THE IMPLICATIONS OF INTERACTIVE EBOOKS ON COMPREHENSION

By

SHEILA K. FRYE

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Dr. Cindy Hmelo-Silver

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Dr. Erica Boling

_____

Dr. Patricia Kennedy

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ABSTRACT

This study examined how the interactive features of eBooks affect comprehension, the behaviors that participants engage in during the Read-to-Me and Read-and-Play reading modes, and the affordances and constraints of these reading modes. A repeated measures design was used to analyze the reading behaviors of 30 second grade, lower-level readers while using the two eBook modes. Participants met individually with the researcher for two, 30-minute sessions. Data was gathered on the participants' before-reading background knowledge, during-reading behaviors, post-reading retellings, comprehension question responses, and personal views of reading interactive eBooks. Results of repeated measures ANOVA revealed that students gained comprehension over time, but there was no effect of condition or interactions. Qualitative data revealed that participants demonstrated considerable insight into the stories and made extended inferences about characters' motives and critical story events. The findings indicated that eBook designs such as the read aloud feature, speech bubbles, and animations afforded the participants' ability to make meaning across both modes, resulting in stronger comprehension outcomes.

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DEDICATION

To my boys: Mommy can play now.

To my parents, who always encouraged me to follow my dreams.

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CHAPTER 1: INTRODUCTION

Reading theorists have long understood that readers comprehend by acquiring and making meaning of text located in a static and complete physical compendium (Allington, 2001; Centre for Research and Innovation in Learning and Teaching, 2009; Fountas & Pinnell, 2001; Harvey & Goudvis, 2000; Jewitt, 2008; Snow, Burns, & Griffin, 1998). The 21st century, however, has expanded this understanding of comprehension to encompass the multimodal environment filled with audio, digital, and visual modes, all working together to help the reader to construct meaning. For the purposes of this study, "multimodal learning" was defined as the integrated meaning making systems of electronic texts presented across a wide range of semiotic resources, like visuals, texts, audio, and videos (Jewitt & Kress, 2003; New London Group, 1996; Rowsell & Casey, 2009; Walsh, 2009). One element of multimodal learning that has significant pedagogical potential is the interactive electronic book (eBook).

An "eBook" is a form of electronic text that has the same features as traditional printed books, such as illustrations and text, but may also contain digital enhancements that change the reading experience into one that requires the reader to manipulate and interact with the characters, words, or other textual elements to traverse the plot. Most commonly termed as "interactive," this notion is defined as a feature of learning environments that permits multidirectional communication (Markus, 1990). Thus, "interactive eBooks" are software applications that provide users with a multimedia literary experience especially designed for a touch screen device. Namely, interactive eBook applications have hotspots embedded within the software that allow readers to become actively involved in the experience of reading. Subsequently, researchers hypothesize that users are able to create meaning in ways that transcend the stagnation of printed text (Dalton & Proctor, 2008; Gee, 2007; Kress, 2003). As a

result, these multimodal features may help increase users' comprehension of texts and build knowledge in alternate, but similarly meaningful ways. However, due to the relatively new development of interactive eBook applications, there is a shortage of empirical studies examining the pedagogical effects of this form of multimodal learning. Researchers continue to explore whether interactive eBooks support lower-level readers with comprehension.

Problem Statement

Reading is a complex task, and students who have difficulty reading in the early elementary grades will continue to struggle in all academic areas if interventions are not initiated to provide support (Allington, 2001; Duke & Pearson, 2002; NICHHD, 2000). In recognition of the difficulty in teaching reading and providing these supports, the importance of explicitly teaching reading was brought into the national spotlight in the late 1990s after the United States Congress commissioned the National Institute of Child Health and Human Development (NICHHD) to work with the U.S. Department of Education to establish a National Reading Panel (NRP). The NRP's aim was to evaluate recent reading research studies and make recommendations about effective instructional approaches. In the report, the NRP described five major tenets of reading instruction critical to student achievement in literacy: phonemic awareness, phonics, fluency, vocabulary, and comprehension (NICHHD, 2000). The NRP found that comprehension was the most critical reading skill for students to develop in order to reach learning goals. In order for a reader to effectively comprehend text, the reader must actively make meaning through a metacognitive process that demands intentional and thoughtful interaction between the reader and text (Graesser, Wiemer-Hastings, & Wiemer-Hastings, 1999; NICHHD, 2000; nblatt, 1994). The NRP report noted that reading comprehension can be facilitated through various cognitive tools to help recall information, make inferences, and think

critically about text. According to the NRP, these comprehension strategies and skills should be integrated within the language arts curriculum as early as Kindergarten and be supported with a variety of tools and techniques rather than just a singular theoretical and methodological frame (NICHHD, 2000).

Given the rapid development of information technology, the 21st century has seen an increase in new literacy tools available for meaning making, especially for students who struggle with reading. Traditionally, literacy encompassed learning to read, write, and appreciate the printed word. The 21st century view has suggested that literacy is interactive and dynamic, and processing meaning goes beyond merely encoding and decoding text (New London Group, 1996). Researchers and teachers are beginning to explore the way meaning is constructed through multimodal texts (Anderson-Inman and Horney, 2007; Bearne, 2003; Jewitt, 2002; Kress, Jewitt, Ogborn, & Tsatsarelis, 2001; Walsh, 2008).

Over the past 10 years, various studies have explored learning environments that utilize multimodalities to enrich student learning in literacy classrooms, and more studies are underway in an attempt to gain pedagogical understandings of how classroom literacy practices can be affected through multimodal and interactive technologies (Bearne, 2003; Kress et al., 2005; Jewitt, 2002; Rowsell & Casey, 2009; Walsh, 2008; Walsh, 2009). In one case study (Welsh, 2009), young students engaged in interactive multimodal activities that allowed them to manipulate objects on a screen and participate with technology using visual, tactile, and kinesthetic senses. Welsh (2009) found that this engagement with technology increased motivation and interest in learning, and Medwell's (1996) comparison of children's use of audiobooks to printed storybooks illustrated that students using the multimodal texts showed improved story recall over peers in the control group.

Despite these findings, a gap remains between research and classroom practice, as a review of the literature showed that a limited number of experimental studies have been conducted on interactive multimodal learning environments (Jewitt, 2005; Mayer, Dow, & Mayer, 2003; Plass, Chun, Mayer, & Leutner , 2003). Furthermore, there has been a lack of agreement about the degree to which eBooks increase literacy skills in the area of comprehension. The new development of interactive eBook applications – which only became widely available in 2010 – and their ensuing popularity have highlighted a need for educational research to examine the pedagogical effects of this multimodal literacy tool (Cahill & McGill-Franzen, 2013; Serafini, 2011; Schugar, Smith, & Schugar, 2013). By exploring the connection between interactive eBooks and comprehension, educators might better support readers through an interactive, digital platform.

As such, the purpose of the dissertation study was to consider the comprehension effects, behaviors children engage with, and affordances and constraints of interactive eBooks. The specific eBooks chosen for the study had two options for reading: a Read-to-Me mode or a Read-and-Play mode. The Read-to-Me mode had automated actions that did not necessarily require user control, including audio narration, page advancement, and additional speech bubbles. The Read-and-Play mode, by contrast, was completely controlled by the user and encouraged user interaction with the interface. The only automated aspect of the Read-and-Play mode was the initial audio narration.

Research Questions

The study's research focus was designed to explore the following questions:

1. How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade?

2. What are the behaviors that participants demonstrate while reading in the Read-to-Me and Read-and-Play modes?
3. What are the affordances and constraints of the Read-to-Me and Read-and-Play modes of reading?

CHAPTER 2: LITERATURE REVIEW

The purpose of this exploratory dissertation study was to examine the juncture between comprehension and multimodal literacy to improve comprehension skills. I framed the literature with theories of reading comprehension and multimodal learning.

Reading Comprehension

To become proficient readers, students must be able to fluently decode printed text and simultaneously construct meaning from the language of text (Gough & Tunmer, 1986). Comprehension is the ability to make meaning and construct knowledge, an act that stems from the interaction between the reader and the text. In order to comprehend a text successfully, readers must actively reflect on and decode the printed word, combine this with their prior knowledge, attend to unwritten nuances and inferred purposes of the author, and finally synthesize this information to make new meaning (Beck & McKeown, 2006; Duke & Pearson, 2002).

Because of the complexity of the reading process, the notion of active reading is crucial. Readers have to consciously make sense of what they are reading and not just passively receive information (Beck & McKeown, 2006). Much of the research on reading comprehension has shown that to construct meaningful representations of text, readers need to be highly engaged (Block & Pressley, 2003; Dorn & Soffos, 2005; Fountas & Pinnell, 2001; Harvey & Goudvis, 2000; Keene & Zimmerman, 1997; Wilhelm, 2001). Successful comprehension requires readers to be able to think about their reading, an act of metacognition that leads readers to build connections, make inferences, synthesize, determine what is important, visualize, and generate questions.

Correspondingly, the ability to construct meaning from text is grounded in Vygotsky's (1978) work with the notion and depth of cognitive tools. According to Vygotsky (1978), learning is influenced by environmental factors like cognitive tools; people make meaning through the mediation of these tools. Derry (1990) defined "cognitive tools" as devices that support, guide, and expand the meaningful cognitive processes of its users. Cognitive tools can be internal, like metacognition or inner speech, or external, like a book or software program. Whether internal or external, cognitive tools are essentially knowledge facilitation means that can be applied to a variety of subjects. Cognitive tools help accentuate active participation of the mind in learning. Thus, the process of learning is not an accumulation of items into a mental database, but is a transformation of knowledge in which the learner actively makes sense from a range of events presented through cognitive tools. Consequently, learners use cognitive tools to assign meaning to new information by relating it to prior knowledge, mediating thinking, and engaging in problem solving (Palinscar, 1998).

Students who struggle with reading often have trouble comprehending and need opportunities to engage with cognitive tools designed to enhance understanding. For the dissertation study, a "lower-level reader" was defined as a student who was behind same-age peers in age-appropriate reading skills (Allington, 2001; Snow, et al., 1998). A lower-level reader usually requires specific academic interventions, such as Basic Skills Instruction, to support literacy learning in order to fill in the gaps that caused the child to fall behind. According to Allington (2001) and Harvey and Goudvis (2000) signifying indicators of lower-level readers are not knowing how to determine important details from minor ones and the inability to connect old knowledge with new knowledge. Without these skills, engagement with the text suffers, and lower-level readers also struggle with decoding, especially if a text is above

their reading level. The lack of skill in using prior knowledge, identifying important details, and the struggle to decode interact results in readers who do not readily make strong inferences or deep connections between ideas and have weak retellings and responses to readings (Wilhelm, 2001). Moreover, lower-level readers develop a limited ability to perform more literal comprehension and often need cognitive tools to scaffold making meaning (Allington, 2001; Harvey & Goudvis, 2000; Wilhelm, 2001). Research hypothesizes cognitive tools like interactive eBooks may provide multisensory stimuli for lower-level readers in ways that allow for deeper text analysis and processing (Craik & Lockhart, 1972; Mayer & Moreno, 2003).

Multimodal Learning

The theory of multimodal learning states that learners make meaning and demonstrate understanding through different modes and resources found within print and screen-based technologies (Jewitt, 2005). With a multimodal eBook, there is a synergistic and interactive relationship between the reader and the interface of the story. Rather than just decoding a printed text or listening passively to an audiobook, the focus of an interactive experience is on the learner, who is an active participant in the two-way action of the storytelling process (Moreno & Mayer, 2007). Interactive eBooks have hotspots embedded within the stories that allow readers to become directly involved with the text to activate and control animations, sounds, and related activities. The activities in an interactive eBook are designed to promote a sense of control on the part of the learner and elicit sensory or cognitive curiosity (Malone & Lepper, 1987). Learner control is a significant feature of interactive eBook applications; the reader has the ability to shape, expand, and determine paths to access content as part of the reading process (Alessi & Trollip, 2001; Dalton & Proctor, 2008; McLoughlin & Lee, 2007).

The majority of the literature surrounding multimodal learning and interactive eBooks falls into two categories: empirical and conceptual. In spite of the growing interest in and creation of interactive eBooks, there have been few empirical studies examining eBooks' impact on comprehension, especially with elementary-age students who are lower-level readers. Most of the studies in the extant literature did not focus on lower-level readers, thus emphasizing the need for continued research with this population. Furthermore, a review of the literature demonstrated that the sample sizes for the greater part of the empirical studies remained small but varied widely, ranging from 20 to 149 participants (Korat & Shamir, 2008; Okolo & Haynes, 1996).

One empirical study focused on comprehension outcomes of interactive eBooks that contained hotspots, such as character animations and games (deJong & Bus, 2002). The authors found that students in the intervention group demonstrated higher results than those in the control group. A later study conducted by Vehrallen, Bus, and deJong (2006) resulted in the same findings. In the 2006 study, Vehrallen et al. conducted a randomized-control trial with 60 kindergarten second language learners. The researchers compared the effects of using a multimodal eBook with a static eBook. They found that the effect sizes were larger for the intervention group and concluded that the multimodal features of the eBooks supported second language learners' understandings of stories (Vehrallen et al., 2006). Other empirical studies noticed an association between interactive eBooks and comprehension skills, as demonstrated by the elementary students' ability to recall information and make inferences (Grimshaw, Dungworth, McKnight, & Morris, 2007; Pearman, 2008; Seyit, 2010; Shamir, 2009).

Conversely, several studies found that some of the embedded multimedia cues in eBooks could have an adverse effect, as they can distract readers from the main storyline and interfere

with comprehension (deJong & Bus, 2002; Trushell & Maitland, 2005). For instance, readers may experience cognitive overload and become disengaged from the plot (Delaney & Landow, 1991) or become increasingly involved with more superficial animations, thus compromising the essential meaning of the story (Thrushell, Maitland, & Burrell, 2003). The contradictory findings emphasize the importance of investigating which features within interactive eBooks serve as affordances and constraints in light of comprehension outcomes (McLoughlin & Lee, 2007).

The majority of the qualitative literature on multimodal literacy learning centers on shifting the traditional notion of literacy from the ability to read and write bounded and static text to a definition that views literacy as interactive and dynamic (Barton, Hamilton, & Ivanic, 2000; Bruce, 2003; New London Group, 1996). Multimodal literacy learning goes beyond the ability to read a single-dimension text because readers have to synthesize information in multiple formats from a variety of sources (Gilster, 1997), an act dominant in the lives of students in the 21st century (Rosen, 2010; Rowsell & Casey, 2009).

Qualitative studies have found that multimodal literacy learning emphasizes critical thinking, because it enables readers to construct new knowledge and express ideas through various types of media that extends beyond traditional print technology (Martin, 2006; Schugar et al., 2013). The knowledge construction that occurs when engaging with multimodal texts combines what people read and write with how they use and understand material through multimodal discourse: audio, video, images, and conventions of digital media (Centre for Research and Innovation in Learning and Teaching, 2009; Jewitt, 2008). Jewitt (2008), for instance, emphasized that it is important to attend to how various modes of media shape what is to be learned and the process that accompanies it. Jewitt (2008) claimed this understanding is a necessary prerequisite to improving the design of teaching and learning in a multimodal

environment. Furthermore, the shift from a focus on linguistics to multimodalities compels learners to navigate, decipher, and examine texts in novel and increasingly interactive ways. To illustrate, Chan and Black (2006) conducted a study of 189 seventh-grade students and found that students who interacted with direct-manipulation animation outperformed their peers on complex learning of science material. Additionally, researchers from the Centre for Research and Innovation in Learning and Teaching (2009) found that digital media stimulates high levels of engagement and involvement in classroom activities, particularly when using outputs such as podcasts and animations. In essence, multimodalities help make static images and text come to life and provide more possibilities for learning (Anstey & Bull, 2006; Unsworth, 2002).

With multimodal eBooks, readers construct meaning during learner-controlled transactions that support story understanding and other aspects of literacy learning (deJong & Bus, 2003; Moreno & Mayer, 2007; Smith, 2001). Interactive eBook applications present readers with digital learning environments that reinforce knowledge building in a variety of ways that require action on the reader's part. Even though learners utilize conventional literacy skills as they navigate a text, critical thinking becomes paramount as readers interact with the story by manipulating images, sounds, animation, and text (Jewitt, 2005; Mayer & Moreno, 2003). Readers have to be able to listen to the story narration, identify important details, make inferences, decipher visuals, operate various modes, relate animations to the overall narrative, and ultimately, synthesize all of this information to make meaning. In sum, researchers have agreed that engaging in multimodal interactive eBooks is a complex act that ultimately empowers learners and unlocks critical literary spaces for students to make meaning (Jewitt, 2005; Kervin, Mantei, & Herrington, 2009; Mayer & Moreno, 2003; Rowsell & Casey, 2009).

Embodied Conjectures

The two interactive eBooks that are part of this study are situated in design principles that support both multimodal and text processing theoretical frameworks (Figure 1).

To illustrate, the two eBook modes enable users to synthesize pictures, text, audio and animation to mutually support one another in knowledge building. The user combines this information with the printed words, prior knowledge, and inferences to further process the text. Essentially, these modes serve as scaffolds to support and expand meaningful cognitive processes and, ultimately, help the user make meaning (Jewitt, 2005; Kervin, Mantei, & Herrington, 2009; Mayer & Moreno, 2003; Rowsell & Casey, 2009).

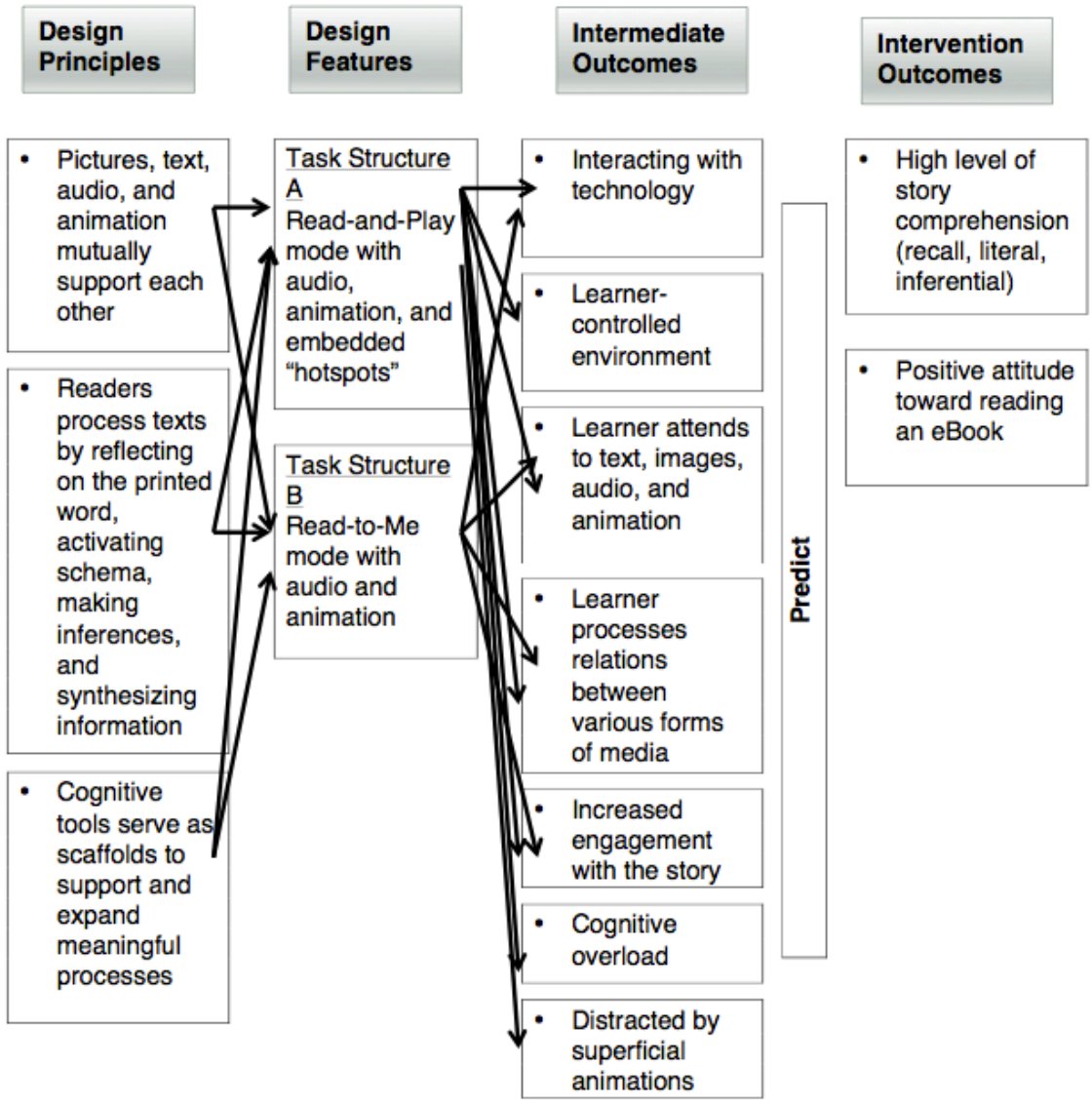

Figure 1: Map of embodied conjecture and predicted outcomes.

Anderson-Inman and Horney (2007) emphasized the role that eBook enhancements could play in helping lower-level readers overcome hurdles in comprehension. For example, if an eBook is read aloud the reader does not have to exert cognitive effort to decode words, allowing the reader to focus more on making meaning. Additionally, eBook animations may support a reader when visualizing story events, a strategy that directly affects comprehension (Allington, 2001; Fountas & Pinnell, 2001; Harvey & Goudvis, 2000; Keene & Zimmerman, 1997). As

such, it is anticipated that the intermediate outcomes of the dissertation study will allow users to interact with technology, attend to and process various modes of media, engage with the texts, and, in the case of the Read-and-Play mode, control the learning environment. I hypothesize that if young readers interact as expected with the eBooks, the Read-and-Play mode will lead to stronger comprehension than the Read-to-Me mode due to the increased learner control. On the other hand, it is possible that users may experience cognitive overload and be distracted by superficial animations because of the "seductive details" in the Read-and-Play mode. In this case, the Read-to-Me mode might lead to enhanced comprehension. Furthermore, the readers' background knowledge and familiarity with the specific stories may have more to do with improved comprehension than the specific mode in which the readers engage.

For the dissertation study, an affordance of a user interface was defined as "the attributes that provide potential for action" (Kennewell, 2001, p. 106). Constraints were defined as "the conditions and relationships between attributes that provide structure and guidance for the course of actions" (Kennewell, 2001, p. 106). Constraints are not the inverse of affordances but are "complementary and equally necessary for activity to take place" (Kennewell, 2001, p. 106). Examining the design features that serve as affordances and constraints provided insight into how readers use these elements to make meaning.

CHAPTER 3: METHODOLOGY

The research described in this dissertation used a mixed methods approach. In qualitative studies, researchers investigate little-understood phenomena in real-world settings and facilitate an examination of matters in depth and detail (Marshall & Rossman, 1999; Patton, 2002). Quantitative data was collected and analyzed to provide measurable and comparable results of the intervention. Quantitative data was used to compare before-reading and post-reading retelling outcome measures as well as total comprehension question response scores. Data collection extended over four months.

Research Questions

My research questions were as follows:

1. How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade?

2. What are the behaviors that participants demonstrate while reading in the Read-to-Me and Read-and-Play modes?

3. What are the affordances and constraints of the Read-to-Me and Read-and-Play modes of reading?

Research Design

In this exploratory dissertation study, I focused on two interactive eBooks geared toward children that can be read in a Read-to-Me or Read-and-Play mode: *Cinderella* and *The Three Little Pigs,* both developed by Nosy Crow Limited (2013). The second grade appropriate titles were chosen because their Read-and-Play mode goes beyond having the option to hear the text read aloud. Users are able to use the mode to interact with the eBooks through touch and must actively participate with the software's interface to move the story along by enabling animations,

hearing additional speech from the characters not found in the printed text, and zooming in to reveal hidden details. In contrast, the Read-to-Me mode is not learner-controlled, but does automatically include some of the extra animation and narration found in the Read-and-Play mode. In addition, the Read-to-Me mode advances to the next page on its own; in the Read-and-Play mode, the user controls how long to spend on each page and when to turn the page. The key differences between the Read-to-Me and Read-and-Play modes are outlined in Table 1.

Table 1.

Key Differences Between Two Reading Modes

Feature	RtM	R&P
Read Aloud Feature	Automated	Automated
Speech Bubbles	Some automation, but user could initiate	Only Initiated by User
Advancement of Pages	Some automation, but user could initiate	Only Initiated by User
Interactive Games	Only Initiated by User	Only Initiated by User

Note. RtM = Read-to-Me. R&P = Read-and-Play.

Sample

I purposefully sampled 30 grade 2 participants. Participants were selected from the entire second-grade in one suburban elementary school in New Jersey. I am employed at this school as a Reading Specialist but do not work directly with any of the participants. The sample consisted of 17 girls and 13 boys. The racial breakdown was 63.3% white (n = 19), 23.3% Asian (n = 7), 10% Black (n = 3), and 3.3% Biracial (n = 1). The participants were selected because they scored in the bottom 20% on their most recent Developmental Reading Assessment (DRA) (Beaver & Carter, 2006). According to reading levels defined by Fountas and Pinnell (2012), 53% (n = 16), were reading below grade level at the onset of the study: level E (n = 4), level G (n

= 4), level H (*n* = 4), and level I (*n* = 4). Additionally, 14 of the participants were reading at grade level: level J (*n* = 7), and level K (*n* = 7).

As a result, almost half of the participants received additional instructional support in reading. Of those, 20% received Basic Skills Instruction (*n* = 6), 20% had an Individualized Education Plan (*n* = 6), and 3.3% had a 504 Plan (*n* = 1). This population of readers typically struggle with comprehending text beyond the literal level and need instructional scaffolds and guidance to make inferences and understand implicit information in text (Allington, 2001; Snow, Burns, & Griffin, 1998; Tyner, 2009). The focus of the study on how the lower-level readers interacted with books in a digital learning environment may improve the design of interventions intended to help the learners make meaning and build knowledge.

Data Collection Methods

The study consisted of a repeated measure design. Each participant read two eBooks that were unknown to them. I randomly assigned each participant to one of the following conditions, which determined the reading order for each session:

1. *Cinderella* Read-and-Play, *The Three Little Pigs* Read-to-Me (*n* = 8).
2. *Cinderella* Read-to-Me, *The Three Little Pigs* Read-and-Play (*n* = 7).
3. *The Three Little Pigs* Read-and-Play, *Cinderella* Read-to-Me (*n* = 8).
4. *The Three Little Pigs* Read-to-Me, *Cinderella* Read-and-Play (*n* = 7).

Observation Protocol

Qualitative data provides researchers with a wealth of information collected through on-site interviews, observations, and documents (Patton, 2002), and a qualitative inquiry approach requires an active and involved role for the researcher. I sat with each participant individually for two non-consecutive 30-minute sessions at school and observed what each one did while

reading the eBooks on an iPad. Each participant was observed, videotaped, and interviewed throughout the reading sessions to explore how the interactive nature of the eBooks impacted comprehension. In addition, an iPad screencasting program was used during each reading session to capture how each user interacted with the eBooks including the antecedents and consequences of targeted interactions.

Field notes. Observations offer qualitative researchers the opportunity to gather live data in natural settings (Cohen, Manion, Morrison, & Morrison, 2007; Patton, 2002). Therefore, as the participants were engaged with the eBook, I noted verbal and nonverbal interactions between the reader and eBook. By writing field notes that focused on nuances such as when a participant touched the screen and made vocalizations, I was able to describe what the users were doing during the reading sessions. Conducting observations assisted in understanding which aspects of the interactive eBooks may have impacted comprehension.

Video recording. Likewise, video recording each session from beginning to end helped capture audio and visual data in real time (Derry et al., 2010) and served as a critical data source. Observations can be biased and lead to noting inferred behaviors; it is important to write down what one sees, not what one thinks one sees. During the data analysis phase, I supplemented observation notes with the video recordings to triangulate the data and get a more complete picture of what occurred during each reading session. Video recordings ranged from twenty to forty-five minutes in length.

Pre-reading interviews. Before each reading session, I interviewed each participant about the respective story for that session to gather background knowledge (Appendix A). The same directions were given to each participant in the Read-to-Me or Read-and-Play mode before reading the book on the iPad. The iPad was placed face-up on the table centered in front of the

participant.

During-reading interaction. During reading, I did not interact with the participants in any way unless a participant asked me a direct question. I did, however, have to prompt several participants reading in the Read-and-Play mode to explore the page by touch. This redirection was given only if a participant did not touch the screen after reading pages 1-3 (not counting pressing the screen to turn the page). If redirection was needed, I went back to the app's main menu and reset the story to page 1.

Post-reading interviews. Immediately after reading, each participant was asked to give an oral retelling of the story (Appendix B). This task requires a great deal of cognition on the reader's part and is often a difficult skill for lower-level readers to master (Wilhelm, 2001). As such, the ability to successfully retell a story can be thought of as a prerequisite for making meaning (Gunning, 2013; Morrow, 1985).

Next, I asked structured comprehension questions to gather data about each participant's understanding of the story (Appendix B) beyond what is explicitly stated in a text (Fountas & Pinnell, 2001; Harvey & Goudvis, 2000; Keene & Zimmerman, 1997). Determining readers' ability to make inferences is crucial because fiction writers do not explicitly include everything they want readers to know about a text, forcing readers to gather text clues to make meaning (Boushey & Moser, 2009; Fountas & Pinnell, 2001). Researches have agreed that strong readers connect with a text through inferences, a strategy that separates them from lower-level readers (Allington, 2001; Harvey & Goudvis, 2000; Oczkus, 2004; Wilhelm, 2001).

Finally, I asked specific questions about the interactive literary experience (Appendix C). These post-reading questions inquired into the participants' perceptions of the interactive eBooks themselves, affordances and constraints, and how this medium may have impacted their

understanding. Answers to these questions provided insight into how the affordances and constraints of the e-Book were utilized in a learning environment (Day & Lloyd, 2007; Kennewell, 2001; Lockee, Moore, & Burton, 2001).

Data Analysis

The mixed methods dissertation study included qualitative and quantitative data. As such, the data from this research was analyzed and coded deductively and inductively in light of comprehension, reading behaviors, and affordances and constraints.

Qualitative Analysis

I transcribed the videos from the sixty reading sessions and uploaded them to *Dedoose*, an online software program designed for mixed methods data analysis. Next, I broke each transcript into coding units. These coding units were developed based on the interview questions: (a) before-reading prior knowledge, (b) after-reading retelling, (c) after-reading comprehension responses, and (d) interactive eBook reading experience responses.

Looking at the after-reading comprehension responses from a qualitative standpoint, I sorted the units for this section into five child codes (Appendix D). Every response given by each participant for the four after-reading comprehension responses was assigned one of the following codes: (4) Extended Inference, (3) Surface Inference, (2) Literal, (1) Some Accuracy and Some Misinterpretation, or (0) Incorrect/Off-topic.

Research has suggested that positive emotions are an indicator of engagement and play a role in memory and comprehension (Blumenfeld, Kempler, & Krajcik, 2006; Graesser & D'Mello, 2012; Scharer, Pinnell, Lyons, & Fountas, 2005; Ratey, 2001). In fact, Blumenfeld et al. (2006) asserted that deeper engagement with classroom material leads to heightened skills and knowledge. Engagement indicates mindfulness, cognitive effort, and intense processing of new

material (Salomon & Globerson, 1987). Therefore, I deductively assigned codes when looking for patterns of reading behaviors.

To capture evidence of the participants' reading behaviors, I observed what participants were doing or saying while reading each eBook in both modes (e.g. gestures, going to a previous page, monitoring understanding by stating, "I don't understand") and later created an observation chart listing these behaviors. If a participant engaged in a particular process once, I made a check mark on the observation chart. Each observed process received only one check mark per session. If the child did not exhibit the behavior, I left the section blank.

To qualitatively explore the third research question about each mode's affordances and constraints, I analyzed the participants' responses to the post-reading metacognitive questions (e.g. "Did reading an interactive eBook help you to understand the story better? Why or why not?"). This information was used to reinforce or counter the affordances and constraints noted in the two eBooks.

Inter-rater reliability. Inter-rater reliability was established for the coding scheme and for identifying video recorded reading behavior. Two independent coders coded 20% of the data for each of the identified coding units. Over four separate sessions, each coder used the codebook and data excerpts to assign a code to each excerpt. After this, I compared the results of each excerpt and applied code to look for number of agreements and disagreements. With this method, we achieved over 80% inter-rater reliability among the agreed upon codes.

Additionally, two independent coders viewed 20% of the video data and made a check mark on the observation chart for coding the behaviors. I compared the observation charts and highlighted the number of agreements and disagreements for the two coders, and found we achieved over 80% inter-rater reliability for the agreed upon codes.

Case studies. The analysis generated from the qualitative data was used to create case studies of particular individuals. The case studies are discussed in Chapter 4.

Quantitative Analysis

To respond to the first research question quantitatively, I coded and scored the before-reading background knowledge units and after-reading retelling using an adaptation of the Developmental Reading Assessment 2 Comprehension Rubric (Beaver & Carter, 2006) (Table 1). This assessment instrument contains a rubric scale that ranges from 1 to 4.

Table 2.

Before-reading Background Knowledge and After-reading Retelling Rubric

Level of Understanding	0	1	2	3	4
	No Response or Off-Topic Student does not respond or does not discuss the given story	Limited Includes only 1 or 2 events or details	Partial Includes at least 3 events, generally in random order	Adequate Includes most of the important events from the beginning, middle, and end, generally in sequence	Proficient Includes all important events from the beginning, middle, and end in sequence

In addition, a 2x2 within subjects factorial design analysis of variance (ANOVA) was performed to compare the before-reading and post-reading retelling outcome measures of the Read-to-Me and Read-and-Play modes of both eBooks at the .05 level of significance. I also compared the total comprehension question response scores of both books' Read-to-Me modes to the total comprehension question response scores of both books' Read-and-Play modes. By doing a correlational analysis and making comparisons within participants and across modes, I was able to determine the strength of the relationship between the comprehension outcomes.

Table 2 details the relationship between the research questions, data sources, and data analysis.

Table 3.

Relationship Between the Research Questions, Data Sources, and Data Analysis

Research Question	Data Source	Data Analysis
How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade?	Before-reading interview for background knowledge Post-reading retelling and comprehension questions	Comprehension Rubric Code for levels of comprehension Repeated Measures ANOVA Case studies
What are the behaviors that participants demonstrate while reading in the Read-to-Me and Read-and-Play modes?	Observe behaviors during readings Post-reading metacognitive questions	Code for reading behaviors Observation Checklist Case studies
What are the affordances and constraints of the Read-and-Play and Read-to-Me modes of reading?	Post-reading metacognitive questions	Case studies

CHAPTER 4: RESULTS

This chapter presents the findings of the research study. The purpose of the study was to explore the implications of interactive eBooks on comprehension, the behaviors that participants exhibit when reading interactive eBooks within the Read-to-Me and Read-and-Play modes, and the affordances and constraints of each mode. For the purposes of this study, each participant was presented with two interactive eBooks, one of which was in a Read-to-Me mode and the other in a Read-and-Play mode.

Qualitative excerpts are used to provide context and depth and follow the quantitative results. The excerpts are organized by eBook title to allow for comparison of comprehension responses.

Quantitative Analysis

Quantitative results are presented in two stages. First, descriptive statistics are presented in order to provide context to the reader. The descriptive statistics include means and standard deviations. In the second stage of results, the research questions and hypotheses are tested using inferential statistics, specifically with an ANOVA.

Descriptive Statistics

The descriptive statistics for all study variables including means and standard deviations are presented in Table 3. Some of the recorded data was absent during the data-gathering phase due to a technical malfunction. The missing data affected five participants. One participant did not have any data recorded for any of the four post-reading questions for the Read-to-Me mode. A different participant did not have data recorded for two questions in the Read-to-Me mode and one question in the Read-and-Play mode. Three other participants had one response missing from the Read-to-Me mode.

Table 4.

Descriptive Statistics of Reading Outcome Variables

	Read-to-Me			Read-and-Play		
Measure	N	Mean	SD	N	Mean	SD
Pretest	30	2.17	1.32	30	2.13	1.17
Posttest	30	2.93	1.11	30	2.90	1.13
Question 1	29	2.83	1.39	30	3.17	1.15
Question 2	27	3.33	1.18	30	3.23	1.19
Question 3	27	3.33	1.39	30	3.07	1.48
Question 4	28	3.11	1.17	29	2.83	1.14

Inferential Statistics

Research question 1: How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade?

Research question 1 was tested quantitatively by a repeated measures ANOVA. During the repeated measure ANOVA analysis, effects were estimated for mode (Read-to-Me or Read-and-Play), time, and the interaction between mode and time.

A significant impact for mode would be indicated if its interaction with time was found to be significant ($p < .05$), indicating that the change in reading ability from pretest to posttest varied by mode.

Results of repeated measures ANOVA indicated that a main effect existed for time (F (1, 29) = 12.36; $p = .001$), such that participants in the current sample tended to increase proficiencies from pre to posttest. Results of repeated measures ANOVA also indicated that no significant effects were found for mode (F (1, 29) = .03; $p = .86$), and for the interaction between time and mode (F (1, 29) = .00; $p = 1.00$), indicating that the change in reading outcome over time did not vary by mode.

Qualitative Analyses

This section contains excerpts of interviews with a number of participants that demonstrated student comprehension of the texts. All names are pseudonyms to protect the anonymity of the participants. The first subsection contains descriptions of several participants including their background as readers and how they responded to the before reading background knowledge and the after-reading retelling. The second subsection contains a description of the participants' responses to the after-reading comprehension and how their responses reveal their comprehension of the texts.

Before-Reading Background Knowledge and After-Reading Retelling

Research question 1: How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade? Qualitative analysis indicated that the majority of participants increased proficiencies at least one level across both modes.

Joey. One participant in particular, Joey, had a large jump in proficiency levels between his before-reading background knowledge (0 - No Response/Off Topic) and post-reading retelling scores (4 – Proficient) when reading *The Three Little Pigs* in the Read-and-Play mode. As a kindergartener, Joey was identified as needing Basic Skills Intervention (BSI) in Language Arts and continued to receive BSI as a second grader. He was reading well-below grade level and struggled with comprehension, as evidenced by his score on the DRA.

Joey first attempted to share his background knowledge of the story by mentioning the three little pigs as main characters. However, when prompted for additional information, Joey did not offer any more story events but instead shared a general fact about what pigs like to do. The following excerpt illustrates his response:

> R: This story is called *The Three Little Pigs*. Please tell me everything you already know about this story.

Joey: (Smiles and shakes head) I don't know anything…There's three little, there's three little pigs…They like…(Shrugs shoulders) I don't – I never read this book.
R: Ok. But you know something, right? There are three little pigs, and what do they do?
Joey: Pigs always, like, roll over in the mud because they *love* mud.
R: Mmm hmm…have you ever heard the story of the three little, the big bad wolf and the three little pigs?
Joey: (Shakes head) No.

When retelling, readers like Joey have a great challenge; they have to recognize the elements of a narrative arc, determine the most important story events, and recreate the story in their own words. It is for these reasons that a close examination of Joey's post-reading retelling transcript was warranted. Despite grammatical and language retrieval errors, the details in Joey's post-reading retelling were distinctively rich and revealed a strong understanding of the story:

R: Tell me what the story is about.
Joey: They leave the house. This is not even working. (Taps the microphone)
R: No, it's, it's, it's doing it, don't worry.
Joey: Oh…They leave the house to go to make their own. Their mom told, told her, to, the pigs to move, to go to their own, and build their own houses -
R: [Mmm hmm.]

Joey: And the first one build their house, his house with…with…(Smiles) I don't know what the name is, hay?
R: Mmm hmmm.
Joey: And the second one builded it with…brick?
R: Mmm hmmm.
Joey: And the third one builded it with, uh, no, I mean the second one builded it with sticks and then the third one builded it with…wood, I think?
R: Ok.
Joey: Cause wood can't get blowed down. (Shakes head)
R: Mmmm.
Joey: Only if you use like, soooooooo much of it. And then the wolf came? The wolf came, not, the wolf came to the first one, and he blew the whole, he wan- he asked if he could come inside…the, and the first one didn't let him 'cause the chin chin chin…and then it, the, he blew it so hard that his house got down, and then he ran to the second house while he was driving…and then, he came to the second house and those two were still there…and then, he asked if I could come in, 'I'll be nice,' (Smiles) and then, and then they said no so he blew their house, and they went to the se-, they went to the third house and then the same thing happened, the same thing happened…so…he…but…they…he tried blowing it so hard but he missed so he went in

> the chimney…and then he went through but he, but he failed because he hit ice (Smiles)……and they lived happily ever…after.

Joey was able to communicate the major story events in sequence, beginning with why the pigs had to leave their parents' home and go out on their own. Even though he incorrectly identified the material that the third pig used to build his house, Joey did properly state the materials that the first two pigs used. He then brought in the story's antagonist (the wolf) and explained that the wolf used the same scare tactic on the first two pigs to destroy their homes. Joey even shared details germane to the eBook's version of *The Three Little Pigs* such as what the wolf said ("I'll be nice") and how the wolf got from house to house ("driving"). Additionally, Joey discussed a major cause and effect at the third pig's home ("He tried blowing it so hard but he missed so he went in the chimney"), which led to the wolf's imminent downfall. To finish, Joey closed out his retelling with the classic fairy tale ending: "And they lived happily ever…after." Even though it is quite challenging for lower-level readers to determine importance while reading, Joey was able to do this successfully to generate a proficient retelling of *The Three Little Pigs*.

Melissa. Another participant in the Read-to-Me mode demonstrated an increase in proficiency levels between her before-reading background knowledge measure and post-reading retelling when reading *Cinderella*. Melissa moved from a score of 1 (Limited) on her before-reading measure to 4 (Proficient) on the post-reading retelling. As seen in the following transcript, the background knowledge that Melissa tapped into was minimal. Although she incorrectly mentioned that the main character lost "Snow White's" slipper, she did include the idea that the main character had an evil stepfamily. With prompting, Melissa declared that the main character goes to a ball, but did not elaborate any further:

R: This story is called Cinderella. Please tell me everything you already know about this story.
Melissa: That she lost her, um, Snow White's slipper. Um, she has a, like, a stepmom and a stepsister, the sisters, and they're, like, really mean to her.
R: Mmm hmm.
Melissa: That's it. (Laughs)
R: OK. Can you think of anything that happens in the story? Some of the events? In the beginning, in the middle, in the end?
Melissa: She goes to a ball.
R: Mmm hmm.
Melissa: And that's it. (Shrugs)

Retelling a story gives readers a platform to discuss what they remember from a text and, as such, can be a useful measure of one's comprehension (Doty, Popplewell, & Byers, 2001; Morrow, 1996). Melissa's post-reading ability to retell the major events in the story afforded specific insight into her understanding of *Cinderella*:

R: Tell me what this story's about.
Melissa: Um, a little girl named Cinderella and, um, like, she has a stepsister and a stepmother and then, um, like, the stepsisters and the stepmothers are mean so, um, the mail came and they saw this invitation that's going to the ball. And they didn't let Cinderella see so then, um, they left for the ball and Cinderella, she got, like, upset 'cause, like, she, they didn't tell her. And then, um, the fairy godmother appeared and she went and her fairy godmother helped her and she went to the ball…and lived happily ever after. (Laughs)
R: So, tell me what happens at the ball, and after the ball?
Melissa: So, at the ball she meets a prince and the prince asks her to dance. And then, um, it, the clock struck midnight so she had to run home and then she, um, left her slippers. So, the prince said whoever, um, ah, whoever fits this slipper I will marry. So then they went to Cinderella's house and the stepsisters couldn't fit into it and Cinderella, um, tried on the slipper and her fits her and then, um,…they got married.

When comparing Melissa's retelling to her background knowledge, it is evident that she retained a great deal of information after reading *Cinderella*. Interestingly, Melissa included the material that she shared before reading but this time it was in sequence with additional details. For instance, Melissa's retelling still stated that Cinderella's stepfamily was mean, but this time she gave evidence of this ("And they didn't let Cinderella see so then, um, they left for the ball and Cinderella, she got, like, upset 'cause, like, she, they didn't tell her."). Likewise, after

prompting, Melissa was able to share what happened at the ball and how the prince eventually found Cinderella with the help of the glass slipper. In all, Melissa's ability to update her thinking and synthesize her old and new knowledge of the story—a high level reading skill (Allington, 2001; Beck & McKeown, 2006; Duke & Pearson, 2002; Harvey & Goudvis, 2000)—is evident when qualitatively examining her before and after-reading responses.

After-Reading Comprehension Questions

Research question 1: How does the nature of interactive eBooks impact comprehension with lower-level readers in second grade? Review of the transcripts of the post-reading comprehension responses by eBook title provided further insight into the depths of the participants' thinking. In general, regardless of mode, participants were recorded making extended inferences. For instance, one participant in the Read-to-Me mode made an extended inference into why he felt the first two pigs were scared when meeting the big, bad wolf in *The Three Little Pigs*:

> R: So how do you think the first two pigs feel when the wolf comes knocking on their doors?
> Curtis: They felt, they felt scared and nervous becau-, because they thought, they thought, um, the wolf was gonna eat them.

Curtis accurately inferred how the first two pigs felt when the wolf showed up at their doors ("scared and nervous") but then extended this inference by stating that they would be afraid because the wolf planned on eating them. The wolf never explicitly stated that he wanted to eat the pigs when he showed up at their doors, but Curtis was able to combine his prior knowledge with clues from the story to draw a conclusion, a skill that is often difficult for lower-level readers.

Bella, who was receiveing BSI support, had a similar extended response to the same question utilizing the Read-to-Me mode. She demonstrated an ability to reflect upon the story and draw a clear conclusion about the first two pigs' feelings when confronted by the wolf:

> R: How do you think the first two pigs feel when the wolf comes knocking on their doors?
> Bella: Ummm…scared.
> R: Why do you think they're scared?
> Bella: Or frightened.
> R: 'Frightened.' Good word!
> Bella: 'Cause wolves loves pigs and he wants to eat them. And they don't want to die! (Shakes head and smiles)

Like Curtis, Bella inferred that the first two pigs were "scared" or "frightened" because the wolf wanted to eat them. Bella, however, extended her inference to explain that the pigs "don't want to die," a sentiment never verbalized by the pigs in the story. Essentially, Bella added her own thinking to support the pigs' fear and desire to live. Being able to give an insightful response such as this one demonstrated a level of comprehension that typically requires a great deal of critical thinking for all readers, especially lower-level ones.

Successful readers think deeply about their thinking to make inferences and support their inferences with reasons (Boushey & Moser, 2009), as seen with Zuri who used the Read-and-Play mode. As shown in the following excerpt, Zuri explained why the first two pigs' homes were easily destroyed:

> R: So, why is the wolf able to blow down the first two pigs' homes?
> Zuri: Because it wasn't built properly. It was just made out of sticks and straw.
> R: Mmm hmm. And how is that, um, how does that show that it's not built properly? Or they're not built properly?
> Zuri: Because there was no, like, stuff that made it stick together.

To Zuri, the critical building material that the first two pigs were missing was adhesive. There is no moment in the book where the idea of an adhesive is explicitly stated, but Zuri brought in prior knowledge to make an assumption. In her mind, Zuri observed how the first two

pigs made their houses, ruminated on the effect of those actions, and successfully inferred why those homes were destined for ruin.

Another way to authenticate an inference is to support it with evidence from the text (Boushey & Moser, 2009). As seen below in data taken from the Read-to-Me mode, Eva wove an important story event with her inference to reinforce the idea that the third pig remained confident in the face of the wolf:

> R: Why isn't the third pig scared when the wolf knocks on his door?
> Eva: Because, he's like, my house is so strong and I have all this stuff to keep him away.
> R: Ahhh…So, what kinds of things does he have to keep him away?
> Eva: Like, a big pot of water that's really boiling, really hot so…like, when he is coming down the chimney he will hurt himself.

Eva was able to think about how the third pig used heavy-duty materials to build his house, giving him assurance that the wolf would not be a threat. Moreover, Eva inferred that the pig was confidently thinking that he had, "all this stuff to keep him away," as was seen when the pig boiled a pot of hot water to surprise the persistent, chimney-descending wolf.

Later, participants were asked a question that led them to apply what they learned from *The Three Little Pigs* to a scenario in which they would construct their own houses. This type of question can be difficult for students, particularly those with special needs. As Simmons and Singleton's (2000) research showed, students with special needs often have trouble making inferences compared to students without disabilities. Therefore, it is important to delve into a Read-and-Play excerpt from Darren, who has an Individualized Education Plan (IEP) for special needs. As shown in the following excerpt, Darren was able to make an extended inference and think beyond the forest animal in the book to threatening weather in our everyday lives.

> R: Using what you learned from this story, what would you build your house out of, if you were able to build a house, and why?
> Darren: I would brick my house out of brick and wood. The fir-, the top it, the roof should be brick because there could be heavy rains and thunderstorms and the wood part would be inside because um, just in case any rains and…nobody can come in.

Even though the rationale for using wood was not entirely clear, the first part of Darren's response illustrated that he used his knowledge of the world to fully connect with *The Three Little Pigs*. Instead of sharing a literal generalization about keeping one's house safe from wolves, Darren connected his understanding of dangerous elements to explain why he would use a strong material on the roof (to protect the house from "heavy rains and thunderstorms"). It is possible that Darren drew a logical conclusion based on his personal experience with devastating hurricanes in his local area, a skill that proficient readers employ (Oczkus, 2004).

Numerous extended inferences were also made after reading *Cinderella* regardless of eBook mode. Two examples that illustrate high levels of insight into why Cinderella's stepmother and stepsisters treat her the way they do are listed below. The first one is by a participant who utilized the Read-and-Play mode. In this example, Adriana thought about Cinderella's treatment throughout the story and hinted at possible dynamics between blended families:

> R: So, why do the two stepsisters and stepmother treat Cinderella the way that they do?
> Adriana: In the end?
> R: Um, in the, I guess throughout, maybe in the beginning, to the end, or throughout the story.
> Adriana: Mmm……well, they treated her, um, nicely when she got married with the prince -
> R: Mmm hmm.
> Adriana: - And, um, they treated her like a maid when she wasn't married to the prince.
> R: Why do you think they treated her like a maid when she wasn't married to the prince?
> Adriana: Because, um, she was not really that much, she wasn't really part of the family.

Here, Adriana recognized that Cinderella's stepfamily treated her differently based on what was happening in the story. Being able to observe changes in characters and use these nuances to make an inference is a high-level reading skill for making meaning (Emery, 1996).

Adriana explained that when Cinderella was married to the prince, her stepfamily "treated her…nicely" Adriana extended her inference by sharing that Cinderella may have been mistreated in the beginning because "she wasn't really part of the family." Adriana had to combine story clues with her prior knowledge of family dynamics to make an insightful judgment into character motivation. The ability to use reason to explain why characters behave a certain way involves deep thinking on the part of the reader.

Active readers create a symbiotic relationship between a text and their own prior knowledge to construct meaning (Rosenblatt, 1994). This notion was exemplified in the following Read-to-Me excerpt with Zuri, who made references to classism and bullying as reasons for the stepmother and stepsisters' cruel treatment of Cinderella:

> R: So, why do the two stepsisters and stepmother treat Cinderella the way that they do?
> Zuri: Because she didn't, she didn't, like, fit in with them because she had messy clothes, she had messy hair, she wasn't as mean as the, as the, um, stepmother and stepsisters.
> R: Mmm. What do you think about, like, you said that she wasn't as mean as they were. What do you think if she was as mean as them? Do you think that they would still treat her that way?
> Zuri: She would, they would probably treat her a little nicer like them, but not let her in their group because they are the mean girls.
> R: Ohh, they're like the mean girls. That's true. (Laughs)

This 8-year-old participant was able to draw upon her knowledge of class structures to infer that Cinderella's "messy clothes" and "messy hair" meant that Cinderella "didn't…fit in with them." Zuri went on to explain that the stepmother and stepsisters' behavior was deeply ingrained in who they are because they are "mean girls." This reference could have been asserted because of her connection to bullies at school and played on the idea of cliques and the strict exclusivity that accompanies them. According to Keene & Zimmerman (1997), prior experiences influence one's reading and play a significant role in knowledge building. Thus, this evidence of Zuri's thinking beyond the text exposed her deep comprehension of the relationships among the characters in *Cinderella* with the aid of prior knowledge.

Thinking critically about a text is an essential literacy skill that students need to become proficient readers in the 21st century. Zuri made another extended conclusion in the Read-to-Me mode when asked why the glass slippers—a major object in *Cinderella's* story arc—are so important.

> R: Why are the glass slippers important to the story?
> Zuri: Because if the glass slippers weren't in it, then the prince would have never married, never married Cinderella (Shakes head) because that's the whole reason how she found her.
> R: How he found her?
> Zuri: Uh huh. (Nods)

In the excerpt above, Zuri revealed her understanding of a major object in *Cinderella* by critically moving from part to whole. To do this, Zuri had to refer back to the object in the story, determine its importance, and compare the outcome to create a new idea. That is, "What would have occurred if that object did not exist?" By sharing, "If the glass slippers weren't in it, then the prince would have never married…Cinderella because that's the whole reason how [he] found her" Zuri demonstrated the complex reading skill of synthesizing information to build knowledge.

Curtis, when asked the same question in the Read-and-Play mode, echoed a similar sentiment:

> R: Why are the glass slippers important to the story?
> Curtis: Because when the prince, the prince, the prince finds the glass slipper, she goes to every house, he goes to every house and finds and finds, um, and finds everything. Without that glass slipper he wouldn't know who he would marry.

Like Zuri, Curtis correctly evaluated the glass slipper in *Cinderella* and made a sound judgment of its value. Curtis stated, "Without that glass slipper he wouldn't know who he would marry," which illustrated that Curtis thought the glass slipper served as a link between Cinderella and the prince. This type of deep inference is clearly connected to active reading, which requires

readers to maintain a current mental representation of a text while managing their own thinking about a text.

Overall, the fact that lower-level readers were able to make extended inferences after reading interactive eBooks in either the Read-to-Me or Read-and-Play modes suggested that interactive eBooks may serve as a cognitive tool for building comprehension (Derry, 1990; Palinscar, 1998; Vygotsky, 1978).

Analysis of Reading Behaviors

Research question 2: What are the behaviors that participants demonstrate while reading in the Read-to-Me and Read-and-Play modes? Participants exhibited numerous behaviors while reading the stories in the Read-to-Me and Read-and-Play mode. To make the task tractable, I coded this data from live observations and field notes. I used an observation checklist to note the behaviors that participants demonstrated and made a check mark as soon as a participant displayed a particular behavior. Each observed behavior received only one check mark per session. Studying the behaviors that students employed while reading eBooks offered insight into how these behaviors impacted their understanding of the texts. Table 4 contains a summary of the behaviors.

Table 5.

Behaviors Exhibited While Reading in Both Modes

Behavior	RtM	R&P
Taps a Major Character to Elicit Speech Bubbles (e.g. Cinderella, Wolf)	16	29
Taps the Same Character More Than Once on a Screen to Elicit Speech Bubbles	6	13
Participates in an Interactive Game; Taps the Screen to Open/Build an Item	11	30
Drags a Vehicle/Character Around in a Scene	7	13
Flips a Character	3	13
Moves Screen Around to Explore the Setting	6	12
Thinks-Aloud	8	17
Laughs and/or Smiles	11	16
Looks Around Classroom (Distracted)	3	0

Note. Number of students = 30. RtM = Read-to-Me. R&P = Read-and-Play.

Tapping a major character was the most prominent reading behavior participants engaged in while reading in the Read-to-Me and Read-and-Play modes. This is one of the most distinctive features of the two chosen eBooks published by Nosy Crow. After the initial narration is complete, a user can tap a character to see and hear more dialogue from that character. For instance, if a user taps the third little pig while he is preparing a pot of water to surprise the wolf, he exclaims, "Let's get this water nice and hot!" Readers may then infer that the hot water could cause damage to the wolf when he comes down the chimney, leading to a prediction that the wolf may ultimately be defeated by the third little pig's wise ways. The ability to make logical predictions is a skill active readers employ to build knowledge.

Likewise, there is a scene in *Cinderella* where the prince's father is filling out invitations to the ball. The prince stands off to the side, playing a game of paddleball. If the reader taps the prince, he will speak, verbalizing different statements to the reader. For instance, after one tap the prince says, "I don't care what she looks like. I just want someone who's fun." Attentive readers may take this additional narration and infer that the prince is not superficial; he puts more

value on personality than physical appearance. Indeed, this inference is confirmed at the end of the story when the prince fits the glass slipper onto Cinderella's dusty foot and proceeds to marry her. In essence, it is implied that the additional narration stemming from the speech bubbles allows readers to think analytically while reading and serves as a tool for expanding comprehension.

Participants also utilized the two-way design features of the eBooks to engage in interactive games (Table 4). The interactive games were used by fewer than half of the participants in the Read-to-Me mode but by all of the participants in the Read-and-Play mode. The games require users to actively participate in the story to move the narrative along or tap an item to open or build. For example, readers of *The Three Little Pigs* could help the pigs build their houses with the tap of a finger and, conversely, blow on the iPad's microphone to assist the wolf in huffing and puffing and blowing the pigs houses down. As such, observant readers participating in these games might notice how easily the wolf (the reader) blew down the first two pigs' homes, but how impossible it was to blow the third house down (even with help from the reader). In *Cinderella*, users can help Cinderella clean up the dining room by stacking plates on a shelf or get her stepsisters ready for the ball by finding the items that they wanted ("Fetch me that pink hair ribbon." "Where's my tiara?"). These in-text interactions reinforce the idea that Cinderella had to do hard work everyday for her demanding, self-centered stepsisters.

The data from showed that participants also interacted with hotspots that were not directly connected to the stories' overarching narratives in both modes (Table 4). Some of these activations were more seductive in nature and may not necessarily have expanded users' understanding of the texts. For instance, a tenth of participants in the Read-to-Me mode and a third of participants in the Read-and-Play mode "flipped" a character on the screen. This action

comes about when a reader uses a finger to flick the character upward, causing the character to take a clockwise spin in the air. Users can flip characters multiple times on each page if desired. Clearly, flipping characters does not add any value to the storyline and might detract from comprehension. Examples of potentially less-distracting interactivity included the user trying to drag a character or vehicle along the setting on the screen or moving a finger around the screen to explore the setting to access the software's 3-D effects. Participants might have activated the latter two interactive games to gain more information about the stories' settings, but this remained unclear since there was not much textual information gleaned from engaging in these behaviors.

One process seen in eight of participants in the Read-to-Me mode and 17 of participants in the Read-and-Play mode was a think aloud, or voluntary verbalized speech (Table 4). These verbalizations included expressing an opinion ("That was amazing!"), talking to a character ("Go faster!"), and placing oneself in the place of a character ("If I was the fox, I'd be thirsty…because he's hot and sweaty and red."). This revelatory behavior provided insight into what a reader was noticing, wondering, and thinking below the surface of consciousness (Wilhelm, 2001).

Participants were also observed laughing and smiling while reading (Table 4). Because more of the participants exhibited delight while reading in the Read-and-Play mode, it can be inferred that those participants were more cognitively engaged and sustained more interest than those using the Read-to-Me mode.

Finally, a few participants in the Read-to-Me mode looked around the classroom in distraction (Table 4). These participants took their eyes off the iPad during reading and physically moved their bodies in their chairs to look at the clock, classroom posters, or the door.

This behavior might be construed as fatigue, boredom or disengagement from the learning process (D'Mello & Graesser, 2010; Graesser & D'Mello, 2012).

Analysis of Affordances and Constraints of the Two Modes of Reading

Research question 3: What are the affordances and constraints of the Read-to-Me and Read-and-Play modes of reading? A list of affordances and constraints were recorded while observing participants interact with the eBooks in the Read-to-Me and Read-and-Play modes. In addition to the observations, participants were asked to name their most and least favorite things about reading an interactive eBook. They were also asked to discuss whether they felt reading an interactive eBook helped them to better understand the story. These responses were compared to the list of affordances and constraints I had generated. Transcript excerpts also were examined to infer how the affordances and/or constraints impacted the learning outcomes of the participants in their own words.

Integrating technology into the classroom has opened up a range of possibilities to expand students' thinking. These avenues come from affordances and constraints that exist within the relationship between the technology and the user. Affordances are design features that facilitate activity within a given environment, and constraints limit those affordances and the framework of action connected to them (Norman, 1993; O'Brien & Voss, 2011). It was important to examine which affordances and constraints had the potential to support learning and to increase meaning making. Such considerations allow educators to make informed decisions about using technologies such as interactive eBooks in the classroom.

One major feature seen in both eBook modes was the read-aloud element that automatically narrates the main text. This feature afforded users with a decreased cognitive load. The read-aloud feature begins every time a new page is presented. Additionally, as the narrator

speaks in *Cinderella*, the respective word is highlighted on the screen, affording a link between an auditory and visual modality. However, the narration in *The Three Little Pigs*, is not highlighted. The read aloud attribute was the most frequently identified feature for participants in the Read-to-Me mode and one of the top features for those reading in the Read-and-Play mode. One participant said that although she is not a lover of reading, the read aloud feature would actually afford motivation:

> R: What did you like best about reading a book, an interactive eBook?
> Zuri: It reads to you. (Laughs)
> R: Mmm hmm. You like that part the best?
> Zuri: Yeah.
> R: Why is that?
> Zuri: 'Cause I normally don't like to read.
> R: No? You don't? I didn't, I never would have guessed!
> Zuri: (Smiles and shakes head)
> R: 'Cause you're so engaged in the story! I wouldn't have thought that you didn't like to read. But normally you said that you don't like to read, but you like that it reads out loud.
> Zuri: Yeah. (Nods)
> R: So if you had more books that read out loud like this kind of book, do you think you would read more? (Student nods) About the same? Which one?
> Zuri: I would read more.

It is clear that the positive outcomes that stemmed from the read-aloud greatly supported Zuri's reading experience and may impact her future reading choices ("I would read more"). Researchers have shown that the more motivated students are to read, the more likely they are to engage with and comprehend texts (Guthrie & Wigfield, 2000; Wigfield et al., 2008). Providing students with opportunities to read eBooks that have a read aloud feature may afford access to quality books otherwise be outside their reading level.

At the same time, the read aloud feature provided constraints in several ways. For one, the interactive features of each page are not activated until the initial narration is complete. This constraint forces the reader to attend to the complete narrated text, which could positively impact comprehension. This is not guaranteed, however, as I observed several participants trying to

press items on the screen before the initial narration was over, demonstrating that they were not fully attending to the narration. Users were also constrained because the initial narration could not be repeated. This constraint may have a negative outcome since users do not have the means to hear the narration again without returning to a previous page. If users were not paying attention to the initial narration, they may develop gaps in their understanding of the text. Thus, comprehension may have been compromised because of this constraint.

Another affordance seen in the chosen eBooks was the user control embedded within the interactive hotspots. These hotspots provide a two-way experience for users where they decide how to engage with the text in ways that are personally meaningful. For example, participants are afforded the opportunity to touch the characters for additional narration and help characters build or find items, which purposefully add to the narrative's story arc. Other interactivity could be more incidental and exist solely for entertainment. Examples of these interactions included participants making a character do flips or moving items around on the screen for no additive purpose.

Although readers in the Read-to-Me mode have the ability to interact with the hotspots, they may not activate them if they are unaware of this feature. That was the case with 13 participants in the Read-to-Me mode as the first condition. To counteract this constraint, the software designers included a flashing blue dot that appears on the screen to make learning more tractable (Reiser, 2002). The blue dot serves as an affordance to cue users to interact with the screen (Cahill & McGill-Franzen, 2013). For instance, a blue dot will continuously flash on one character after the initial narration is complete, inviting users to touch that character. Once that occurs, the character will speak and provide additional narration. Attentive users can then touch

other items on the screen to produce an action. Indeed, participants who discovered this repeated the action throughout the reading.

Meanwhile, the Read-and-Play mode affords complete control to the user. Users can determine how much time to spend on each page, because the action that occurs after the initial narration does not get activated unless the user touches the screen. After the initial narration, users control what happens, which characters speak, when characters speak, and when to turn the page. As in the Read-to-Me mode, a blue dot appears as a scaffold to prompt interactivity if needed. Some of these actions are constrained, however; users cannot advance to the next page until the initial narration is complete nor can they move characters beyond predetermined screen parameters. For instance, a user could drag a pig around the immediate area surrounding his house on its respective page in *The Three Little Pigs*, but could not move the pig to a scene on a previous page (such as the pig's mother's house). This constraint forces readers to focus on the setting at hand and not alter the storyline from its chosen narrative path.

During the post-reading interview, Zuri discussed the existence of interactive games and user control within the Read-and-Play mode. In one part of *Cinderella*, the fairy godmother asks Cinderella to bring her specific items from the garden to magically prepare Cinderella for the royal ball. The interactive game affords the reader the ability to use a finger to explore the garden and literally take control of the search. Zuri explained how she felt about the search-and-find game in *Cinderella*:

> R: Okay. I noticed the part in the garden where um, the fairy godmother asked you or Cinderella to get things from the garden, like the hose, and the pumpkin, and the mice and so forth. What did you think about that? Having to go and find those items?
> Zuri: (Smiles) That was the best part.
> R: That was the best part? Why?
> Zuri: Because like it was a search, um what do you call it?
> R: Like search and find, or eye spy or…?
> Zuri: Scavenger hunt!

R: Scavenger hunt! Oh! Okay! Tell me about that. So it was like a scavenger hunt…
Zuri: 'Cause like they hide stuff, and you have to find it. (Nods)
R: Now do you think…so you liked that part . That was your favorite part.
Zuri: (Nods)
R: Do you think that had anything…how can I ask this, uh, do you think that it somehow… helped or didn't help you remember what was happening in the story? Or some important details? Or anything like that?
Zuri: (Nods) That was an important detail because that's how they, that's how they made the carriage and if they didn't make the carriage then they couldn't have got to the ball. (Shakes head)
R: Mmm. So did you feel like you had to find every little thing? Or were you okay if you didn't find everything?
Zuri: Well, if…I dunno…
R: Like, do you feel that you had to find all the things she asked for?
Zuri: I don't, like, if I didn't, I don't know if they would just like bring them over to you, so, I think it's important to find everything.

Zuri thought it was "important to find everything" to build Cinderella's carriage and felt that it was within her control to complete the task. Hence, the interactive game served as a cognitive artifact (Norman, 1988) to interact with the environment, manipulate the story, and shape how she thought about the task.

However, not all participants enjoyed the affordances granted by the interactive games and user control. I observed Sonya, who was reading *Cinderella* in the Read-and-Play mode, spend about ten minutes searching the garden for all the items that the fairy godmother asked her to get, including three mice, a wheelbarrow, garden hose, pumpkin, and flowerpots. She dutifully moved her finger around the extended screen searching for these items. Sometimes Sonya would find an item and drag it to the fairy godmother, only to not land in the right spot, sending the item automatically back to its original place. In this case, although users are afforded the ability to participate in the narrative, they are also constrained by the software, which is designed to keep all items in a particular place until it is dragged to an exact location near the fairy godmother. Moreover, the items that users can drag over to the fairy godmother are not constrained to just the objects that are requested. For example, the garden scene is full of other

items such as carrots. A user could accidently tap and drag a carrot to the fairy godmother when trying to grab a watering can. The fairy godmother would then verbalize that the selected item is not correct and would send it back to its original place. This, too, could slow down the time it takes to complete the search-and-find game, as was seen in Sonya's session. The following transcription excerpt describes Sonya's perception of this experience as a whole.

> R: Now, what did you like least about reading an interactive eBook?
> Sonya: Uh, having to find the things. (Points)
> R: I noticed that you spent some time on those pages. So why did you, how come you didn't like that too much? Or what, what about it didn't you like?
> Sonya: Because it took a really long time.
> R: Mmm hmm. It took a long time?
> Sonya: (Nods)
> R: You felt like you had to find everything to move on?
> Sonya: Mmm hmm.
> R: What do you think would have happened if you didn't find everything?
> Sonya: Then you, then the fairy godmother wanted, had everything to make Cinderella into a beautiful princess.
> R: Oh! So you…you were doing those things because –
> Sonya: Um, the step, the fairy godmother told me.

Even though Sonya was afforded control of the scene, she did not like the time it took to complete the task. Sonya remained on task, however, mostly because "the fairy godmother" told her to in order to "make Cinderella a beautiful princess." This suggests a vested interest in the story itself and afforded an opportunity for Sonya to be an active participant. It is important to note that there is a transparent blue arrow at the bottom of the screen designed to constrain the amount of time spent on an interactive game if a user decides to not complete a task, enabling the user to move to the next page before fatigue sets in. However, only a few participants were observed taking advantage of this feature during the Read-and-Play mode, suggesting that students need to be explicitly taught how to use eBook text features as in traditional reading instruction.

Another participant expressed disdain for the interactivity when reading *Cinderella* in the Read-and-Play mode, specifically the superficial action of making a character do flips when flicking the screen:

> R: What did you like least about reading an interactive e-book?
> Travis: … When I touched them, they flip over.
> R: You don't like it when they flip? Or you do like when they flip?
> Travis: When I try to move the screen around, (Motions with hand) they just flip over.
> R: I noticed that, that you were trying to tap on things and they would flip. So was that…did it start to get annoying or was it ok?
> Travis: It started to get annoying.

Here, Travis found the interactive affordance of flipping a character "annoying," especially because he was not intending to elicit that particular reaction. The flips do not add any value to the storyline and solely exist as a seductive detail. Even though this feature entertain some readers, the lack of constraint could be frustrating for others, especially for those who are looking for meaningful, cognitive engagement with the text.

Along with that, an added affordance of the eBooks used in this study was the speech bubbles that pop up if a user touches a character. These visual speech bubbles provide extra audio narration, affording the reader with more information about a character's thoughts and feelings. In fact, the speech bubbles give readers an opportunity to analyze characters and, thus, serves as a tool for deepening understanding. In the Read-to-Me mode, some of the speech bubbles appear automatically after the initial narration is complete, regardless of whether the user taps the screen or not. A few participants did not like this automaticity when reading in the Read-to-Me mode. The following excerpt shows what Viola thought about this affordance after reading *The Three Little Pigs* in the Read-to-Me mode:

> R: Now, what did you like least about reading an interactive eBook?
> Viola: Um, when I had (Hits the table with pointer finger), when they weren't, when if (Flings finger down) I didn't even touch them and they would just say words.
> R: Oh, they would do it on their own.

Viola: (Nods) Uh-huh.
R: Why didn't you like that?
Viola: Because I wanted to touch them. (Smiles)

Viola did not like the automaticity of the speech bubbles in the Read-to-Me mode because she "wanted to touch them," which goes back to the desired affordance of user control. User control directly involves the reader with the story and promotes high engagement. Deciding the pace and order of presentation would have allowed Viola to interact with the learning tool in ways that were meaningful to her.

Like Viola, other participants frequently mentioned the affordance of speech bubbles during the interview sessions. One participant, Adriana, enjoyed how the additional narration in the speech bubbles complemented the plot and expanding her understanding of the text. As seen below, Adriana discussed an early occurrence in the Read-to-Me mode of *The Three Little* Pigs where the wolf is eavesdropping on the little pigs before they leave their parents' house. Adriana was attentive to this scene and drew a strong conclusion about how the wolf knew that the young pigs would soon be out on their own, thus, making them easy targets for lunch:

R: Now, did reading an interactive eBook help you to understand the story better?
Adriana: (Nods)
R: Ok, how? Or why?
Adriana: (Long pause) They, they said some stuff that wasn't in the story.
R: Hmmm. What do you mean by that? Can you tell me a little bit more about that?...Or give me an example?
Adriana: Um, in the beginning, um, when they were talking to their parents about moving, the wolf was in the window and I tapped on him and he said, 'Shh, don't tell them that, that I'm here.' (Smiles)
R: Ohhhh! What do you think, what did that tell you? How did that information add to your understanding of the story?
Adriana: Because then I knew, um, knew that he wanted to get the pigs. (Smiles)

Clearly, the user control ("I tapped on him") and added narration informed her that the wolf "wanted to get the pigs." These affordances triggered Adriana to think deeply about the story and predict what would happen later, a skill that proficient readers frequently use.

At the same time, a constraint does exist in the Read-and-Play mode; the speech bubbles do not automatically appear and are only activated when the user touches a character. Overall, there are a randomized but fixed number of expressed thoughts that occur with each tap. This constraint allows the story to move along at an adequate pace. If there was an endless amount of expressed thoughts through the speech bubbles, users might spend a considerable amount of time listening to the additional narration and lose track of the story as a whole, thus negatively impacting comprehension. In this study, six participants in the Read-to-Me mode and thirteen participants in the Read-and-Play mode tapped a character several times and decided to advance to the next page or character only after the audio repeated.

Researchers have pointed to another affordance of multimodal tools: animation (Anstey & Bull, 2006; Cahill & McGill-Franzen, 2013; Centre for Research and Innovation in Learning and Teaching, 2009; Unsworth, 2002). Animations are illustrations of action and movement (Cahill & McGill-Franzen, 2013) and might help readers construct knowledge through the use of multimedia. Zuri explained how animations were a major affordance that helped her to better understand the story *The Three Little Pigs*:

> R: Did reading an interactive eBook help you to understand the story better?
> Zuri: (Nods) Mmm hmm.
> R: Tell me how.
> Zuri: Well…like, when, when they were kicking the soccer ball and they can't just like, put their foot down and like the soccer ball right there, they have to show kicking it so like…it could have just been like standing outside with a soccer ball.
> R: Mmm hmm.
> Zuri: So…the, when they kicked it, that made it like, like they're playing soccer.
> R: Mmm hmm.
> Zuri: And…when like he, the fox could have just, like, landed in the water and could like, come out, came out…but he jumped back up and out the chimney.
> R: Mmm hmm…and so how does that help you to understand the story better? Or why does that help you?
> Zuri: Cause if he just stayed there I would, like, think that, like, he…he, like, couldn't get out but he got out, so. (Nods)

Zuri made an interesting point about how animation afforded her with implicit information about the story. In the scene when the third pig defeats the wolf with a scalding pot of water, the text does not explicitly state how the wolf got out of the house after being burned. However, the animation shows that the wolf goes back up the chimney and later goes "howling down the road."

Likewise, animations afford users the opportunity to make images come alive and visualize story events, a major strategy that enables readers to make sense of text. Russell, who had an IEP, discussed how the animations within the interactive eBooks helped him picture what was happening:

> R: Did reading an interactive eBook help you to understand the story better?
> Russell: Yes.
> R: Mmm, tell me how.
> Russell: Because um, I can, I can see why, it, it all looks like it's real and I can picture in my head and it comes on the screen.
> R: Oh! So how does that help you understand the story or remember the story?
> Russell: Um, pictures help me know about the story.

As Russell said, illustrative affordances like animations helped him "know more about the story" and are constructed to support, complement, or broaden understanding of a text. Furthermore, Russell stated, "I can picture it in my head and it comes on the screen." This is in line with Mayer's (2001) knowledge construction framework, which suggested that learning consists of forming a mental representation made up of new information and existing knowledge. Fortunately, the animations are constrained to match the text on the screen, highlighting the main events within a scene. This constraint provides a vital lens to help readers attend to what is important in the story. Ultimately, knowledge building was afforded by animations, which stimulate visual and auditory modes to receive information, and can broaden access to meaning making (Moreno & Mayer, 2007).

CHAPTER 5: DISCUSSION

This chapter synthesizes the findings, limitations, implications, and recommendations of the dissertation study. The purpose of the study was to consider the comprehension effects, behaviors that children engage with, and affordances and constraints of interactive eBooks.

The results of this study indicate that reading interactive eBooks may have a positive impact on comprehension and can serve as cognitive tools, allowing lower-level readers to make meaning. Participants in the study made significant gains between pre and post-reading measures and provided a great number of extended inferences in their after-reading comprehension responses across the Read-to-Me and Read-and-Play modes. These inferences demonstrated that participants thought deeply about the texts, made valid predictions, and analyzed characters to make meaning (Fountas & Pinnell, 2001; Keene & Zimmerman, 1997). Furthermore, participants successfully synthesized information to build knowledge, a skill that is typically challenging for lower-level readers (Bloom & Krathwohl, 1956; Harvey & Goudvis, 2000; Keene & Zimmerman, 1997; Wilhelm, 2001).

The dissertation study also qualitatively examined the behaviors that participants engaged with when reading interactive eBooks in the Read-to-Me and Read-and-Play modes, a practice supported by Jewitt (2008). As echoed in research by the Centre for Research and Innovation in Learning and Teaching (2009) and Chan and Black (2006), the participants in this study were absorbed in high levels of interactivity and engagement while reading, as demonstrated by their direct manipulation of the software interface. This begins to address Jewitt's (2008) call for a deeper understanding of these processes as fundamental elements for designing multimodal learning environments in an ever-changing digital domain.

Participants were also observed thinking aloud during the Read-to-Me and Read-and-Play reading sessions. When students think aloud while reading, they are actually slowing down their processing to monitor comprehension (Fountas & Pinnell, 2001; