CHAPTER 2

Systems at Play: Game Design as an Approach for Teen Self-Expression

MATTHEW FARBER, MIA KIM WILLIAMS, LETHA MELLMAN, AND XUN YU

ABSTRACT

The purpose of this mixed methods study was to analyze the impact of a facilitated game design experience on teens' awareness of systems thinking and self-expression of their lived experiences. To investigate how teens incorporated issues that are important to them through the processes of game design and systems thinking during a summer program, a concurrent nested mixed methods design was used (Creswell, 2003). Using qualitative data and analytic procedures, participant-created artifacts and observational research notes were examined. A pre/post survey provided descriptive data, as well as ordinal data, that allowed us to investigate any statistically significant change in participants' awareness of systems thinking. The findings inform how game design can be used as an approach for teen self-expression and developing an awareness of systems thinking. Findings suggest that through constructionist game design teens did make the connection between systems in their daily life. The findings also suggest that the teens were not necessarily cognizant of this awareness.

INTRODUCTION

In a recent study, 70% of teens aged 13 to 17 years (*n* = 970) reported anxiety and depression as top concerns for their generational peers (Horowitz & Graf, 2019). Teens in this study felt personal anxiety about how their academic success in school and would impact post-graduation goals (college acceptance, eventual career happiness) (Horowitz & Graf, 2019). These anxieties were reported much more than other stressors teens may encounter such as teen pregnancy, bullying, drug use, alcohol consumption; 61% of teens reported pressure to succeed academically, while 4% reported personal pressure to use drugs (Horowitz & Graf, 2019). These findings draw attention to what issues are important to teens in their day to day lived experiences.

During adolescence, when teens are navigating these issues, neural networks in the teen brain experience heightened plasticity, making social and nonsocial information processing more adept (Blakemore, 2018a; Knoll et al., 2016). The teen brain develops socially, based on adult and peer interactions (Blakemore, 2018a, 2018b). Peer interactions can exacerbate negative risk-taking behavior amongst teens (i.e., smoking, texting while driving) but also can influence teens to take positive risks (i.e., auditioning for a school play) (Blakemore, 2018a; Do, Moreira, & Telzer, 2017). Teens may be unaware of the systems that they inhabit, or how these systems function (Blakemore, 2018b), and likely even less aware of how the interactions they have with peers impact their development. However, the importance of these interactions with peers to their brain development warrants a better understanding by teens of their impact and awareness of the systems in which they live.

Systems thinking describes a worldview, or understanding, that all actions are interdependent and interconnected, and do not behave linearly (Salen & Zimmerman, 2003; Sellers, 2017). When teens explore and make meaning about the systems that they inhabit, they can feel empowered to affect positive change in their own lives (Senge, Cambron-McCabe, Lucas, Smith, Dutton, 2012). Games, which model simple and complex authentic systems in lived experience, provide a space for teens to explore and use systems thinking.

Games can be used as a practice space for teens to develop thinking about systems (Peppler, Danish, & Phelps, 2013; Rufo-Tepper, Salen, Shapiro, Torres, & Wolozin, 2011; Sellers, 2017). Games are "systems where players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (Salen & Zimmerman, 2003, p. 80). Further, some games can engage players in the process of metacognition; players hypothesize how designers think in order to solve well-ordered, meaningful problems (Gee, 2007; Squire, 2011).

Playing games is pervasive throughout U.S. households: 70% of families have a child who plays games ("Essential Facts," 2019). Playing digital games online increasingly provides a digital landscape where teens cultivate friendships (Anderson, Duggan, Lenhart, Smith, & Perrin, 2015). Fifty-five percent of frequent gameplayers report that playing games helps them connect with others ("Essential Facts," 2019). Amongst teens, girls tend to connect with others on social media, while boys play digital games together as a way to spend time and to interact with their peers and friends (Anderson et al., 2015). Further, 78% of people who play games report that games provide relaxation and stress relief ("Essential Facts," 2019).

Games not only model real-world systems, they can also evoke "deep, socially based emotions triggered by choice and consequence" (Isbister, 2016, p. 10). In games, players can feel guilt, complicity, pride, or shame as consequences to their actions (Hunicke, LeBlanc, & Zubek, 2004; Isbister, 2016). For instance, Braithwaite's *Train* (2009), part of the Mechanics is the Message series, included game pawns, railroad boxcars, and broken shards of glass as playable components. The rules instruct players to move pawns that represent train passengers from the boxcars. It is eventually revealed that boxcars are destined for Auschwitz, the Holocaust concentration camp. In *Train*, player interaction with mechanics drives a dynamic system that makes players feel complicit, an emotion that is complicated to achieve in non-interactive forms of media like books or film (Isbister, 2016). In playing *Train*, players explore why people blindly follow rules, as well as why people become bystanders, doing nothing in the face of tragedy (Romero, 2019).

Constructionist gaming describes the cycle of playing followed by game making and sharing (Kafai & Burke, 2015, 2016). The Sackboy Planet

community in *LittleBigPlanet 2* (Media Molecule, 2011) is an example where players make, share, and play user-designed game worlds (Rafalow & Salen, 2014). Making games is artifact production (Hunicke et al., 2004; Kafai & Burke, 2015, 2016; Rusch, 2017; Yang & Chang, 2013), a process that involves active engagement of making, reflecting upon, and sharing an external artifact (Kafai & Burke, 2015, 2016; Resnick, 2017). The meaning-making that happens through making is central to the tenets of constructionism (Papert, 1980).

In this study, we examine how playing and making games can be used as an approach for teens to self-express the systems that they inhabit and the issues that matter to them. This study analyzed games produced by teens during a two-week summer program. The program had been piloted before with varying alterations in curriculum and learning goals. Previous pilot studies elucidated issues that teens face. Findings informed further codesign sessions and the creation of new games that draw on teens' experiences and preferences to support them in achieving and maintaining their social and emotional well-being (Rivers & Rappolt-Schlichtmann, 2017).

The purpose of this research is to describe how game design relates to teens' awareness and self-expression with regards to the systems that impact their lived experience. Three primary questions guided the research:

1. How do teen participants in a game design program connect their game prototypes to issues that matter to them?
2. Do teen participants in a game design program become aware of different systems thinking components by making games?
3. In what ways do teens engaging in game design become aware of systems thinking components?

Theoretical Framework

The Mechanics Dynamics Aesthetics (MDA) Framework (Hunicke et al., 2004), widely used both for designing games and analyzing games (Ralph & Monu, 2014; Schrier, 2019; Walk, Görlich, & Barrett, 2017), served as

the theoretical framework for this research. Fundamental to the MDA Framework is a systems-focused concept that games are not transmissive media like film and books are, but instead they are "interreactive," describing the two-way interaction between game and player (Smethurst & Craps, 2015, p. 273). In games, the player consumes what the designer creates in a dynamic system (Hunicke et al., 2004). Through this lens, games are "artifacts, not media," as the behavior of games changes based on player actions (Hunicke et al., 2004, p. 3).

The MDA Framework considers games from the perspective of both the players and the designers around three lenses: mechanics, dynamics, and aesthetics. Designers create mechanics that cause the game as a dynamic system to behave a certain way. Players experience the aesthetics of the game system when they interact with it (see Figure 1). It is the game's dynamic system that evokes aesthetics, manifesting as players' emotional sensations (Hunicke et al., 2004). When playing a game, players may sensate challenge, connection, fear, guilt, or pride.

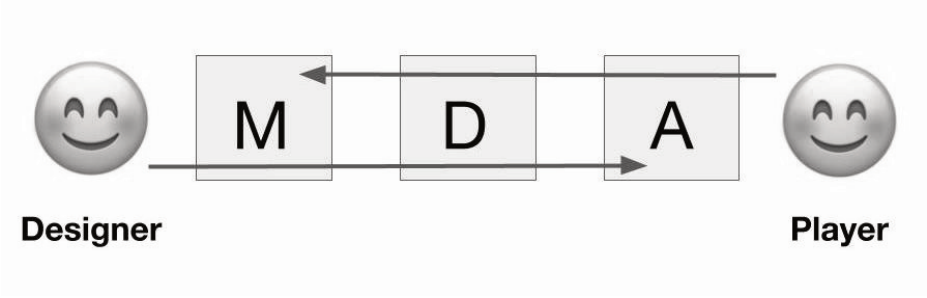

Figure 1. Designer and player perspectives (Hunicke et al., 2004, p. 2).

In the MDA Framework, mechanics refer to *all* components of games, digital or tangible; mechanics include game pieces, rulesets, and core mechanics, or repeated actions players take (e.g., Salen & Zimmerman, 2003; Sicart, 2009). As a concrete example, in the tabletop word-building game *Scrabble* (Hasbro, 1938), the mechanics are the game board, letter tiles, the letter tile tray, as well as all of the rules that guide or constrain what players can or cannot do when they place tiles on the board. Mechanics remain static until play begins; they sit stored in a board game box, computer algorithm, or in the players' minds (e.g., mechanics of

charades). It is not until players place letter tiles on the *Scrabble* game board that the dynamic system emerges, and the game becomes more than the sum of its components. The dynamic system of *Scrabble* includes, for example, a player's knowledge of the accumulating scores of each player, which then can influence player strategy.

In games, players have a sense of agency to make meaningful choices (Murray, 2017), which can lead to emotional investments and inconsequential outcomes (Isbister, 2016). As the dynamic system is driven, mechanics are set in motion by "active player choice," resulting in many emotions unique to games (Isbister, 2016, p. 9). Within the context of designing games, Hunicke et al. (2004) suggest using the MDA Framework backward, starting with the aesthetics, making player experience the initial design goal. Next, a dynamic system (or game engine) that can accomplish the aesthetic should be considered, which is finally followed by the mechanics that will set the dynamic system into motion.

Other game analysis frameworks have emerged in literature, adding or changing some of the MDA Framework's three lenses. For instance, Schell's (2008) Elemental Tetrad views games in terms of mechanics, aesthetics, story, and technology, where story affects emotions, and technology affords different types of dynamic systems (Ralph & Monu, 2014; Schell, 2008). The Design, Dynamics, and Experience (DDE) Framework is another extension of MDA, in this case, specific just to digital games (Walk, Görlich, & Barrett, 2017). Our study involved participants in playing, analyzing, and making both digital and analog games. After reviewing competing frameworks, we decided to use the MDA Framework because it can be used for analysis as well to inform design tool of both digital and analog games.

Systems Thinking as a Habit of Mind

Compared to a linear mental model of the world represented by a series of causes-and-effects, systems thinkers view the world dynamically, as interconnected with interrelated components (Assaraf & Orion, 2005; Norman, 2013; Salen, Gresalfi, Peppler, & Santo, 2014; Senge, 1990/2006; Shute, Masduki, & Donmez, 2010). In *The Fifth Discipline: The Art and Practice*

of The Learning Organization, Peter Senge (1990/2006) proposes systems thinking as a mindset, and as a teachable skill.

To become a systems thinker, one needs to pause and reflect on mental model assumptions of causes and effects in the world, and then rethink how each element of that mental model may be a component of a larger system. In dynamic systems, the actions of the components within that system can result with intended, but also unintended, consequences (Senge, 1990/2006). As an illustrative example, Senge (2006) described military retribution to terrorist attacks as a linear, cause-and-effect way of thinking, which does not consider unintended consequences or competing points of view. When seen through a systems thinking lens, responsive military attacks can make one nation seem more threatening to its enemies, thus leading to insurgencies and the possibilities of future terrorist attacks (Senge, 2006).

In the framework of 21st century skills, or The P21 Framework, systems thinking describes how problem solving occurs when students can analyze how parts of complex systems interact ("Framework for 21st Century Learning," 2019). According to Shute et al. (2010), people with systems thinking skills demonstrate the ability to "(a) define the boundaries of a problem/system, (b) model/simulate how the system works conceptually, (c) represent and test the system model using computational tools, and (d) make decisions based on the model" (as cited in Shute, Sun, & Asbell-Clarke, 2017, p. 146).

While desirable as a 21st century skill, research suggests that teaching students to shift mental models and schemas from linear thinking (cause-and-effect) to non-linear, or cyclical thinking (thinking in systems) is a persistent pedagogical challenge (Cabrera, Cabrera, & Powers, 2015; Hung, 2008; Wilensky & Jacobson, 2014). Unlike an assemblage of unrelated parts (e.g., a bowl of fruit), systems are characterized by being dynamic, comprised of components that each affect the overall behavior of the system as a whole (e.g., a bicycle's gears, chains, handlebars, and tires). In true systems, if a component is added or removed, the entire system changes (Salen & Zimmerman, 2003).

Research suggests that students should first learn how to distinguish

systems from non-systems; doing so will better prepare them to parse out underlying components (Assaraf & Orion, 2005; Kali, Orion, & Elon, 2003; Salen et al., 2014). Students can further understand systems through analyzing positive and negative feedback dynamics between smaller, individual parts (Kali et al., 2003; Watson, Pelkey, Noyes, & Rodgers, 2016). One method for analysis is the use of concept maps, where boxes (or nodes) visually represent components, and arrows indicate directionality of the feedback relationships. Concept maps are visual representations of the causal feedback loops of systems and are also effective as an assessment tool to measure students' systems thinking abilities (Watson et al., 2016).

There are few studies about shifting habits of minds from linear thinking to systems thinking. Of note is a longitudinal study at Quest to Learn, a New York City public school that uses games and a systems thinking curriculum (Kafai & Burke, 2016; Rufo-Tepper et al., 2011; Toppo, 2015). Students were assessed on their systems thinking abilities at four intervals across 20 months through questions about dynamic relationships (e.g., lack of sleep to drinking coffee for next day fatigue that leads back to lack of sleep). Students also were asked questions about complex social systems that they may experience in school, such as perceived peer pressure competition to wear and collect Silly Bandz (animal-shaped rubber bands; Shute, Ventura, & Torres, 2013). Results indicated that students, with teacher facilitation and support, demonstrated a significant improvement in systems thinking skills (Shute et al., 2013).

Systems thinking is narrowly defined as a problem-solving skill, while the related skill of computational thinking (Shute et al., 2017), describes the ability to cognate a mental model that aligns to the branched logic of computer code (i.e., if-then statements, decision trees; Papert, 1980; Salen & Zimmerman, 2003; Weintrop et al., 2016). Berland and Wilensky (2015) compared two groups of students who were tasked to learn about computational thinking and systems using robotics. One group programmed computer-simulated virtual robots, while the second group interacted hands-on, using physical robots. Findings suggested that computational and systems thinking skills may be dependent on the medium that students use to learn about those systems (Berland & Wilensky, 2015).

Teaching Systems Thinking with Games

Games model self-contained systems (Peppler et al., 2013). Each game component influences the overall state of the system (Fullerton, 2018; Salen & Zimmerman, 2003; Sellers, 2017). Games situate learning as players must consider how components, events, characters, and other parts of games relate to the overall system (Gee, 2007; Kaufman, Flanagan, & Belman, 2016).

In games, players have perceived control over choices and then experience the consequences of their actions (Isbister, 2016; Murray, 2017). Players make meaning from interacting with the affordances after receiving feedback from the game as a system (Cardova-Rivera & Young, 2013). For instance, the game *PeaceMaker* (Impact Games, 2007) simulates the ongoing Palestinian-Israeli conflict, while promoting perspective-taking by players playing both sides of the issue (Cuhadar & Kampf, 2014). Players of *PeaceMaker* make choices and then must react to the consequences that follow (Cuhadar & Kampf, 2014).

SimCityEDU: Pollution Challenge! (GlassLab Games, 2014) explicitly tests players' systems thinking abilities using embedded psychometrics. Evidence-centered design (ECD) in the game's code measures players as they balance virtual city systems by creating efficient school bus stop routes and low pollution cities that also have low unemployment. In one study, during play player mastery of positive and negative relationships in interconnected systems was assessed (Mislevy, et al., 2014). Among students in grades 6 through 8 (n = 400), there were significant improvements in systems thinking skills as measured during play (vs. pre- and post-play) with effect sizes from 0.47 to 0.87 standard deviations (Cohen's d) (Mislevy et al., 2014). While promising, there remains limited empirical evidence that playing games can lead to long-term observational changes in habits of mind (Wu & Lee, 2015).

In addition to playing games, game authorship can be an effective way to teach systems thinking (Fullerton, 2018; Kafai & Burke, 2015, 2016; Sellers, 2017). For instance, the process of creating games about climate change

engages youth in understanding how biomes as dynamic systems function (Puttick & Tucker-Raymond, 2018).

When making games, designers consider how tangible (dice, pawns) and digital (onscreen avatars, non-playable characters) components, as well as the players, interact in the game as a designed dynamic system. Components, which are mechanics in the MDA Framework, provide game authors with "objects-to-think-with" (OTTW; Brady, Holbert, Soylu, Novak, & Wilensky, 2014; Holbert & Wilensky, 2019; Papert, 1980). Holbert and Wilensky (2019) suggest that OTTW can be more transformative than games alone, as they facilitate meaning-making in systems experientially. By using digital design tools such as Gamestar Mechanic, which includes drag-and-drop blocks that have unique functions (each block is an OTTW), as well as allotting time for playing and discussing different tabletop games, youth have been shown to develop systems thinking skills (Bell, 2018).

Akcaoglu and Green (2019) studied how game design can promote systems thinking amongst middle school students (n = 19) enrolled in a game design course. Participants began the course by using coding tools to recreate culturally popular games (e.g., *Pac-Man*; Namco, 1980). Student-produced causal maps (concept maps and flowcharts) were used to illustrate the systems authored in those games. The causal maps "not only aided in their understanding of the relationships that existed in a system; but these external representations may have also helped students overcome a difficulty inherent to the design process: visualizing concrete relationships among multiple variables" (Akcaoglu & Green, 2019, p. 15).

In addition to authoring games based on subject-specific content, game design can engage and raise youth voice, choice, and agency (Danilovic, 2018; Sellers, 2017). When authoring games about one's lived experience, parts of the designer's life can become symbolic components, or OTTW, of their game as a designed system. This may prompt youth to identify and share issues that matter to them. These issues can be anything from what it means to have mutually respectful relationships with adults to how it feels (and what they need) to handle daily stresses, among many other topics (Danilovic, 2018; Rusch, 2017).

While literature is emerging on how game design practice teaches systems thinking skills (e.g., Akcaoglu & Green, 2019; Bell, 2018), there remains a deficit in the literature at the intersection of game design as a means of self-expression. This paper explores how teens can use game design as a medium for self-expression while also fostering systems thinking skills.

Game Design Studio

Game Design Studio (GDS) was a multi-session game design program created to teach teens design thinking, systems thinking, reflection, and social and emotional skills (Rivers & Schlichtmann, 2017). GDS had been field-tested and refined with approximately 50 youth, ages 13-18, since its inaugural pilot in the spring of 2017. For the current study, 16 teens spent 45-hours in the program, which took place over two weeks (9 days; week 1: Monday-Friday; week 2: Monday-Thursday), 5 hours per day. The setting was at a public university campus in the Rocky Mountain region of the United States.

GDS focused on narrative game design, defined for our purposes as telling story through game systems, which aligned with curricula around self-expression. Narrative games are less goal-driven and sometimes present narratives nonlinearly (Upton, 2018). In addition to learning systems and narrative game design, GDS participants were led in activities related to social systems (not dynamic systems). These included drawing a racetrack with obstacles that represented challenges participants face in their everyday lives. Participants also participated in a facilitator-led brainstorming activity about issues that youth face locally and nationally.

Participants began each day playing tabletop and digital games curated by GDS facilitators. Tabletop games included: *Jenga* (Hasbro, 1986), *Happy Salmon* (North Star Games, 2016), *Fluxx* (Looney Labs, 1997), *Forbidden Island* (GameWright, 2010), and *Tsuro: The Game of the Path* (Calliope Games, 2006); digital games included: *Super Smash Bros. Ultimate* (Nintendo, 2018), *Never Alone* (E-Line Media, 2014), and *Mario Kart* (Nintendo, 2014). The goal of these play sessions was to boost fluency about games as systems by analyzing their mechanics, dynamics, and aesthetics. Participants analyzed some of these games into five distinct

parts: components, challenge, goal, space (tabletop, computer screen), and rules. These sessions evoked emotional responses from players (e.g., cooperative mechanics in *Forbidden Island*; frivolity and social fun from the fist-bump mechanic in *Happy Salmon*). Teens were explicitly instructed to consider ways of remixing played mechanics into their team's game prototypes.

The first week of GDS focused on analog game prototyping using an array of components such as blank hexagon game tiles, assorted die, graph paper, colored pencils, and wooden cubes. GDS facilitators led participants through narrative design lessons, including one-hour workshop sessions on character design and world-building. These sessions utilized design document worksheets that included prompts (i.e., describe your game world's environment, draw a map of the continents in your world, what are the languages, beliefs, and values in your world). GDS facilitators asked participants to switch their worlds with others, and then to author a story in which the characters they designed interacted in others' designed worlds. Participants completed activities individually, while daily game development time involved teams. Team dynamics varied, with a few participants voluntarily changing partners.

In the second week, GDS facilitators introduced Twine, an open-source writing tool used to author interactive hypertext fiction. GDS facilitators helped teen participants to use Twine, guiding participants to create nonlinear narratives controlled when players click on-screen hypertext. In Twine, text and hypertext are visually represented as square cards or nodes; these nodes are then coded to connect and interconnect according to hypertext rules. As a design tool, Twine affords authors to write using the second person voice ("you"), which invites emotional storytelling (Salter, 2016; Tran, 2016).

Teen participants were given design prompts to inspire the games they would design, assigned randomly by die roll, using a 10-sided die (see Table 1). The design prompts were written to encourage teams to design first for aesthetics, then to work backward, considering the dynamic system and then mechanics (components, rules) that would evoke the prompt's aesthetics (e.g., Hunicke et al., 2004). Four of seven teams created game prototypes based on these prompts.

Table 1.

Game Prompts Randomly Assigned Through Dice Roll to Design Teams.

Roll (d10)	Prompt
1-2	Design a game about a change you want to see in the world. How can the player be part of that change?
3-4	Design a game that reflects core values (or a core value). How can the player accept, embody, or reject those values during gameplay?
5-6	Design a game that advocates for a community or person. What do they need and how can we help?
7-8	Design a game that inspires confidence or rewards strengths and personal growth in someone who plays it. How can the game mechanics make someone feel good about who they are?
9-10	Design a game that conveys teamwork to solve a "world problem." What kind of problems in the world require teamwork?

METHOD

The purpose of this study was to investigate how teens incorporated issues that are important to them into processes of game design during a GDS program. We were interested to know how and to what extent teens' self-expression, awareness of systems thinking, and understanding of the interplay between game spaces and personal lived experiences would be reflected in games they designed.

Mixed Method Design

A concurrent nested mixed methods design was used in this study (Creswell, 2003). Qualitative data and analysis procedures were the dominant method, which relied on information generated through participant-created artifacts and observational research notes. A pre/post survey provided descriptive data as well as ordinal data that allowed us to investigate any statistically significant change in participants' awareness of systems thinking. A concurrent nested mixed method afforded us the ability to collect information at different levels and to provide corroboration of findings within the study.

Participants

Participants (*n* = 16) were male youth with an average age of 15 years (range = 13-18 years), from suburban and rural areas in the Rocky Mountain region, who voluntarily enrolled in GDS. All attendees were invited to participate in the study; one chose not to consent to the study but still participated fully in the program. His individual artifacts were excluded from this analysis. GDS was not gender-limited and was marketed to local school districts and after school organizations; however, only male youth signed up to participate. Eleven of the participants identified as Caucasian, 6 as Hispanic or Latino, 1 as Asian, and 1 as Hawaiian/Pacific Islander; several of the participants identified as more than one race. While this number adds to more than the participant number, it is possible some answered more than once, as they may identify with more than one category. All participants had prior gameplay experience with digital and analog games; 12.5% (*n* = 2) of participants reported any prior game design experience.

Data Collection

Multiple data were collected during this study to answer the research questions, including observational notes, a subset of Likert-like responses from a pre- and post- survey, and two artifacts: game prototypes and game pitches. All participant-created data were activities that were part of the GDS curriculum for all participants. At the conclusion of GDS, data generated by research participants were separated and non-participant artifacts and survey data were discarded. All data were anonymized in compliance with human subjects' protections.

Observational Field Notes

Two researchers participated as observers during the program's duration. Each collected ethnographic-style notes to capture descriptions of day-to-day happenings, comments and actions of participants, and comments and actions of facilitators. We also collected perceptions through reflective field notes (Bogdan & Biklen, 2007).

Pre- and Post- Survey

A pre- and post- survey was conducted on Qualtrics that included demographic information, seven open-ended questions, and 16 Likert-like scale items with five response choices (strongly agree, agree, neutral, disagree, strongly disagree). The survey questions focused on participants' perceptions of gaming, gameplay, systems, and teen issues. For this paper, three Likert-like scale items were used to identify any change in participants' perceptions about gaming and teen issues. Questions about systems thinking competencies were adapted from Shute et al. (2013) which had validated its interrater reliability of systems thinking scores. Questions about teen perceptions were adapted from validated and reliable studies about youth attitudes towards educational games as well as sociocultural issues (e.g., Çankaya & Karamete, 2009; Chen, Lien, Annetta, & Lu, 2010; Hedden & Zhang, 2002).

Artifacts

The game prototypes and game pitches were created by the participants as part of the GDS activities. We collected images of the games as well as paper or digital prototypes. Game pitches were captured on video; the slide decks that were used by participants during the pitches were also collected as artifacts. All were used in the analysis of the games.

Teams were given bounded time each day to prototype games based on their design prompt. Paper and digital prototype games were created and the final prototype was used as the artifact in this research. The prototyping process was iterative throughout GDS based on facilitators' and other teams' feedback during playtests. Games were early prototypes; rules were not always yet written and components not fully completed.

The "Game Pitch" was the culminating activity of GDS and took place on the final day of the program. It focused teams on a delivery date for prototypes and supported the teen participants' process to think about the design as one entity to be shared. Participants were given a Google Slides deck template and a list of requirements. The goal of pitch preparation was for participants to practice talking about their design, and how it connects to

their design prompt, while not spending too much time developing slides. Game prototypes were pitched to professionals in the field. The Game Pitch was not competitive, but the experts asked probing questions and offered notes for further shaping the games.

Data Analysis

Consistent with a concurrent mixed method design, various data were analyzed simultaneously and brought together to develop findings.

Qualitative Data Analysis

The game design artifacts were coded and analyzed for a deeper understanding of teens' lived experience, the systems that impact their lived experience, and their ability to express and experiment with those systems through the act of making games. Data analysis follows an interpretivist approach, a paradigm that gleans meaning from observed experiences, artifacts and actions (Corbin & Strauss, 2008). Utilizing a constant comparative analysis of the data collected (Corbin & Strauss, 2008), artifacts and observation field notes were read and viewed as they were generated and again at the end of the data collection period.

The MDA Framework was used as a lens to analyze systems in participants' games. According to Hunicke et al. (2004), first mechanics should be analyzed, followed by dynamics, and then aesthetics. As these were prototypes and not finished games, aesthetics shared by teams were what the designers intended, and were not necessarily fully realized. Time constraints limited teams' ability to iterate on ideas to create playable completed games. Each team's planned aesthetics were captured in a slidedeck as well as a video recording of their presentation given during the pitch session. Reliability of the qualitative analysis was established by repetitive analysis by at least three of the researchers.

Survey Analysis

Participants' pre- and post-survey responses were compared to determine

whether there was any significant change in perceptions about connections between game design and life experience. This comparison was completed for a subset of Likert-like items on the survey. A paired *t*-test was conducted with the level of statistical significance set at .05. The analysis presented three critical pieces of information: (1) the mean pretest score, (2) the mean posttest score, and (3) the *p* value. A *p* value less than the specified level (.05), indicates there was a statistically significant difference between the pretest and posttest score. A *p* value larger than .05 suggests that participation in the GDS had no statistically significant impact on participants' perceptions. A two-directional analysis was made.

Null Hypothesis

- There was no statistically significant difference between participants' responses on the pre- and post-survey. (H0: $\mu 1 = \mu 2$)

Alternative Hypothesis

- There was a significant change in participants' responses on the pre- and post-survey. (H1: $\mu 1 \neq \mu 2$)

The statistical analysis in this mixed method study was conducted with the small sample size of teen participants' responses ($n = 16$). It does not imply statistical generalizability but provides insight into the change in perception of the participants and supports the qualitative measures.

FINDINGS

The findings in this section share descriptions of games participant teams prototyped by the end of the second week of GDS, game prototype analysis using the MDA Framework, and a comparison of the pre/post responses from the survey.

Team Prototypes

The following are descriptions of game pitches given by the seven teams

who created the game prototypes, supplemented by collected observational field notes, and data from the recorded presentations and the slidedeck participants created. Each subhead is the name of the team, which had between one and four members. Four of the seven teams created prototypes inspired by the design prompts; three created their own prompts on which they built their game. Teams are listed alphabetically.

The Banana Boys

The Banana Boys was a three-member team. Their design prompt was, "Design a game that inspires confidence or rewards strengths and personal growth in someone who plays it. How can the game mechanics make someone feel good about who they are?" To address this, they created *Delta 97*, a character-driven game prototype. In *Delta 97*, character cards became central; players are given information about weapons and character "life points," but no narrative wrapper.

The Banana Boys originally planned a digital "non-Euclidean" first-person shooter game; however, the team pivoted during week two to design a card game called *Delta 97*. The team considered this a paper prototype for an eventual digital game. *Delta 97* was intended to be played as a "free-for-all," where the last player remaining wins, or as a collaborative multiplayer game. In the game pitch, one of the designers remarked that free-for-all is stressful, which is why it was included as a play mode. In the Game Pitch, the designers described decisions around inclusivity:

> Each character has a role so each player feels important. It is important for people to identify with characters and feel confident about who they are and what they are doing. So, we also decided to mask our characters to allow the players to decide the gender and race of these characters.

During the pitch, the team was asked by the panel of experts why their diverse characters still appeared as humanoid (all were described as human except for one cyborg who has wheels for legs). One team member responded that it was "easier for players to project themselves on a character that is humanoid." Characters also lacked facial features, which

the design team said was due to constraints, "it makes it easier for us to model."

The game starts with players deciding play mode (free-for-all or multiplayer). Players then choose a character and perform several actions per turn. First, they attack by rolling a 20-sided die, then they draw a new weapon card. The number on the card correlates to a type of weapon. When a player kills an enemy, they discard their weapon card and take their enemies' weapon. The game ends when only one player or team remains.

Chicken Nuggets

Chicken Nuggets was a two-person team: a collaboration between one GDS participant who had been part of a team but opted to leave the group because of creative and team dynamic differences, and one GDS facilitator who assisted the participant in design. Chicken Nuggets designed *Rotate,* a two-player, cooperative board game. Each player is one of two twins who must work with the other player. It was designed around a theme not part of the design prompt die roll: "To make a collaborative game that is fun."

Rotate included a narrative wrapper about twin angels who are split apart at birth, but need to reunite to defeat a monster. The game's board consisted of paper tiles adorned with curved lines (see Figure 2). Paper tiles resembled tiles in *Tsuro: The Game of the Path*, where lines on tiles form a path. *Tsuro: The Game of the Path* was played and analyzed by this participant earlier in the week (led by a GDS facilitator).

The goal of *Rotate* is to line up tiles to enable players to move towards the center, the place where they fight the monster. Players roll a six-sided die (a d6), which lets the player know how many spaces to move. Players can move their token in any direction from one tile to another. They may also rotate a tile their character token is on, as well as surrounding tiles.

Figure 2. Chicken Nuggets prototyping Rotate.

If a player gets to the center (the opposite end of their tile game board), the monster attacks. That player then rolls the monster die (a d6 die) and subtracts that from his/her/their life points. The players then attack with a d6.

Each player starts the game with 50 life points, and the monster starts with 100 life points. Players can only attack when they reach the center; if one player is in the center, and the other is still working through the tiles, only the player in the center battles the monster. This constraint gives the monster an advantage over fighting a single player; this condition becomes equalized if both players fight the monster together.

HD Studios

The Comedian is a murder-comedy Twine story from HD Studios, a team of two GDS participants. The player is a detective who must solve a murder.

To continue playing, the player must choose "OK," and avoid dark humor options. If the player does click a dark humor option, the player dies and it is revealed that they are the murderer. None of the non-playable characters react positively to the jokes the player makes (or selects, from presented choices). The narrator is actually unreliable; the player is actually the murderer. The team stated that the game is "basically about Karma: you make a bad joke about someone, you get Karma." The Twine story will then loop back to the start of the story.

Originally a paper prototype during week one, the team pivoted to Twine in week two. When they switched, they changed the prompt. Instead of the design prompt from the die roll, the team decided they wanted "to find a good way to make murder funny." To accomplish this, they used Google Search using search terms "dark humor jokes." After reading the search results, they altered the jokes to fit the story (e.g., "someone falling off a building for someone falling [in love] with them"). During the pitch, the team stated they searched "dad jokes," too.

The game was decision-tree based, built in Twine, where the player must choose the correct dialogue and choices to win. Penalties include death or jail. The player cannot hit the back arrow on Twine, which is stated in the rules. The narrative advances as the player makes choices by answering questions.

The Memes

The Memes, who had three team members, designed *Broken Violin*, a Twine horror story, with added humor in the narrative. The team's design prompt was, "Design a game that advocates for a community or person. What do they need and how can we help?"

Their Twine story begins as the player meeting a homeless individual. Players are given a choice to give him money. The team explained, "You can choose to give money to a homeless man or not to. [The homeless man] is really a wizard, but you will only find out if you give him money." This decision affects the further gameplay outcomes.

This branched narrative continues as players hear a playing violin. Players

then must choose to go outside into the forest to follow the violin's sound, or to remain inside. If players go outside, they die immediately. In the Game Pitch, the designers self-critiqued the strength of their narrative.

The story advances as the player makes choices by answering questions. The player cannot hit the back arrow on Twine, which was done intentionally as a set-back penalty for wrong decision-making. In *Broken Violin*, the player will always die.

The goal was to be kind prior to being rewarded. According to the team, "You don't need to know who you are helping to help." In the story, it is revealed that the homeless person is actually a wizard, and the player only discovers if he or she gives him money. The team stated that homeless character is always present when the player returns home, which one of the youth designers found humorous.

Purgatory Gaming

Purgatory Gaming had four teammates, but only three members presented. Their prototype, *War with the Demons*, was built using Twine, addressing the prompt, "Design a game about a change you want to see in the world. How can the player be part of that change?" The team interpreted the prompt, stating, "Our change in the world is how war can change the world. When someone who you know who is in the service dies and you have to go through a rough grieving process (i.e., WWII, etc.)." One participant stated that the team struggled writing a nonlinear story that also had to be unique. Another challenge of their creative process was trying to make a fully playable prototype within two days; the team had pivoted from a tabletop role-playing game to Twine.

Players control Soap, a 21-year-old who "has been in the humans' military for 3-years ever since the wars around the world between all the different races started happening." This protagonist is "quite skilled all-around when it comes to shooting any kind of weapon." Soap lives at home with his/her/their mom and pet *pegacorn* (fictional animal).

War with the Demons was inspired by the *Call of Duty* (Activision, 2003)

wargaming franchise. The narrative wrapper was from a participant who had written it before GDS. Titled, *The Never-Ending Legacy*, he wrote,

> Humans, elves, orcs, giants, dwarfs, and necromancers all lived in harmony until the demon nation attacked. The attack caused all the nations to fight amongst each other. For safety and protection, you joined the military and moved you, your mom and pet *pegacorn* into the military base.

The Twine story starts as Soap awakens, selects a weapon, gets dressed, and eats breakfast. All seems normal and calm until the player opens the front door. There is a battle raging outside that "pulls the player from a typical day and thrusts the player into an intense battle." One minute the player is telling his/her/their mom "I love you," just as though "he or she were going off to school, just like every day." In that instant, the player realizes that the daily routine is a battle for self and world preservation.

The player moves through the narrative by selecting choices such as: "Do you stay and fight with your military buddies, or do you retreat?" These choices inevitably lead players to die with honor or as a coward. If the player feels that Soap has died prematurely, they may restart the story. When Soap's captain dies, the player has the choice to "do as they taught you or try to get revenge." Purgatory Gaming said that is was an intentional design choice, stating, "Players deal with grief through this character because war can drastically change somebody's life and even their whole world depending on what happens."

Sly Games

Sly Games, who had two team members, designed *Gaming Has Saved Me*. It was based on the prompt, "Design a game that advocates for a community or person. What do they need and how can we help?"

Gaming Has Saved Me is a Twine story about a boy who plays *Fortnite* (Epic Games, 2017) and *Playerunkown's Battleground* [*PUBG*] (PUBG Corporation, 2017) to "get through his tough home life." The team stated that their prototype was "meant to show how one day your life can be near perfect, and the next day you have many struggles, but there is always a way to get through it." This was also part of their slide deck: "What inspired our game

was showing how video games can be used for good, some kids don't have a good life and they rely on video games to keep them comfort when no one else can." In the pitch, one team member remarked, "Some kids don't have a good life and they rely on video games to keep them comfort when no one else can."

This game intended to show players how their lives can have "many bad turns that put you in a bad situation." The team stated that this affects many people and felt that it "needed to be known that video games can help people get through challenges." *Gaming Has Saved Me* was designed to show other teens that they "are not alone and many people go through what they are going through."

The Twine story advances as the player clicks choices that are a series of questions. The narrative has a looping structure; no matter what happens, parents remain fighting, people continue to yell at the player, and the player always escapes to play video games. Parents fight over topics such as the player's grades in school and money earned from mowing the lawn. Regarding the inclusion of arguing parents, the team stated, "it happens all the time."

The Twine story concludes as the player, who is playing video games, declares, "Video games saved my life."

Taem Meme

The End is a Twine story from a one-participant member team, Taem Meme. The player-protagonist is a Robot named Axe who works for the evil Lord Puguinie. Instead of using a randomly determined design prompt, this participant decided to "take the characters in the game authors(s) head and write a story and game about them that other people would like."

In the Game Pitch, Taem Meme explained his narrative, character interactions, and character development expanded as he implemented his ideas through various GDS activities. He had conferred with GDS facilitators, sharing ideas and thoughts.

During week one, *The End* was prototyped on paper; Twine used in week 2 (see Figure 3).

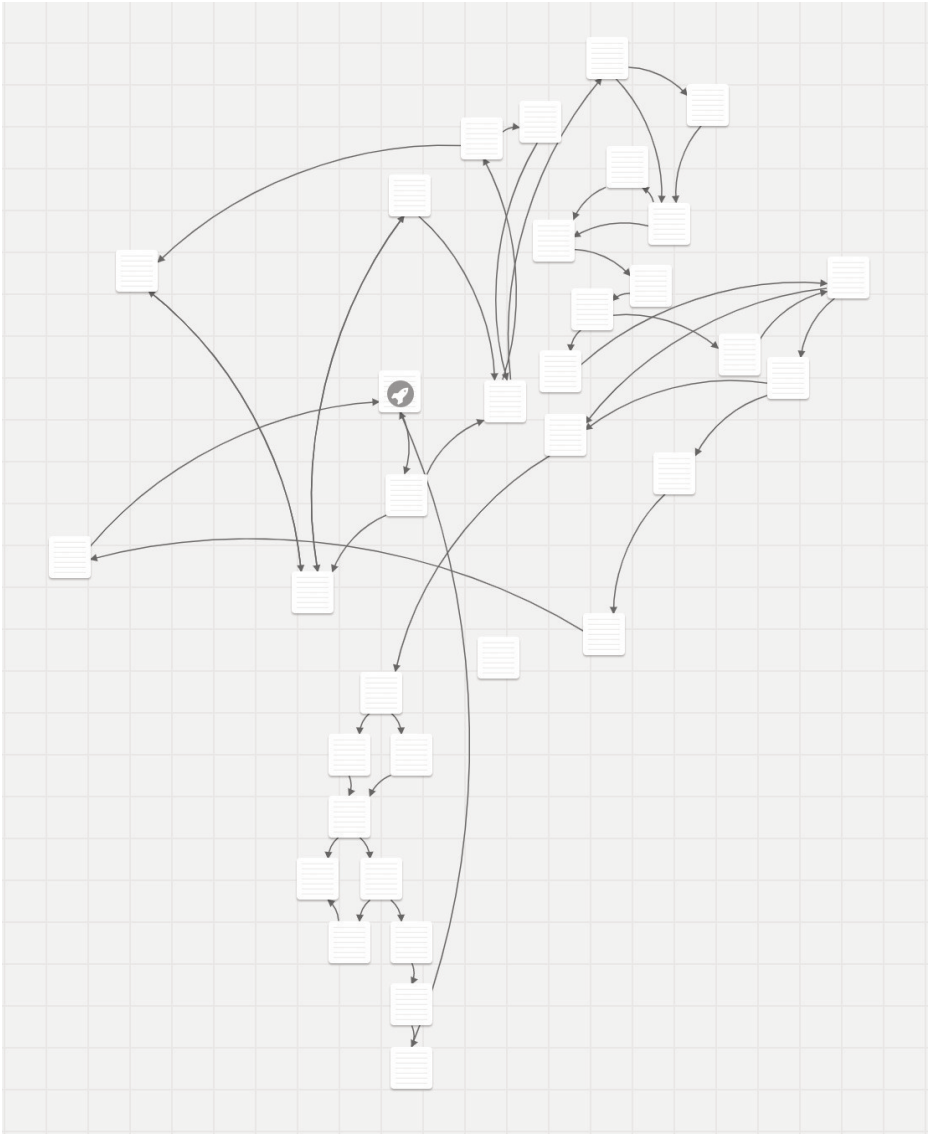

Figure 3. Twine node map of Taem Meme's The End.

The story begins as the player wakes up in the castle's medical bay, finding Lord Puguinie fighting an enemy in the throne room. Lord Puguinie tells the

player to find his minions again to take over the world, stating, “Puguinie wants to destroy the universe!” During the Game Pitch, the participant asked, “Will you trust your gut? Or will you disappear into a void of endless suffering?”

As the robot Axe, the player discovers that he/she/they are the first robot infected by the Puguinie Virus. As a result, Axe became an evil robot who only can obey Puguinie’s commands. However, Axe can still choose his actions.

As the narrative develops, Axe finds clues about the Puguinie Virus. Axe eventually meets Sammy, the hero of the world, and then interacts with him in the story. Finally, Axe realizes Puguinie’s evil plan: The player learns that Lord Puguinie is planning to destroy the universe and everyone in it. Axe decides to save the universe instead. To do so, Axe must find three “important items.” The narrative concludes with a plot twist near the end: Axe was the first robot created by Puguinie, and is “actually a good robot in disguise. She was discarded after losing one battle.”

Issues that Matter to Teens

One of the early activities in the camp was a brainstorm discussion that generated issues that were important to the teen participants. During this session, they focused on global issues and general categories including drugs and alcohol, lack of appreciation, misinformation, teen-parent issues, generation gap, lack of control/rules, friendships, and popularity. Participants were eager to share these ideas. After many minutes, the conversation became somewhat personalized when one participant offered, “using violence, like suicide” and said “I have a friend…” as he identified the topic as being important to teens. This prompted some additional issues such as violence at home, parents, specifically parents who don’t get along, and depression. However, the participants did not reveal if they had personal experience with an issue they shared. This is in contrast to the talk around the issues that appeared in their game prototypes and pitches. In conversations with the facilitators, team members talked more openly about personal experience by self or others they knew as reasoning for why a game component was approached with

a particular aesthetic in mind. An example of this was a conversation with participants who revealed that home life was challenging, and thus identified it as a teen issue they shared among members. "We found out that we have in common that our parents fight all the time so we wanted to have humor in our game," stated one participant. "Gaming is a way to get away from it… I put on headphones."

Table 2 lists major issues identified by teen participants in the game prototype or during the pitch.

Table 2.

Teen Issues Identified in Prototypes by Teens

Team Name	Prototype	Issues in Game	Issues in Game Pitch
The Banana Boys	*Delta 97*	Struggle to be comfortable with who you really are	Need for gender equity
Chicken Nuggets	*Rotate*	Struggle between good and evil	Impact of your actions on others
HD Studios	*The Comedian*	[not directly included in the game mechanics]	Using humor to deal with hard situations, Karma
The Memes	*Broke Violin*	Need for kindness	[No additional issues identified by team members during pitch]
Purgatory Gaming	*War with the Demons*	Impact of war Uncertainty of life	Dealing with grief
Sly Games	*Gaming Has Saved Me*	Challenging home life	Video games have good qualities and can be a support to teens (perception of games)
Taem Meme	*The End*	Struggle between good and evil	Making the right choices

Other participants shared stories of similar struggles at home more openly in their game pitch and how that impacted the unpredictability of the gameplay in their prototype. Some teams were more open about sharing personal stories and some were more aware that they were purposefully using their experiences as mechanisms for how players might interact within their game. Some appeared to be purposefully selecting the aesthetic, but participants did not offer this information; some found it difficult to respond to prompting questions from facilitators about the origination of ideas or aesthetics.

MDA Analysis

We used the MDA Framework to analyze systems in participants' prototyped games (see Table 3). When analyzing games, we considered the mechanics first, as mechanics create the dynamic systems that can evoke aesthetics (Hunicke et al., 2004). One prototype was a tabletop role-playing game and one was a tile-based board game. The remaining five prototypes were hypertext fiction built with Twine. Teams added rules to their Twine story prototypes, stating that players were restricted from clicking the back arrow to select alternate choices.

In hypertext fiction, aesthetics connect to descriptive storytelling ("game as drama;" Hunicke et al., 2004, p. 2; Salter, 2016). In interactive fiction, player empathy may be dependent upon the strength of the narrative (e.g., Castano & Kidd, 2013). Player emotion may be evoked from feeling agency to select story choices (Isbister, 2016). Players may also feel agency in how they mentally interpret written text, even though they may not actually control the narrative (Mendelsund, 2014).

It is recognized that in formalist terms (e.g., Juul, 2005), hypertext fiction (Twine) is not a game, even though the narrative is driven by player decisions. Twine stories are interactive, not interreactive (Smethurst & Craps, 2015); the system reacts to player choice but does not itself change based on those choices (Juul, 2005). As a web-based application, Twine translates passages on a web browser. Subsequent story web pages do not exist until (or unless) the player-as-agent interacts with hypertext, thus creating the story as they click, mouseover, or otherwise provide input.

As these were prototypes, the descriptions in Table 3 are based on the Game Pitch presentations, not from observing player responses. Instead, teams described their prototyped games in terms of mechanics, dynamics, and desired aesthetics, or emotional outcomes.

Table 3

Team Game Pitch Prototypes Analyzed Through the MDA Framework

Team Name	Prototype	Mechanics	Dynamics	Aesthetics
The Banana Boys	*Delta 97*	Cards, character sheets, dice, pencil, paper, tabletop. Two play modes: "free-for-all" and multiplayer. Rules: when an enemy is killed, players have to discard weapons and take the enemy's weapon. Players have actions based on die roll.	Impending attack from other players; randomness of die roll	Narrative: Game as drama. Fantasy: Game as make-believe. Challenge: Game as an obstacle course.
Chicken Nuggets	*Rotate*	Character and monster tokens; players' and monsters' die; action cards; game-board of moving tiles; Rules: must stay on continuous line to move token; players can either move the character one tile or rotate a tile to move onto; player can only move or change tiles the number rolled on the die; monster cannot attack until one twin is in the center.	Player cooperation; randomness of die roll	Fellowship: Game as social framework. Challenge: Game as an obstacle course.
HD Studio	*The Comedian*	Branched narrative. Added rule: players may not click back arrow.	Hypertext fiction	Narrative: Game as drama. Dark humor. Frustration.
The Memes	*Broke Violin*	Branched narrative. Added rule: players may not click back arrow.	Hypertext fiction	Narrative: Game as drama. Self-awareness, Integrity.
Purgatory Gaming	*War with the Demons*	Branched narrative. Added rule: players may not click back arrow.	Hypertext fiction	Narrative: Game as drama. Fantasy: Game as make-believe.
Sly Games	*Gaming Has Saved Me*	Branched narrative. Added rule:: players may not click back arrow.	Hypertext fiction	Narrative: Game as drama. Submission: Game as pastime.
Taem Meme	*The End*	Branched narrative. Added rule: players may not click back arrow.	Hypertext fiction	Narrative: Game as drama.

Survey Responses

A paired, or dependent, *t*-test was conducted with the level of statistical significance set at .05 for a subset of responses on the pre/post survey. There was no significant difference in the scores for the pre (M = 4.31; SD = 0.70) and the post (M = 4.00; SD = 1.03) responses to *I think about the messages in the games I play,* $t(15) = 1.58$, $p = .14$ There was no significant difference in the scores for the pre (M = 4.13; SD = 0.89) and the post (M = 3.81; SD = 0.98) responses to *I think about how games represent different kinds of people,* $t(15) = 1.43$, $p = .17$. There was also no significant difference in the scores for the pre (M = 4.19; SD = 0.66) and the post (M = 3.94; SD = 0.85) responses to *I think about how games represent different kinds of life experiences*, $t(15) = 1.73$, $p = .10$.

In all three pairs, the null hypothesis was retained. However, it is of note that the mean in all three pairs was lower, which represents that participants agreed less with the statements on the post-assessment.

DISCUSSION

All the participants in this study made a transition from gamer to game designer, including learning about game mechanics, world-building, design, and narrative construction. Participants noted differences of awareness about systems and how systems exist in games and in lived experiences.

Game Prototypes as Teen Artifact

There was a lack of connection between game prototypes and the systems inhabited by participants' life experience. Six teams gravitated towards global themes that affect youth (i.e., war, good vs. evil) rather than issues or systems that may affect participants personally or directly. Sly Games's *Gaming Has Saved Me* theme of arguing parents was one exception, as it was set in a home environment populated by arguing parents.

It is unknown if the mechanics in prototypes were inspired by facilitator-led discussions, autobiography, or remixed fiction because participants were not forthcoming with this information. While HD games shared common

experiences among teammates related to challenging home life, we do not know if the arguing parents in Sly Games's *Gaming Has Saved Me* was based on participants' homes, or whether the idea was from the design prompt, or in a GDS brainstorming activity. We also do not know if Purgatory Gaming's *War with the Demon's* violent backdrop represented the neighborhood where participants live or if it is a video game trope weaved into their prototype's narrative.

Symbolism was often not exhibited: participants were not abstracting components and rules of their lives into prototyped games. In other words, participants did not break down issues that affect their lives into playable OTTW (Brady et al., 2014; Holbert & Wilensky, 2019). Yet, participants were able to discuss their prototypes as systems during the game pitch session.

Abstracting may be more of a cognitive challenge to some teens than writing narrative. It is possible that more explicit instruction was needed for participants to abstract their lives into their prototypes if games had less of a narrative focus.

Awareness of Systems

The short answer to the second research question, "do teen participants in a game design studio program become aware of different systems thinking components by making games?" is yes. For example, Chicken Nuggets demonstrated awareness of the affordances collaboration and cooperation give to gameplay in *Rotate*. It is impossible to win alone, privileging working together in a battle to defeat a common enemy. A player must think about how an action they execute impacts the other player, as well as their own character, and how that action contributes to or detracts from the common goal. This demonstrates awareness of the relationship among components within a system and parallels lived experience. Taem Meme also showed awareness of this relationship through the interplay of characters who represented good and evil in *The End.*

Participants demonstrated systems awareness, but not systems fluency, in the survey responses. Participants showed no statistically significant

change in understanding of systems. But, it is important to remember the parameters of the study, which includes 16 teen males during a two-week game design program. It is more interesting to note that participants' average responses indicating their awareness of the connection between lived experience and games dropped about three-tenths of a point for each question. As teen participants develop awareness of this connection, their knowledge of what they do not engage with, or their lack of awareness, becomes more prevalent. Thus, this could account for the lower average during the post-survey.

In the GDS, facilitators and participants worked with the understanding that most things are complicated. We worked with a value-added group dynamic launched by the improv game *Yes, And*. The findings indicate participants were aware of systems. Their depth of understanding, application of systems to game design, and transfer of knowledge about systems in the game to understanding of systems related to teen issues were significantly individualized, even among group members. In conversations with facilitators, team members had different rationales for particular narrative components or game mechanics. More analysis of the qualitative findings is necessary to understand the complexities of their individual levels of awareness of systems and is outside the scope of this particular paper.

With the exception of Chicken Nuggets' *Rotate*, prototypes were either hypertext fiction or tabletop role-play. As games, tabletop role-play are "borderline cases" of games (Juul, 2005, p. 28), as they can have flexible rulesets. Five teams used Twine, a hypertext interactive (not interreactive) writing tool. Hypertext fiction breaks down narratives into smaller parts, which became story paths, or nodes. Their resulting branched stories were visual, represented on-screen as "node maps" (Salter, 2016, p. 2), a web of connected boxes (see Figure 3). While not dynamic or interreactive, node maps visually resemble concept maps, a useful tool in teaching awareness of systems thinking to youth (e.g., Watson et al., 2016).

Nodes in hypertext differ from abstracting components and rules to be symbolic. In hypertext fiction, nodes represent threads of a story, not symbols that abstract larger concepts. As a comparison, in Braithwaite's *Train* (2009), boxcars, yellow pegs, and rulesets work together to create a

dynamic system that evokes an aesthetic response from players (complicity and dread) (Isbister, 2016). In most participants' prototypes, narrative design took precedence over mechanics and dynamics. While GDS activities included lessons on character, narrative design, and world-building; games do not require a narrative wrapper, and games do not always tell stories (e.g., Bogost, 2017; Flanagan as cited in Farber, 2017). In GDS prototypes, rather than aesthetic responses to dynamics, player choice within branched narratives were often used to evoke emotional responses from players.

Four of the GDS prototypes were developed character sheets, sometimes with detailed drawings. Character sheets are common in tabletop role-playing games such as *Dungeons & Dragons* (Arneson & Gygax, 1974; Wizards of the Coast, 2014). In *Dungeons & Dragons*, players take on different identities and then make decisions in a guided system, led by a dungeon master (DM). *Dungeons & Dragons* is a collaborative storytelling game where players' power may directly relate to gender, gender representation, race, racial distrust, and racism (Garcia, 2017).

None of the GDS prototypes were playtested to the extent that a dynamic system emerged. While *Rotate* had a clear goal and moveable tiles, the other GDS prototypes lacked a dynamic system where mechanics could interreact with player choice and evoke aesthetics. It is possible that more time may have led to an emergence of dynamic systems.

We note here that there are social science models that share the same name of "systems," such as Bronfenbrenner's (1979/2006) ecological systems theory model. His model suggests that individuals develop as a function of their interactions with people, objects, and symbols across several nested and interactive contexts (home and family, school, parents' workplaces, mass media, laws, and cultural ideals, etc.) over time. Systems thinking differs in that it describes a worldview about causal relationships. Perhaps narrative design (e.g., hypertext fiction, tabletop role-playing games) is a better approach for modeling social systems than authorship of games that have true dynamic systems. Hypertext fiction and tabletop role-play design may afford narrative over dynamics.

Gameplay as Learning Space

Using games as a medium for teen self-expression was valuable in establishing a learning space. Teens engaged in meaningful conversations about issues that were important to them during both gameplay and game design. The opportunities that GDS afforded teens proved to be an outlet for social and emotional processing and allowed participants to personalize issues and ideas or keep them in a neutral space, where they could project the ways that they see the world. In transitioning from player to designer as a mechanism for understanding systems, game prototypes became a vehicle for sharing ideas about their life issues (personal or not) in a way that allowed others (players of the game) to experience the issue the way the designer wanted. It was a way of communicating. However, the level to which participants were purposefully making decisions to connect lived experience and teen issues with player experience is unclear.

There was value in having participants play games and talk about them before creating prototypes. Playing games provided a mentor text (Newman & Fink, 2012) for the teens' game design process. For instance, Chicken Nuggets's *Rotate* had a similar tile-turning mechanic as *Tsuro: The Game of the Path*, a game played during GDS. All the participants entered the camp with ideas about games and some vision of what they thought they would design in the camp. Playing games and identifying game mechanisms, narratives, aesthetics allowed them to think about how the game parallels (or does not parallel) lived experience. Participants were introduced to Twine through playing a hypertext fiction horror story, *the uncle who works for nintendo* (Lutz & Parker, 2014). Following the story, participants were led in a discussion about how the strength of narrative, as well as the inclusion of other elements (e.g., sound effects in the story such as thunder and a clock chime) created an aesthetic of dramatic tension. (We note the use of sound to build suspense is not unique to games; it is a dramatic technique also used in film, radio, and theater.) Learning happened about systems without content being direct or presented as a dominant activity or expectation of the camp. Playing games, talking about games, and making games created an environment where teens could talk about issues they wanted to and learn about systems thinking. They applied both in their game prototypes. This finding

sparked many additional questions about game design as a formal pedagogy.

Directions for Future Research

The constraints of this study (size, duration, setting) provide results tethered to this specific camp environment. However, the potential for similar results of systems awareness and design development in participants need not be bound by the same constraints. It would be interesting to observe how GDS activities manifest in an English language arts class as a multimodal composing approach. Alternatively, learning could focus on abstracting narrative elements and literary devices as game mechanics for a design project that could be studied in both formal and informal learning settings. Another possibility could engage participants in game abstraction exercises using political cartoons or symbolism in historical fiction and apply these elements as game mechanics. This twist on the GDS curriculum engages learners with the process of game design as a way for unpacking and constructing complex content-driven concepts scaffolded with gaming.

The sample included in this study was 13-18-year-old males who self-identified as gamers. It is intriguing to consider what results may have emerged if different demographics of teens participated. How would issues important to female teens differ from the males? What types of game prototypes would evolve with the change of culture or location of participants? We noted throughout GDS that participants may have been biased to create games according to the types of games they like to play. Player identity and profiling might be beneficial to this type of research and add additional insights to participants' reasoning for prototype creations. Further research in a variety of formal and informal learning settings is crucial to exploring how teens best interact with their world through game design.

Conclusions

The purpose of this study was to explore the relationship between game design and teen's awareness of systems in games and those in their lived

experience. Game design was selected as an approach to investigate this relationship in part due to the mechanics and aesthetics that exist in games, which parallel the mechanics and aesthetics that exist within human life. Commercial games are often designed to promote awareness of a particular issue or topic, and games are something with which many teens engage. In GDS, gameplay proved to be a vehicle for teens to communicate about issues that mattered to them. GDS also provided tools and opportunities for participants to share their perceptions of teen issues and lived experiences in an informal environment while designing games. We explored how the game design process became a mechanism for participants' awareness and knowledge development about systems in games and the spaces in which they live. The GDS and prototyping experience allowed participants to create something meaningful and reflective of themselves, while also giving them a tool to communicate things that are important to them with others.

Our findings suggest that through constructionist game design teens did make the connection between systems in their daily life, and yet they were not necessarily cognizant of this awareness. Deepening this knowledge of awareness for teens in the future, through methods such as game design, may lead to better self-expression and allow teens a substantial outlet for public awareness regarding issues that matter to them.

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