and Hand (2019) to explore *identity positioning*, or how someone framed or was framed during the study, and the accompanying shifts in narration. These authors and others (Pinkard et al., 2019) theorize that relationships with other people can be the biggest indicators and mechanisms by which identities develop and are sustained.

Research Questions

Informed by all of these theories, we ask (1) How did learners engage in identity positioning through playing the game? (2) How if at all did their identities develop?

From answering these questions we hoped to learn which aspects of the game were most important for players to feel empowered and knowledgeable about how one might start to generate change in social issues they care about using useful math.

Methods

Game Design. In the game's first iteration, focusing on just math identity, players were invited to create a mathematical weather model in an embedded GeoGebra applet. The weather model was to predict and

counteract the negative effects of intentionally inflicted climate disaster by the U.S. Navy to try to force islanders of the Northern Marianas islands off their ancestral home (Figures 3, 4, & 5). (This narrative is closely based on current events; Hofschneider, 2019; Limtiaco, 2019). Thus the game presents players with an anticolonial framing where they fight back by leveraging relationships with islanders and using mathematical tools like curve of best fit. Players decide what makes a good prediction, positioning them as competent mathematical modelers who can use their skills for good. These frames are where we expected to see shifts in mathematical identity using the Cobb, Gresalfi & Hodge (2009) indicators.

Interview Design & Relationship to Participants. Participants were asked questions about their identity and interest in math and gaming, and related topics. The second author was the interviewer, and since they were the participants' math tutor, they had rapport with the participants.

Data Collection. Data was collected using GoPro cameras with a pre-interview, 20 minutes of gameplay, and a post-interview.

Analysis. Analysis included open coding of transcripts and video data. A second pass was done to generate qualitative codes around positioning and narration, including codes like "Susana positions herself as a gamer" and "as not a gamer" or "narrating her interest in climate change." From these codes we connected ideas, collected additional evidence, and revised the emergent themes using a grounded theory approach (Glaser & Strauss, 2017).

Results and Discussion

In this short proposal, we focus on Susana, a student for whom we identified meaningful shifts in identity (see Table 1 for details of analysis). In the full paper, we will present analysis of all participants.

Evidence for Susana's Identity Development

Early in gameplay Susana asked the interviewer, "Am I right? Is it roughly right?" and the interviewer said, "Play the game" perhaps a little roughly. Susana pursed her lips and continued playing. Later, Susana compared her predictions against the temperature simulation and evaluated the model herself, saying, "So...Did I get it right? No....went up by 2 it looks like." Because this framing of Susana's ownership over her own correctness needed support and encouragement, we do not have evidence that her identity positioning as a mathematical authority extended outside the context.

Although the social justice premise began to challenge Susana's idea that "games are not beneficial to my learning" she still asserted her ideas about the usefulness of games remained unshifted, saying, "one math game won't change that." However, she remained an avid fan of board gaming with friends, saying "I like...playing with a group of friends, like a board game because it's real in the moment." Because Susana sustainably used her long-held ideas as an ideational identity resource to name and act upon her gaming *preferences* (Azevedo, 2013), she positioned herself as a gamer in some contexts, and as NOT a gamer in others. Her encounter with our game only further strengthened this framing. It's important to note that this duplicitous gamer identity development was not one we intended to support, but it was crucial to understand what identity was being supported by our design.

It seemed Susana had a well-developed interest connection to the social justice framing since she wanted to be a climate scientist. "I wanted to help save the people quicker, so I just went with the calculator" describes Susana's interest in solving the problem using a readily available tool. When asked if she would take what she learned elsewhere, Susana said, "I think something about how we were doing it. How we were like figuring out something for the greater good. I think that's probably something where you have to use math for the greater good of the population, specifically since we're in the era of climate

change,” positioning herself as one who imagined and *might* use math for social good. It’s important to note that this identity as one who could use math for social good was an identity we intended to support.

Analysis of Susana’s Identity Development

Table 1 summarizes our analysis of Susana’s identities that we identified as shifting through framing, positioning, and narration. Shifts in narration, and corresponding shifts in frame, helped us identify development of identity.

