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MOTIVATION AND LEARNING ENGAGEMENT THROUGH PLAYING MATH VIDEO GAMES

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ABSTRACT

Purpose: With video games being a source of leisure and learning, educators and researchers alike are interested in understanding children's motivation for playing video games as a way to learn. This study explores student motivation and engagement levels in playing two math video games in the game *Club Penguin*.

Method: This is a qualitative case study conducted in a North American elementary school after-school program. It involves two children ages eight and nine playing math games. Data sources in this study include interviews, observations and video recordings of game playing.

Findings: Participants in this study are not always motivated to play math video games. They can sustain engagement in game playing for seven to twelve minutes before seeking another game or activity. Participants show some signs of disengagement during math game playing.

Significance: Findings from this study can inform teachers, parents and instructional designers about what impacts children's motivation and engagement levels while playing math video games.

Keywords*:* Video games, math games, motivation, engagement, case study, Pufflescape, Bits and Bolts.

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INTRODUCTION

Playing games is an ancient form of recreation (Piccione, 1980) and has become a prominent leisure activity as increasingly sophisticated entertainment-oriented technologies emerge. Games that use computer technology and video display are known as video games (Juul, 2005). Video games are growing in their popularity in the United States. In fact, more than 150 million Americans play video games. Of this, 42% play on a regular basis for three or more hours per week (Entertainment Software Association, 2015). The popularity of games is also evident among American youth as 60% of them play video games on a daily basis (Rideout, Foehr, & Roberts, 2010).

What motivates people to play video games? What contributes to their engagement? Related to this, Bartle (1996) identified four main video game player profiles, applied particularly to adults, based on gaming preferences: (a) *achievers* are interested in completing game-related goals such as collecting rewards such as badges, treasures, and coins); (b) *explorers* seek to interact with the video game space in order to find every nuance or detail of the game; (c) *socializers* play video game to establish relationships with other players; and (d) *killers* enjoy competing against and potentially defeating characters or other gamers. There are criticisms of this typology due to the fact that Bartle has based his determinations on online discussions among experienced players rather than basing his characterizations on empirical evidence (Schell, 2008; Yee, 2006). From a different perspective, Yee (2006) identified three main motivational factors that entice people to play video games: (1) *achievement*, which includes satisfaction from advancing in the game, competing with others, and understanding game mechanics such as rules and systems; (2) *social*, which includes satisfaction from socializing, developing long-term relationships, and being part of teams; and (3) *immersion*, which includes satisfaction from discovering hidden objects in the game, role-playing and customization of virtual characters.

While Bartle's and Yee's studies provide a framework for research on motivation and gaming, they solely focused on game content and structure. These studies omit the "fundamental or underlying motives and satisfactions that can spark and sustain participation across all potential players and game types" (Ryan, Rigby, & Przybylski, 2006, p. 348). In contrast, Ryan and colleagues (2006) argue that motivational factors associated with enjoyment and persistence should be examined rather than players' behaviors and/or gaming preferences. Using Self-Determination Theory (SDT) (Ryan & Deci, 2000) as a theoretical lens, Ryan and colleagues (2006) found three innate psychological needs that attract and entice people to play video games: autonomy, competence and relatedness.

Most of the aforementioned studies were conducted with adults, which make us wonder if similar motivational factors apply to children and adolescents. Limited research has been conducted that examines children's motivations for video game play (Ferguson & Olson, 2013). In one early study, Olson (2010) surveyed more than one thousand middle school students and identified three main motivational factors for playing video games: social, emotional, intellectual and expressive motivations. In terms of social motivation, the researchers determined that children enjoyed playing because they could hang out with friends, compete with one another, teach each other, develop friendships, and experience leadership within the game context. Emotional motivations involved playing video games to regulate feelings, such as relaxing or coping with anger, as well as feeling a sense of immersion during game play. In terms of intellectual and expressive motivations, researchers found that children enjoyed video games because of the challenges involved in achieving mastery, the opportunities to express one's creativity, and the make-believe and discovery moments that happen during game play. Even though Olson's (2010) study provided a different set of categories from the one presented in Ryan and colleagues' (2006) study, there are similarities in the motivations for playing video games. In fact, in 2013 study about children's motivation to play video games, findings aligned with the SDT theoretical model and its three innate psychological needs (Ferguson & Olson, 2013).

Learning Experiences with Video Games

Researchers may wonder whether playing video games can benefit learning. Educators and researchers have explored the potential merits of video games for education (Gee, 2007; Squire, 2003; Shaffer, Squire, Halverson & Gee, 2005;), which include, but are not restricted to, improved cognitive processes such as problem-solving and decision-making (López & Cáceres, 2010; Moline, 2010) as well as improved cognitive abilities such as speed processing (Anderson & Bavelier, 2011). Nevertheless, reported improvement in learning processes relies on the general cognitive effect of video games as opposed to just learning academic content. Therefore, following section of this paper discusses research conducted with video games designed for educational purposes.

Video games for educational purposes have yielded positive learning experiences (Barab, Arici, & Jackson, 2005; Barab, Sandler, Heiselt, Hickey & Zuiker, 2007; Barab, Zuiker, Warren, & Hickey, 2007; Kafai, 2010). For example, studies found a positive impact on learning by using *Quest Atlantis* in a variety of content areas such as language arts, social studies (Barab, Arici, & Jackson, 2005), and science (Barab et al., 2007; Barab et al., 2007). Research outcomes with *Whyville,* another video game designed for education, reveal children gain both practical and abstract knowledge from playing the game. Practical knowledge relates to gaming literacies such as how to execute specific actions within the game (Fields & Kafai, 2010a, 2010b). Abstract knowledge relates to theory or hypothesis generation regarding game functions and science content within the game (Kafai, Feldon, Fields, Giang, & Quintero, 2007; Kafai, Quintero, & Feldon, 2010). While knowledge gained in the aforementioned studies is important, the video games that were used contained only science-related content. Analysis of video games related to other content areas is needed.

Several studies examined the benefits of using video games to enhance children's mathematical understanding (Chang, Wu, Weng, & Sung, 2012; Habgood & Ainsworth, 2011; Ke, 2008a, 2008b; Pareto, Haake, Lindström, Sjödén, & Gulz, 2012). In general, learning mathematics through video games has yielded a positive propensity toward math as a knowledge area (Ke, 2008a, 2008b; Pareto et al., 2012). However, mixed findings exist in the literature about the advantage of using video games in math education. Ke (2008b) found there no strong evidence to support video games enhancement of students' math understanding and metacognitive skills. In contrast, Pareto and colleagues (2012) found evidence to support the positive effect in students' math comprehension from playing a video game focusing on math skills. Still, the researchers did not find compelling evidence to support playing a math video game resulted in more positive attitudes toward mathematics. A potential explanation for this result could be that students did not associate the positive outcomes of the game activity with math practices at school.

Examining the educational benefits of math video games is complex as it may take more than having students play video games to realize achievement or identify motivational factors. In a meta-analysis of video games that were designed for educational purposes, Young and colleagues (2012) found that a majority of studies conducted with math video games showed a limited number of studies being cited or replicated. Other math game studies (arithmetic and geometry) that focused on elementary school students have been limited in numbers and show mixed results. Olkun, Altun and Smith (2005) did reveal positive results with students using geometric puzzles. Their findings suggest a positive effect on students' geometric reasoning about two-dimensional (2-D) geometric shapes.

Conversely, Beserra, Nussbaum, Zeni, Rodriguez and Wurman (2014) found no statistically significant differences in students' arithmetic learning during video game versus non-game-based activities. The video game features did not influence children's learning compared with other technologies used. Still, the researchers found video game-based activities to have a significant impact on students' interest and engagement.

In examining children's interaction with video games designed for education purposes, Fisch, Lesh, Motoki, Crespo and Melfi (2011) observed pairs of students playing three different math video games. Findings from this study suggest children applied the same mathematical strategies to video games as they did to those used in non-digital settings. Students often began with basic strategies such as *matching* (finding a number of pieces that matches the gap on railroad track) and later applied more sophisticated strategies (*additive* and other *advanced* strategies) when their initial strategies did not meet the games' demands.

Even though video games can contribute to instruction and learning, they should be thoughtfully and cautiously incorporated in academic settings. Specifically, instructors and practitioners need to account for players' motivations to engage. For example, both players' intrinsic and extrinsic motivation may be impacted based on the interaction between each player's reasons to play and the game's characteristics. It is intriguing to examine how players apply varying levels of effort and persistence to playing educational video games. It is also important to investigate their behavior and the learning processes through the lens of motivation theories (Deci & Ryan, 1985; Ryan & Deci, 2000). The next section describes the video game used to analyze motivation theories.

Youth Play with Club Penguin™

Club Penguin™ is a two-dimensional (2-D) virtual world where children can create a Penguin account and use avatars to play games. Virtual worlds can be defined as environments where a large number of players simultaneously interact with and within contained online spaces (Cannon-Bowers & Bowers, 2008). These spaces allow for users to play games and/or engage in non-gaming activities such as customizing their avatar or adopting virtual pets. By playing games within the virtual world, children earn virtual money, such as coins, that can be used to make purchases for their characters, which may be considered as a motivating factor. Studies conducted with Club Penguin™ (Barreto, 2016; Burley, 2010; Marsh, 2010, 2011; Meyer, 2009) examined a broad continuum of topics that revealed new literacy practices among children as well as new perceptions and behaviors while playing in this virtual world. These new literacy practices emerged as a result of using technical skills such as creating and logging into an online account as well as reading or finding information (Marsh, 2011; Meyer, 2009).

In these new spaces for play, children not only acquire and practice skills, but they also experiment with identity construction. Children might adopt different roles while playing (Marsh, 2010) or present oneself as the avatar of the opposite sex (Burley, 2010). The different roles included: (a) *fighter*, as someone engaged in snowball fights; (b) *nurturer*, as someone caring for their virtual pets; and (c) *collector-consumer*, as someone collecting objects or shopping activities. Overall, studies indicated that playing in Club Penguin™ simulates and extends non-digital forms of play with children might creating their own understanding of rules for these environments (Burley, 2010; Marsh, 2011).

Given that none of the aforementioned studies with Club Penguin™ focused on its educational video games, this study sought to investigate elementary school students' motivations to play educational math video games in Club Penguin™. The research question that guided this study was: How do math video games affect elementary school students' motivations to learn through play?

METHODOLOGY

The games that were covered included arithmetic (counting and addition skills) and geometric concepts. Instances of learning in mathematics were also studied while children interacted with Club Penguin™. A qualitative case study was conducted with six children, between the ages of 7 and 10 who participated in an after-school program. Five of the participants were girls and one was a boy. All participants were Caucasians and came from middle-income families. For this paper, two participants, referred to here as Elizabeth and Rachel, were selected to delineate the cases as their interactions with the math video games illuminated the research questions (Yin, 2014). Both participated in eleven game sessions. Each game session was estimated to be an hour in length. During these game sessions, participants played two math games, *Pufflescape* and *Bits and Bolts*, for about seven to twelve minutes.

Data Collection and Procedure

Ten one-hour long sessions of game playing were held in an after-school program at a private school where both participants were enrolled. Qualitative data was collected from these visits. Closed- and open-ended interview questions were used to design an interview protocol by which to clarify information and generate descriptions of participants' perceptions and experiences (Roulston, 2010). Videos recordings of computer screens were also used as a qualitative data source to show how participants interacted with math games in Club Penguin™. These screen recordings were the primary data source for this study.

Data Analysis

Interaction analysis (Jordan & Henderson, 1995) was used to analyze and identify the cases. This technique was conducted to examine children's interaction with the video game. Additional qualitative practices from Grounded Theory methods (Corbin & Strauss, 2008) were also used to identify recurring patterns and themes throughout data collection process. After an initial analysis of the data set, common games were identified as well as the way children played within the video game environment. Transcriptions of video recordings included annotations of screen-based activities, such as objects that participants were manipulating within the game or mouse cursor movements.

Video data were grouped based on children's activities that occurred during a game session. Gerunds such as "playing" Bits and Bolts or "visiting" Penguin's igloo were used to label these events in order to provide a sense of action and sequence to the data (Charmaz, 2006). Jordan and Henderson (1995) also suggested the researcher attends to "segmentation," especially transitioning from one segment of an event to another. These procedures were used as a way to observe segmentation patterns of imminent game disengagement. Segmentation patterns were indicated by repeated mistakes, when a participant was logging out, or when moving the mouse cursor near the exit button.

FINDINGS

A typical game session involved children playing specific math games for as long as they could sustain their engagement, which ranged from seven to twelve minutes, depending on the math video games. All participants appeared to enjoy playing in Club Penguin™ as they often verbalized their enjoyment and were eager to login into the game. Nevertheless, they were not always motivated to play math-related video games. Most children showed signs of disengagement with one of the math games, Bits and Bolts (see Figure 1), because of the math tasks involved in the game. That is, participants had to select and count the correct combination of bolts to meet the number displayed on the screen. Children showed disengagement with this particular game by negotiating downward the amount of time allotted to play this game ("four minutes") or by voicing displeasure in playing it ("not Bits and Bolts. I don't wanna play Bits and Bolts"). Conversely, some participants continued to play Bits and Bolts in order to earn coins, which could be used to purchase items for their penguin avatar in Club Penguin™.

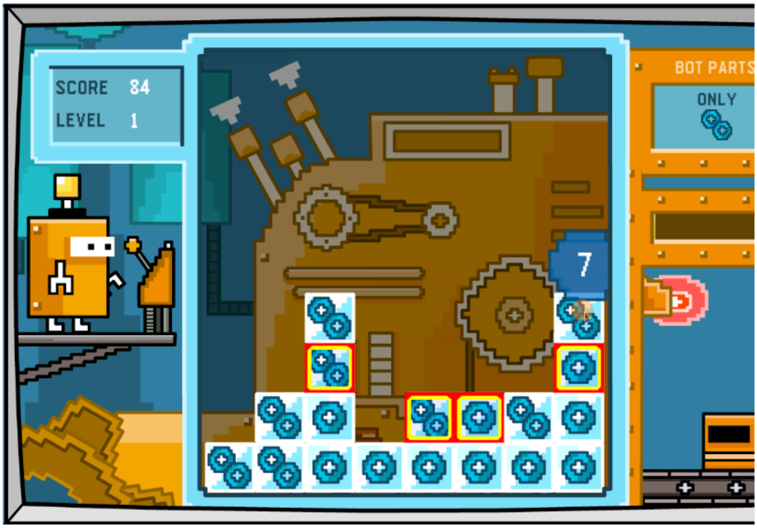

Figure 1. Screenshot of children's playing Bits and Bolts.

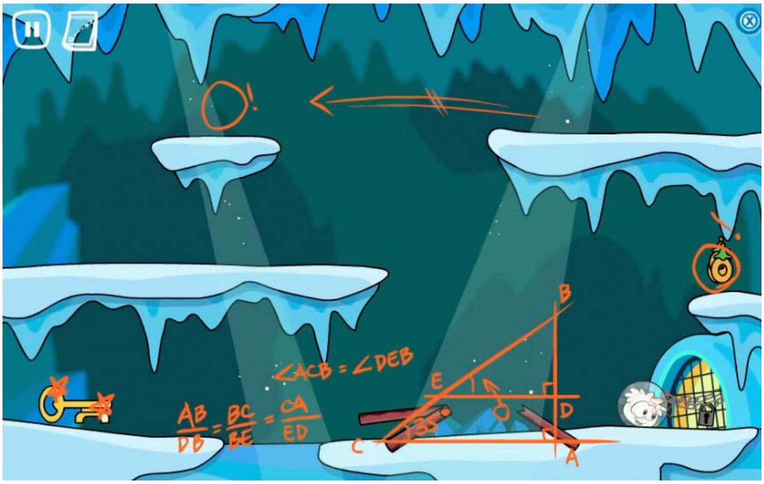

Figure 2. Screenshot of children's playing Pufflescape.

Another math game played by participants was Pufflescape (see Figure 2.). In this game, participants practiced mathematical knowledge such as identifying geometric shapes by helping their Puffle, or virtual pet, escape from an icy cave. Players were required to use geometrically-shaped blocks of snow to build ramps. This allowed them to collect a key to open the gate that leads to the next level of the game. Besides the key, players could also collect *O' berries* to score more points in the game and to earn more coins. To collect berries, participants had to strategically plan and complete challenging tasks in the game. Rachel, one of the participants, devoted little effort to collecting berries because they were not required to move up to the next level. In contrast, Elizabeth did devote a lot of effort and persistence to collect all rewards (both berries and key) for each level before moving on to subsequent levels. Excerpts from these cases are presented below.

