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Children's conceptions of stories in educational games

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Abstract

The GLS community at large have extolled on the necessity that a story/fantasy has in its relation to educational games. This study is a report on interviews done with 16 children after playing two educational games that were deemed to have high and low amounts of stories by the author and story grammar frameworks found in the research literature. The findings and interviews with the children tend to suggest that characters are of principal importance to children and that game mechanics can be leveraged by children to drive a story when none is present.

Introduction

Much has been made by researchers outside (Habgood, Ainsworth, & Benford, 2005) as well as those currently active in games and learning community about the importance of story and its important relation to games and learning (Barab et al, 2007; Jiménez, 2014, Slota, Young, & Travis, 2015). While some of these studies have been largely experimental and aimed at looking at the types of story and more specifically how fantasy has helped increase student scores (Malone, 1981; Parker & Lepper, 1992; Habgood & Ainsworth, 2011) others have noted the relative importance of story to games (Reeves & Read, 2009) and how it helps to promote inquiry (Barab et al, 2007) as well as shape player's conversations and goals (Slota et al, 2015). Story's link to learning and play has also been evident in other areas as well, as researchers have argued for the benefits that acting out stories can have in helping students better understand those stories (Pellegrini & Galda, 1982; Williamson & Silvern, 1991). The link between role-playing, play and learning connects directly to educational games, as one could argue that the work done in placing students in role-playing scenarios is leveraged in games, particularly in epistemic games (Shaffer, 2006) where students can learn to play the role of a doctor, scientist or other professional worker.

With so many proponents arguing for the usefulness of stories in both learning and in games for a variety of reasons, I wanted to explore this link further. What is it about stories that children tend to find so powerful and how are those stories leveraged when they decide to play games? One argument made by one proponent of story is that stories can provide vivid images (Simmons, 2006), which could be a factor in helping people remember those stories in the long term. To explore this question, I wanted to focus on the simple premise that we need to know more about how children understand stories and how that

knowledge relates to games. To help answer this question, I interviewed children to investigate what aspects of stories children remember in educational games. Based on pre-existing literature and research that argues for the beneficial effects that all types of stories have on comprehension and memory (Black & Bower, 1980, Bower, 1978; Kintsch & Van Dijk, 1978; Mandler & Johnson, 1977; Rumelhart, 1975; Thorndyke, 1977), I would hypothesize that children who played games that lacked story would not be able to remember a game as well as children who played games that had a deeper story.

To investigate this claim, I needed to find two games that had differing amounts of story, which I think would be best operationalized by applying them to the aforementioned story frameworks. After researching the variety of frameworks meant to categorize and classify relatively small stories, I chose the Thorndyke framework based on its flexibility (see Figure 1), which would be useful for games that have very little to no story. With story and narrative having very broad interpretations in the games and learning community, it may be helpful to define how the word *story* will be used in relation to games. I am going to use the term *story* mostly as an expanded form of the word *fantasy* used by Parker & Lepper (1992) in which they operationalized fantasy as a way to establish a context for a particular game. Rather than use term *fantasy*, I would like to use the term *story* because other researchers have argued that fantasy does not encompass stories because situations involving day-to-day occurrences may not be considered as fantasy (Saltz, Dixon, & Johnson, 1977). Thus, the term story here is meant as a context that can be used or leveraged as part of a game. In the Thorndyke framework, stories are broken down in *setting*, *theme*, *plot*, and *resolution*, with each category being broken down still further. For example, *setting* consists of *characters*, *location* and *time*, while *plot* is composed mainly of sub-goals and outcomes. With the framework chosen I needed to choose two games that had stories that fit this framework in different ways. In looking for a game which I believed to have a “stronger story”, I chose a game called *Tug-of-War* based on how it applied to the Thorndyke framework (Figure 1: right) as well as because of my close knowledge of the game. *Tug-of-War* is a card game that helps students with taking fractional components of whole numbers and has a story about two teams of people trying to recruit as many people to their side as possible to win a tug of war (Jiménez, Arena, & Acholonu, 2011).

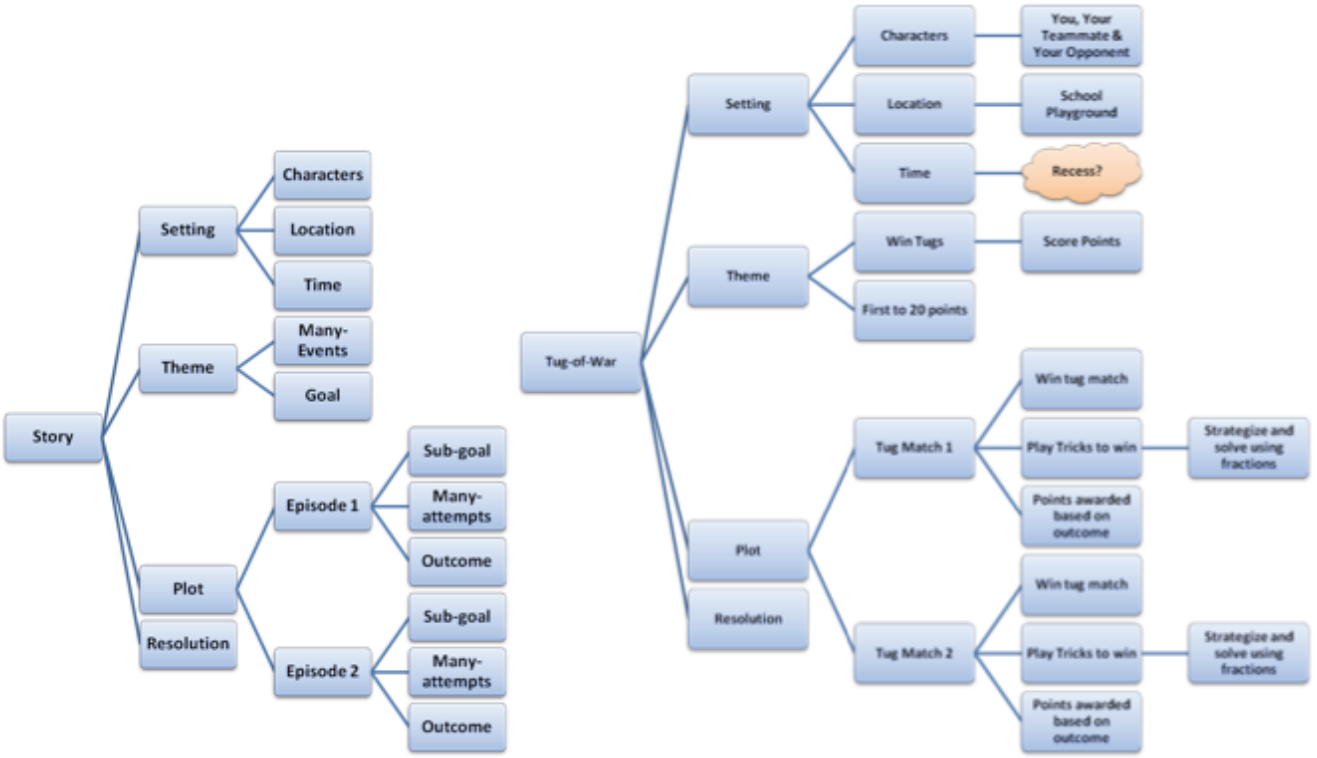

Figure 1. Thorndyke's theory (left) and Tug-of-War's instantiation (right).

After examining a number of factors in looking for another game that did not adhere as closely to the framework, I arrived at using *Number Eaters*, a clone of a classic edutainment game, *Number Munchers* (Ito, 2007). The goal of *Number Eaters* is to control a Green Monster who has been tasked with eating all of the numbers that correspond to a specific equation given in the upper right corner. While the Green Monster moves around, it also has to avoid landing on the same square as the Purple Monster while finding the numbers. Once it finds all of the squares that have the correct answer to the equation, the player then moves on to the next level. The next level presents the player with a new grid of numbers and a new equation for the player to calculate.

Number Eaters' story has many limitations when applied to the Thorndyke framework. My conceptualization of *Number Eaters* (Figure 2, below) as it applies to the Thorndyke framework may help one understand the game's limitations. In the figure, areas marked as clouds are areas where there was little information provided. For instance, the setting's location for *Number Eaters* is very abstract, to the level that it could be considered non-existent, which is why I labeled it in the framework as "Grid". There is also no mention of the time at which this game is occurring, and there are no episodes or events that lead up to the theme for the game. The areas marked as ovals are areas where I think non-story game elements better fit with the application of the Thorndyke framework for the games.

Number Eaters became the prime choice for comparison because of the similarities and differences it had with *Tug-of-War*. The two games are similar in that they both integrate math into the main game mechanics (Habgood, Ainsworth, & Benford, 2005; Hunicke, LeBlanc, & Zubek, 2004). Nonetheless, *Number Eaters* differs from *Tug-of-War* in that it does not provide any story-based reason for doing the math problems that it presents and calculating the number does not advance the story aspect of *Number Eaters*. *Number Eaters* also stood out because it could cover fractions content; it is seen as a classic

educational game, and served as a nice contrast because it has a minimal story, yet may still appeal to children. I also chose *Number Eaters* over the classic *Number Munchers* because of the former's free availability on the Internet, making it easy to access via different computers. With both games chosen, I began the study described below.

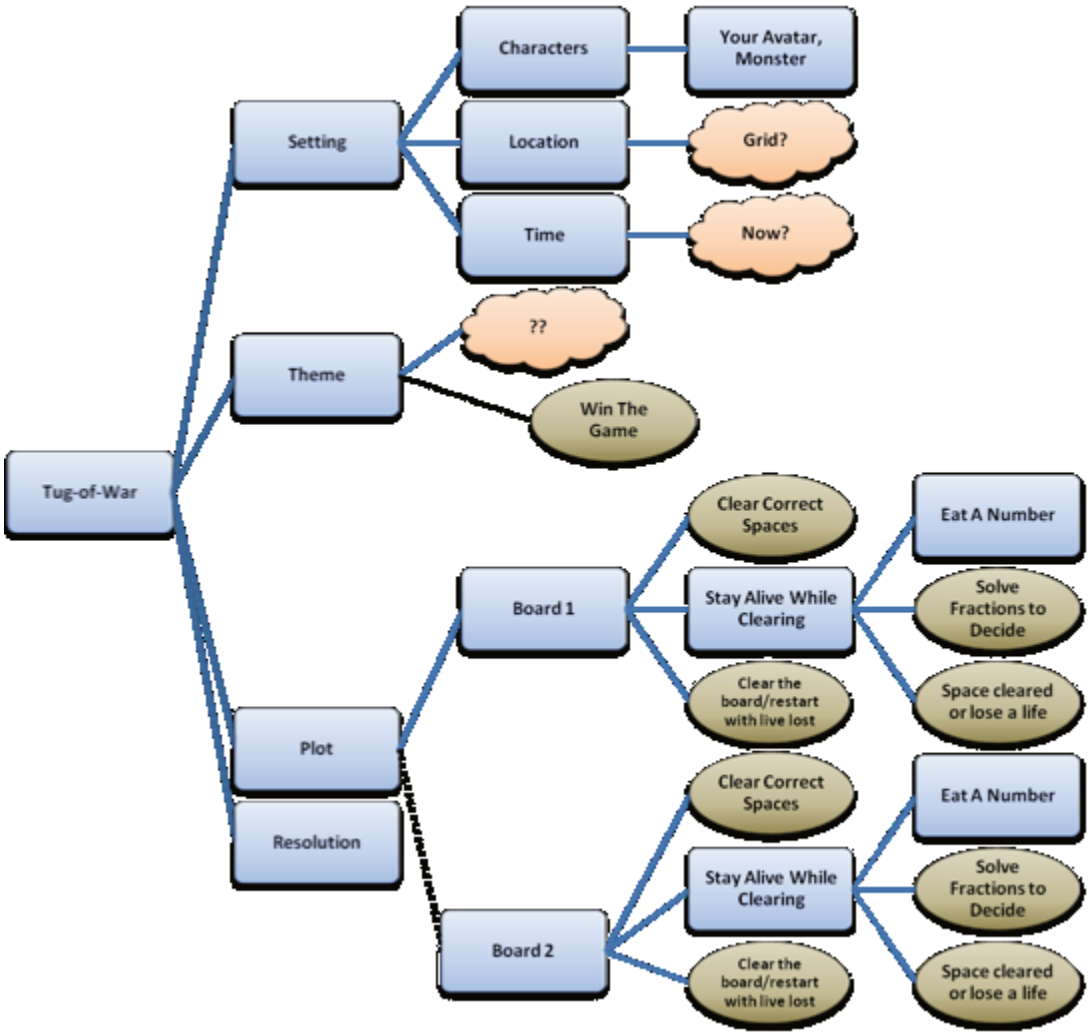

Figure 2. Number Eaters game applied to the Thorndyke framework.

Interview Study

Participants

Sixteen students participated in the study – ten females and six males. Five of the students were incoming third graders, six were incoming fourth graders, and the remaining five were incoming fifth graders. All participants were part of an after-school club; the club's mission implies that the club seeks to meet the needs of children in communities where they are not met effectively. The after-school club is located in a suburban area of Northern California.

Method

First, children played both educational games for approximately one hour each. The order in which participants played the games was counter-balanced, so that half of the students played Tug-of-War first, while the other group played Number Eaters. Each student was introduced to the two games by a researcher. A researcher introduced and explained to each of the students how to play the game, but did not mention anything about the story. While the students played the games, the researcher was present only to assist the child or answer any questions they may have, staying mostly out of their way.

After playing both games, the children were then interviewed. The length of time between when the children finished playing the game and when they were interviewed ranged from one to three days. For the interview, the children were invited to meet with a researcher individually. Next, the researcher followed an interview protocol during the meeting. Fourteen out of the sixteen interviews were recorded using a video camera. In the other two interviews, a video camera was not used based on the privacy choices outlined by the parents. In those two interviews, the researcher took field notes of their responses.

Materials

Children played both *Tug-of-War* and *Number Eaters* on a laptop computer. While I initially wanted children to play solely the fractions sub-game of *Number Eaters*, children played any version of *Number Eaters* they wanted, which included children playing games where they worked with basic arithmetic. This decision was made because the participants did not have the requisite knowledge to solve the fractions problems in Number Eaters. Most of the participants decided to play the Addition version of the Number Eaters game, which meant their goal in the game was to look for spaces that had an addition problem equal to the target number provided to them in the game.

Interview Questions

Each interview lasted approximately 20-30 minutes and involved a one-on-one session between an interviewer and the interviewee. The protocol followed a semi-structured interview, with a set of initial questions and sets of questions used to prompt students to elaborate on their answers to those initial questions. The interview was broken up into two phases. The first phase had questions that were meant to "break the ice" for children to talk about stories in general. Children were asked to discuss their favorite cartoon show and were prompted to provide in detail what happened in either their favorite episode or the last episode they watched. Follow-up questions were asked to ensure that the children were finished with their description of the show. This first phase served to gauge their storytelling capabilities, to help make visible what matters to them, and to understand what they recount as part of their stories. This phase also informed me of their ability to understand stories in traditional media (television/film), which places a large emphasis on story. While both *Tug-of-War* and *Number Eaters* have a semblance of a story, the story is not the central component of either game, so having a source of comparison to another medium where story is central was important.

The second phase of the interview concerned the two games the children played. The children were

asked approximately the same set of questions for both games. The questions were: “Tell us what the game was about” and “Did the game have a story? Children were then asked to elaborate on their responses. Finally, they were asked questions that addressed the differences between the games, which were to discuss why they thought the math was present in the game and why performing the math equation was important. To understand how they conceptualized the calculations with respect to the game, children were also asked what happens after they calculate the answer and its significance. To help the children in answering these questions, the interviewers presented the children with relevant screenshots of the game. These screenshots were shown at the end of the interview in order to not influence what participants told us initially about the game and the story. The interview study was piloted with two children, and a few questions were modified. Similarly, a few questions were introduced to the protocol, most notably to ask children specifically about the characters in the game and their responsibility or interaction with those characters.

Description of the Analysis

All of the playtime and interviews were done with the children over the course of two weeks, with most students taking one or two days to finish the study. All interviews were uninterrupted and took 20-30 minutes to complete. Some of the playtime had to be split for some of the students due to having to leave early for the day.

Shortly after finishing all interviews, tapes were watched, and an open-coding indexing scheme was employed. In open-coding, I wrote down surprises and general themes (such as creative interpretations) that I noticed from looking at their responses. Each videotape was then transcribed. These transcriptions were done at the conversational level and did not include non-lexical utterances, except long pauses. The transcripts were recorded into a web-based form that I created. With regard to the two non-taped interviews, I decided that my field notes looked close enough to the transcriptions that I could place the notes into the form as well. The transcriptions enabled me to analyze and more quickly look up information from each interview.

After transcribing the interviews, the Thorndyke grammar was applied to each child’s conceptualization of each game. After practicing my application of the grammar and validating it with the knowledge that I had of the Thorndyke grammar, I understood more of the limitations of the grammar. More specifically this grammar was meant to be used in stories with a single protagonist or character. With a deeper appreciation for the grammar, I then applied the Thorndyke grammar to both *Tug-of-War* and *Number Eaters* (Figures 1 and 2). From those applications, I then developed a set of codes that I used to count and structure children’s interpretations of the two games. The result of that analysis caused me to generate two major findings, which are discussed below.

Results

One theme that came about early on in the interviews was the importance of the characters to the children. In relating to the first interview questions, fifteen out of the sixteen subjects were able to recount a show or movie that they had mentioned as being their favorite. In relation to the first interview questions, after the children would mention their favorite show, the other researcher and I would ask them to describe the show to us, and thirteen out of the fifteen children started their description by naming one of the main characters, or a few main characters and how they were related to each other.

For some students who would mention the same show the same characters would often be the only consistent information. For example, two of the participants mentioned that their favorite television program was called the *Regular Show*, which is an animated show on *Comedy Central*. When both were asked to describe the show, their responses were:

> "It's about like a blue jay and a raccoon start working at a job, but then they start slacking off too much so their boss Benson pressures them to work harder" (Response #1 – Incoming 5th grader, Male)

> "Basically about this blue jay and squirrel and they like in the commercials. It's anything but a regular show, like everything new happens in episodes" (Response #2 – Incoming 5th grader, Male)

While both have come up with different explanations to the question, "What is this show about?", what one can infer from each description is that both children recognize that the show is about a blue jay and a furry mammal. Both children described the characters first, rather than describing the setting or other details about the show, which reflects the general pattern shown by the thirteen students who mentioned characters. Of the two students who did not mention characters initially, one started off by mentioning that they did not know how to speak English very well, and the other mentioned that the show was fun but hard to explain. Nonetheless, the fact that students mentioned characters first suggests their importance to the children.

The importance of the characters to a story was also demonstrated in the *Number Eaters* game. Because *Number Eaters* had two monsters that children could find appealing, I found children generated many facts to help them explain the game that were based on the characters. Although not all were immediately forthright with mentioning the monsters, all of the students did identify when prompted that there were two characters on the screen, a "protagonist green" monster that they control, and an "evil purple" monster that they must stay away from. Students then generated scenarios that used the characters and the game's rules to explain their encounters in the game. For example, one student mentioned that a character would become sick if they ate the wrong number, and a majority of the students would say that the purple monster would eat the green monster (nine out of 16) if they ever came into contact with each other, although this is something that was never explicitly mentioned in the game.

Students who did not mention the purple monster's responsibilities would also mention other facets that were not part of the game. For example, two children mentioned that the purple monster tries to block the green monster from getting the numbers, and another two mentioned more accurately that the monster could get the green monster, rather than eat it. The remaining children gave erroneous statements, but even some of those were invented, such as one student who stated that the purple monster was there to protect the green one. Whether correct or inaccurate, the children's statements about the role that the purple monster has in the game, provides evidence that the children are remembering the characters. I would propose that the children are then using the characters and their experience in the game, to generate reasons that align to their own stories about the game.

This conjecture falls in line with previous literature done by Bower (1978) about characters and their motives, where they showed that when characters had a motive, subjects would add more detail to the story depending on the character's motive. In line with this research, I believe that students use their knowledge of characters and game mechanics to infer actions for those characters that align to both the story and the game. The difference here is that rather than the children knowing the motives of the characters beforehand, the children are filling in the goals of those characters by observing the

actions that they perceive those characters to be taking during the course of the game. I would argue that children are using the game's mechanics to determine motives for the characters in the game. This finding is important because it makes it salient to me that in game design, the characters are a central focus for children who play a game.

Nevertheless, children do not always need characters to memorize the game's rules. Characters could serve as an anchor point around which students could organize their information. However, students could also use the general game process to store most of the information they needed about the game. In contrast to *Number Eaters*, *Tug-of-War* did not have much of a mention about characters. Nonetheless, they did refer to other elements in the game, namely stink bombs and air fresheners, which are two components in the game. It could be that the stink bombs and air fresheners in *Tug-of-War* served as surrogates for the characters that children used to anchor their initial responses about the story. 11 out of the 16 children mentioned stink bombs and air fresheners when they were asked "What is Tug-of-War about?" in some capacity in their first sentence. Only two of the sixteen children failed to mention the air freshener or stink bomb directly. The representations that the students gave and their anchoring around the stink bombs and air fresheners almost makes it analogous to the purple and green monster or other characters that are present in stories. The lack of mentioning characters also could be because in the *Tug-of-War* game, the protagonist that they follow is themselves, but there is no direct mention of that in the game.

Before conducing this study, I thought that children who played *Number Eaters* would not have a good recollection of the game's rules because they did not have a good story to use as a basis on which to organize the game's information. My analysis of their interviews demonstrates that they do use the story as reasoning for the game's rules. However, contrary to my hypothesis, children still had a good understanding of the game and its rules. For *Number Eaters*, it seems that students use the game's traditional mechanics and their experience with the game to conceptualize a story. Contrary to enjoying the game and story together – like in *Tug-of-War* – Students are using their experience in *Number Eaters* to come up with a story for the game.

For instance, the theme of the game, according to Thorndyke, would be to win the game, but there is no reason to win the game, other than a person's innate desire to win. You win *Number Eaters* by clearing the correct spaces, solving math equations along the way, and moving to the next level. These lines of reasoning mirrored what I found in the interviews. While only three children mentioned the overall goal of winning the game, the majority did mention that they were out to eat numbers (13), and that the goal of eating a number and calculating the number was to clear the numbers from the board (13). Moreover, half of the children mentioned the reason for clearing the board was to move on to the next level: a classic game mechanic. This last statement provides evidence for the argument that for many of the children, the goals of the game provided enough of a context for doing the activities. When no story was present, it seems children anchor to mechanics and characters and when appropriate, apply stories to that mechanic. This type of anchoring and then generating story could explain the aforementioned finding that the majority of children would make up answers about how the purple and green monsters would interact in Number Eaters.

In truth, this theory about leveraging game mechanics to fill in holes in the story was also evident in *Tug-of-War*, based on another interview where a child explains his version of the *Tug-of-War* story:

> "The story is that you have [to] pass all the levels from pulling the rope, and there's the math you have to do the

> math, so the story is you have to do everything so you have to get 20 points so you can be passing the levels." (Incoming 4th Grader, Male)

The last part of their sentence is interesting because this student ended up incorporating a common game mechanic, the mechanic of a game having many levels, and their desire to pass the level by gaining a certain amount of points. From their speech, one could infer that the reason this student believed they needed to get the 20 points in the tug of war matches was to move on to the next level. Therefore, they used a common game mechanic of moving on to the next level in order to justify why they were trying to achieve a certain amount of points. *Tug-of-War* has no reason for having 20 points as a goal, nor does it have a good system of tying the matches together, so it looks like the student used this to generate a scenario that fit with their understanding of the game and its story.

Conclusion

This study was meant to explore more deeply what elements of story children remember in the context of playing an educational game, in the hopes of leveraging that knowledge to make better educational games in the future. While it was hypothesized that deeper stories would cause students to better remember stories, it was found that children tend to remember characters and possibly game mechanics and place them as a focal point in what they remember. From this they tend to generate and build their notion of what the story would be. It is my hope that this study provides some insight to future game developers on how children perceive story so that the educational games community can leverage it to the advantage of its users.

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