Table 1: Susana’s Identity Positioning and Identity Development

What identity we saw	Identity positioning within frames	Mechanism	Identity development
identity as one who does or doesn't have mathematical authority	Framing: teacher, not students, has authority. Requests for student to take agency	Reframing by interviewer suggests situationally claimed agency	No [1]
identity as one who is or isn't a gamer	Strongly held framing: board gaming w/ friends vs video gaming alone	Prompting, dialogue, sharing memories	Yes [2]
identity as one who envisions and might apply useful math in social justice issues	Imagining / framing of useful math, joining a conversation, or crafting a social movement	Stories and storytelling, social justice framing, imagined futures	Maybe [3]

Answer to RQ 1: How did Susana engage with Identity Positioning? Through narration and framing, Susana was positioned as one who does or doesn't have mathematical authority, who does or doesn't play games, and who envisions and might apply useful math in social issues. As we suspected, the long-term relationship between the interviewer and Susana was one of the biggest mechanisms by which we saw her identity positioning shifted.

Answer to RQ 2: How did Susana’s identities develop? Susana’s gamer identity developed through positioning. Other identities were not further developed although they were “surfaced” so we could see them, through positioning. In such a short intervention, lasting change to an identity should not be expected. However, Susana’s strongly held identity resources resurfaced again to provide additional support for Susana’s identity as a casual gamer with friends but not a serious video gamer.

Susana’s relationship to the interviewer and the opportunities she had to engage and rewrite the social justice narrative were the most impactful identity resources we identified. The next iteration of the game should support more such relationships and opportunities to rewrite important stories.

In addition to the above findings, we conjecture that additional framings might have induced even more shifting. We now present the questions driving our next design decisions.

First, the question “what new horizons are in store for me?” could support the framing “I have new horizons to explore.” This framing positions players as agents who imagine, immerse, empathize, are curious, and figure out. The goal is to observe shifts in how players narrate feeling empowered to push

the limits of control and freedom to learn about themselves and what's important (Annetta, 2010). Thus, design should have an interesting world with compelling graphics, quests, and a central story arc, as resources to empower players to explore, challenge, and shift narration (see Appendix A).

Second, the question “what is important to me and what's my plan?” could support the framing “I can use these tools to empower myself.” This framing positions players as agents who define, plan, and pursue simulated social change using STEM. The goal is to observe more and deeper shifts in players narrating the usefulness of CS and mathematics to realize their goals of making positive societal impacts. Thus, design should support tinkering, interrogating, and rewriting narratives (Gresalfi & Hand, 2019), a transformative shift in positioning (Givens et al., 2016).

Finally, the question “what is important to us, and how can we collaborate?” could support the framing “we have the power to create positive social change.” This framing positions players as agents who receive peer recognition, membership, and feedback. The goal is to observe shifts in how players are framed by others and how players position themselves in a wider social context. Thus, design should support craftsperson guilds, digital workshops, portfolios, or showcases as resources to support students to claim agency, ownership, and rewrite norms, i.e. shifts in narration and frames.

Conclusion and Significance

This study sought to examine how our anticolonial video game might have supported identity, and our findings indicate identity positioning did occur and more positioning is possible with thoughtful design. More studies of this kind are needed, so the long term goal of our research is to explore the identity affordances of certain understudied game design elements (Figure 6). How might players begin to reimagine, narrate, and position themselves within an anticolonial narrative where they explore and interrogate taboo, politically charged issues, rewrite the code, and change the rules?

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Appendix A. Implementation to Date

In Figure 1 players are encouraged to decide to what extent they want to be involved with a team of hackers trying to block malware from the Navy. Here Tita positions main character Clara as perhaps not the “best fit” for a hacker, and players choose from provided options or rewrite the dialogue itself.

Figure 2 shows one miniquest where Clara attempts to hack the Navy servers, with Niko her hacker cousin standing by. This quest supports players to poke around and find the guessing game code within the game source files, practice saving, and learn how to “uncomment” Python code.



Figure 1. Clara's aunt Tita positions Clara as one whose time may be better spent doing other social justice quests instead of hacking.

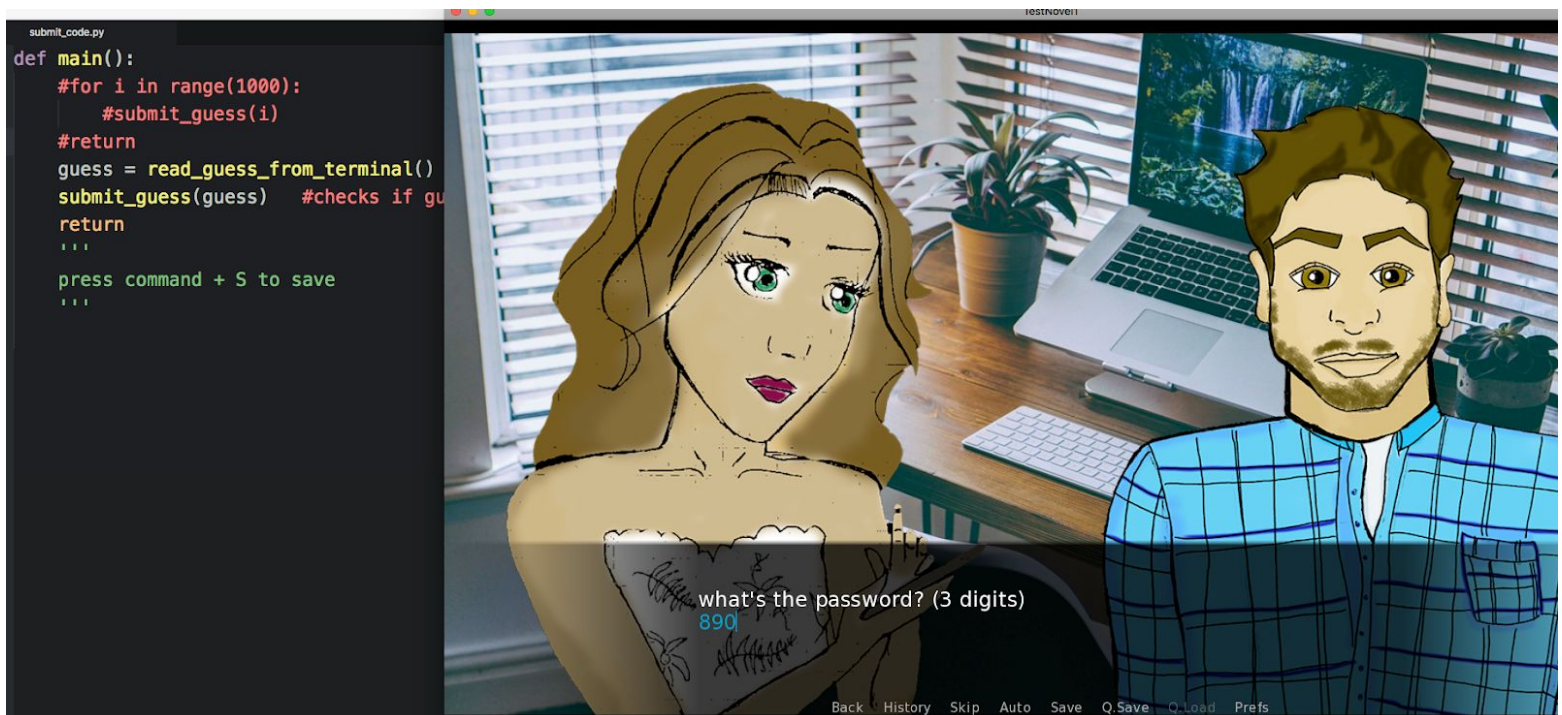
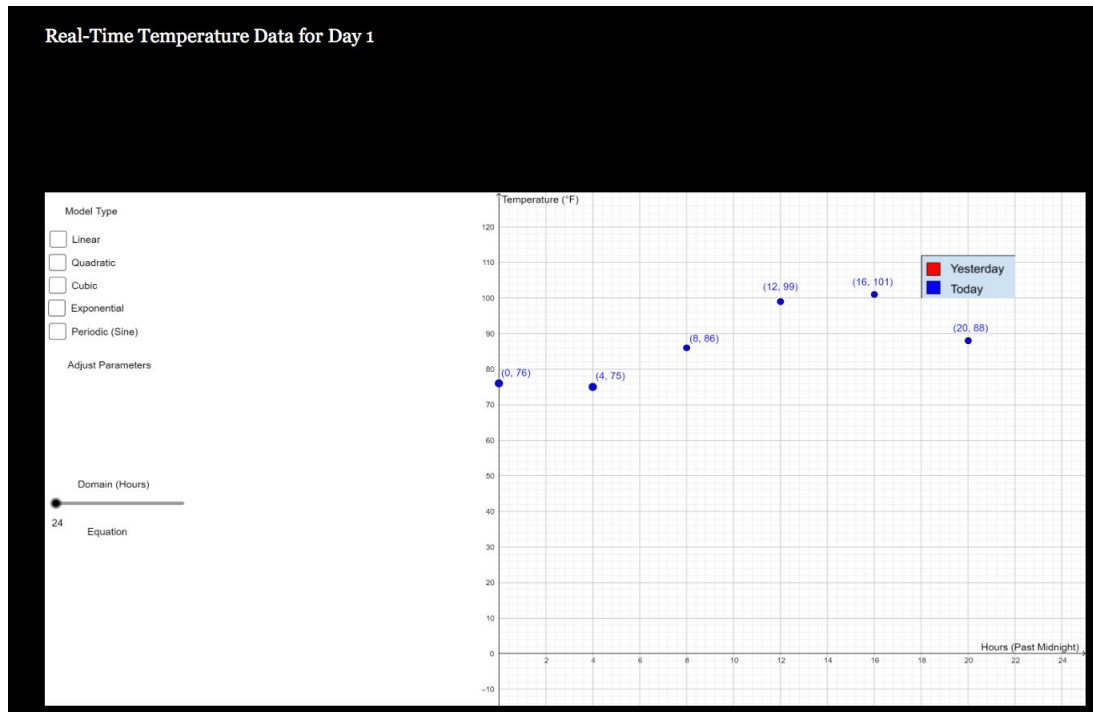


Figure 2: A random number 000-999. Players have to find the code for the guessing game and modify it, otherwise keep guessing indefinitely. Discover a solution already written inside the guessing game code, uncomment it and press "Save."

Appendix B. Figures



How well did your predictions do?

Your prediction for 12 PM was good.

Your prediction for 4 PM was good.

Your prediction for 8 PM was excellent.

Your overall prediction work was excellent.

It worked! The farmers of Tinian are safe, for the time being. I can't help but feel hopeful that our resistance will succeed!

But there's no time to rest. I have a few hours left to **ask around town for information** that might help me make tomorrow's prediction even better.

Figure 3, 4: Players get to see how many farmers' crops they helped save based on their predictions.

It is currently 8 o'clock PM. I have 3 hours left to talk to people.

There are several people I could talk to. The same **older woman wearing a floral-print blouse** that I saw yesterday is still sitting on her bench, gazing up at the bright red sunset with a sad look in her eyes. An **old man on the street corner** catches your gaze and returns it with a smile. A **Catholic priest** in full vestments walks towards his church. A **man with harsh eyes and blond hair in a Navy uniform** speaks quietly but intensely into a cell phone. And finally, two **young girls** are playing a game in the park, being watched by a **woman in her early 20s**.

Figure 5: Players explore and gather information from islanders to help make predictions.

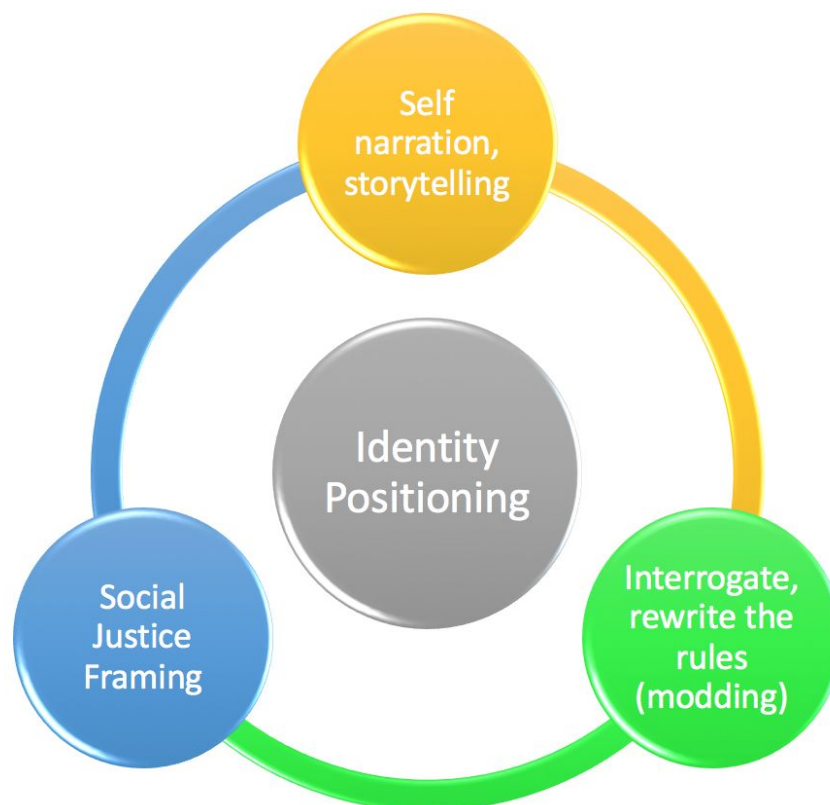


Figure 6: We plan to operationalize Gresalfi and Hand's (2019) frames (blue), narration (yellow), and specific norms and practices (green) to the design of our anticolonial video game.