Intrinsic and Extrinsic Motivation in Play

Elizabeth and Rachel played the game together using one netbook computer to facilitate conversation, a strategy used in a previous study (Fisch et al., 2011). As they played, the children walked the researchers through the game. Both participants played the game with the same Puffle and took turns between levels. While playing the first level of the game, Rachel provided instructions on how to move the Puffle around: "You have to use the arrow keys… collect… roll down… roll off… get the key and roll pass the ice." During Rachel's explanation, she used the keyboard arrow keys to move the Puffle within the game space. She also interpreted the Heads-Up Display (HUD), a technical drawing presented on top of the game screen with data and hints to solve the puzzles in the game. In other words, the HUD presented geometric symbols (right angles, angle congruence, etc.) on the screen that were relevant to the game goal of collecting the key.

Elizabeth started playing the second level determined to collect all berries. While Elizabeth kept playing, Rachel gave her directions, which sometimes clashed with Elizabeth's actions during play. For instance, Elizabeth was trying to collect three berries, which was a difficult task in the game. See below for transcript.

> Rachel: "That way. No, you can't (Elizabeth used the mouse to move an object on the screen). You've got to use the arrow keys."
> Elizabeth put the movable object back to its initial position and rolled the Puffle over to collect the key. Elizabeth wanted to collect all the berries for this level, but Rachel disagreed:

> Elizabeth: "Now, I have to get all the coins."
> Rachel: "No. No, you don't. (…) You don't need to do that, seriously."
> Elizabeth: "Oh, I seriously need to."
> Researcher: "She got it!"
> Elizabeth: "I just schooled you."
> Rachel: "Those are stamps anyway."

While Elizabeth called the berries "coins," Rachel referred to them as "stamps." Regardless of how they identified these game objects, both participants perceived the berries as external rewards. What distinguished these two participants was their approach to rewards. Elizabeth's play behavior could be categorized as an achiever (Bartle, 1996), one who seeks to master the game in every way. Elizabeth would spend significantly more time per level trying to determine how to collect all of the rewards before crossing the gate and would be upset when the Puffle accidentally crossed the gate before collecting all the berries. In Rachel's case, her play behavior did not fit into Bartle's (1996) typology. However, it did correspond to Yee's (2006) *achievement*, in which the player is satisfied to simply advance within the game. Overall, their motivation to play the game involved two spectrums of competence: (1) competence in advancing the game, and (2) mastering all aspects and mechanics of the game. Both interpreted collecting objects in the game could lead to success in the game. Nevertheless, success might have been interpreted differently. While Rachel understood success as moving up in levels, Elizabeth perceived it as overcoming all challenges, collecting all rewards, and moving up in levels.

Elizabeth assumed she would play the next level because she successfully collected all of the berries. However, Rachel did not react positively to that idea. She shouted, "No, no, no fair," and quickly took over the computer to have her turn. Elizabeth begged Rachel to let her play the third level during Rachel's turn: "Oh, I love that one! Please? Please let me do it and then she'll get to have a second turn." Rachel ignored Elizabeth's request and continued playing the game. In this case, Elizabeth wanted to continue playing Pufflescape and displayed a positive attitude and feelings for that specific level. Her behavior indicated she was intrinsically motivated to play.

Achiever Behavior: More Knowledgeable in the Game

Elizabeth and Rachel had different play values when playing Pufflescape, which led to some tension between them. For instance, Elizabeth commented that Rachel "did it wrong" because she did not collect all the berries within a level. Meanwhile, Rachel seemed aggravated with Elizabeth's tendency to collect all the objects in the level as shown in the following conversation:

> Elizabeth: "I gotta do that 'cause I gotta get that coin, don't I?"
> Rachel: "Nope!"
> Elizabeth: "Oh, I want to!"

Given that Elizabeth sought to collect all of the rewards in the game, she was also more knowledgeable than Rachel regarding game features. For instance, Elizabeth told Rachel to "press the cheats," as she called the HUD of the game, which showed math content like angles, calculations, formulas, and how to use resources to collect rewards and move up levels. When Elizabeth was asked by the researchers about what "the cheats" meant, she explained by showing on the screen how to use a geometrically-shaped block of snow to set up a 25-degree angle by which to create a ramp, allowing her to use her Puffle to collect the key.

Elizabeth's drive to collect all of the berries allowed her to explore more of the game environment and to use "the cheats" to understand the embedded math content. Thus, Elizabeth used "the cheats" for both intrinsic (mastery goal) and extrinsic (rewards) motivation purposes. Overall, Rachel did not demonstrate the drive to collect all of the berries and played the game simply to advance through levels. Consequently, she did not have as many opportunities to practice geometrical concepts. Therefore, she did not exhibit achiever play behavior like Elizabeth did.

DISCUSSION

The purpose of this study was to investigate elementary school students' motivations to learn through playing math video games. A review of the literature indicated a variety of motivational factors are associated with playing video games, such as a player's behavior and preferences as well as their psychological needs. Besides enhanced motivation to learn, benefits of learning through play range from cognitive effects to learning academic content. In this study, each of the selected games focused on promoting engagement in and learning about mathematics. To a certain degree, these games covered math content as part of game playing. While Bits and Bolts involved basic arithmetic content, such as counting and addition, Pufflescape embedded geometric content such as angles and shapes. Another difference between these games was the level of exposure to math content. While children noticed Bits and Bolts required explicit math operations, they were unsure about Pufflescape because math was implicitly embedded. These factors potentially contributed to different levels of engagement, motivation, and sustained attention while playing these games. This study found that gaining academic knowledge from playing the aforementioned math video games was limited. Additionally, this study also revealed the motivational factors influencing children's play of the math video games, which were intellectual motivation (Olson, 2010), autonomy and competence (Ryan et al., 2006). These and other factors that could contribute to the findings of this study are discussed in detail below.

Gaining academic knowledge from playing Bits and Bolts and Pufflescape was limited for two reasons: (a) the task required to succeed in the video game and (b) children's prior knowledge in the math content. First, the task and the math content involved in playing Bits and Bolts could be too easy for children in this study since they seemed familiar with counting and were able to identify and match correct numbers without problems. Thus, playing the game could be perceived as a practicing exercise similar to drills (Alessi & Trollip, 2001). In the case of Pufflescape, the academic content was hidden. Most geometric content in the game was presented through a Heads-Up Display (HUD). By clicking on HUD, children were exposed to angles, theorems and formulae to solve puzzles in the game. Although children did not show any prior knowledge in the academic content covered in Pufflescape, they applied the content as they manipulated in-game objects to collect berries and keys to succeed in the game. As children played with Pufflescape, they had an opportunity to learn about the academic content incidentally. That is, children's learning experience was unintentional, unstructured and resulted from some other activities, a process also known as incidental learning (Marsick & Watkins, 2001). Through incidental learning, children had control over their learning experience, deciding if and how to engage with content presented in Pufflescape.

Some motivational factors influencing children's play with the aforementioned games involved intellectual motivation (Olson, 2010), autonomy and competence (Ryan et al., 2006). Similar to Olson's (2010) study, children in this study demonstrated signs of engagement when the math game presented challenges that involved achieving mastery as well as discovery moments. These motivational factors could have influenced an increased engagement to one game over another. Bits and Bolts did not provide any new challenge for children because it involved mainly counting strategies; consequently, children may have grown bored with the game. In contrast, when playing Pufflescape, children were provided with a different problem on each level of the game. This feature of new challenges in the game nourished the players' need for competence (Ryan et al., 2006; Rigby & Ryan, 2011).

Other factors contributing to the findings of this study could be the design of this intervention. Since the game sessions were conducted during an after-school program, children may have been tired and unfocused, which might have contributed to their lack of engagement with the math video games. In a related study conducted in an after-school program (Fisch et al., 2011), children demonstrated limited dedication to math video games, averaging 15 minutes per game, which was similar to the average number recorded in this study. Fisch and colleagues (2011) did not attribute context as a potential factor for this limitation.

The user interface for both Bits and Bolts and Pufflescape has been designed to assist young children with playing the game without much cognitive effort. In each, text was often coupled with icons and short animations on the game screen to help children associate the meaning and actions to be taken within the games. Both games had "instructions" buttons that provided users with information on how to play the games. Nevertheless, children did not read the instructions provided and opted to learn how to play intuitively. By not reading the instructions, children might have had a misinformed idea of each game's purpose, which may have contributed to disinterest and disengagement to one game over another (Barreto, 2016).

When comparing the interface of both math video games, the purpose of Pufflescape was easier for children to grasp because there were visible hints flashing on the main game screen to indicate user actions. Bits and Bolts, on the other hand, provided subtle hints in the top right corner of the screen, which children could have overlooked while playing the game. Besides hints, both math games could have incorporated Non-Player Characters (NPC), explaining what players were to do in the game as a means to guide them through activities using multiple semiotic (signs and symbols) tools (Black & Reich, 2011).

As reported in other studies, math video games that situate and integrate academic content with game play have a better chance to increase engagement and learning (Habgood & Ainsworth, 2011; Ke, 2008a, 2008b). Researchers and practitioners who design or select educational games should consider both the level of academic content integration and the level of game play as a means to promote effective learning. Otherwise, learners might get distracted by gaming features that are unrelated to the academic content (Ito, 2008; Shelton & Scoresby, 2011) and consequently become disengaged from the intended learning activities. The extent to which the academic content is situated within a game might be worthy to explore, especially if children dismiss the content of the game in favor of the entertainment aspect.

The academic content in Pufflescape was hidden and was presented to the player through HUD. By clicking on HUD, children were exposed to angles, theorems and formulae. Children applied this content as they manipulated movable objects to make ramps. Pufflescape provided an optimal challenge to foster a flow experience (Csikszentmihalyi, 1990). In other words, children's cognitive skills improved as increasingly difficult tasks emerged at each level of Pufflescape. When facing challenges to collect all of the berries, children depended on HUD as a reference tool. Children who used HUD to collect the berries had more opportunities to be exposed to the academic content and, consequently, appeared to be more competent at the game play. Children also demonstrated more flexibility and autonomy (Rigby & Ryan, 2011) playing Pufflescape. For instance, children had the choice to collect or not collect all of the berries to level up or advance. Having this choice articulated within the game might have resulted in multiple interpretations of the goals required to be successful.

CONCLUSION

This study shows that even when children play similar games, they can demonstrate different behaviors and preferences during play, as indicated in other studies with Club Penguin™ (Marsh, 2010, 2011). These behaviors vary depending on the tasks presented in the games and children's play preferences. Although previous studies (Ke, 2008a, 2008b; Pareto et al., 2012) indicate students' positive attitudes toward mathematics when playing math video games, this study speculates that children's play preferences and motivation towards math video games may differ based on: (a) the content and to what extent it is present in the game, and (b) intrinsic and extrinsic motivation to play.

Additionally, children playing math video games have been shown to apply multiple strategies in order to be successful. Some of these strategies involve content like children using game tools to position geometric shapes that match appropriate angles. Some of these strategies may be motivation-related, such as when children play for external (coins) or internal rewards (game competence). Children may select their strategies, moving from basic to advanced, depending on the demands of the games (Fisch et al., 2011).

Although previous studies (Marsh, 2010; 2011) suggest some consumerist behaviors as young children engage in shopping activities in Club Penguin, this study did not investigate that. Therefore, the idea of converting game points into virtual currency that players can spend in other play activities might be worthy to explore. Teachers and instructional designers who design educational games for children could incorporate a virtual currency system to allow players to use this currency for game play or for other classroom activities.

Given the limitations of sample size, findings from this study cannot be used as a basis for generalization. Still, patterns identified in the findings might inform future studies with similar math video games. While this study sought to provide a glimpse of young children's learning experiences with math video games, more research is needed (Tobias & Fletcher, 2007, 2011).

Further research could focus on the extent to which young children learn academic content with these technologies. In addition, teachers and parents could also use games, such as Pufflescape, to start a conversation around topics and content that children are learning while playing the game. Video games could also be used to assess performance on task. Teachers can use educational games to assess children's application of previously learned content knowledge and strategies. Finally, findings from this study may enlighten teachers, parents, and instructional designers about children's actions and behaviors while playing math video games. Understanding their experiences might help instructional designers and teachers better plan for the use of games for learning. This study may also inform the use of these technologies in informal and formal settings.

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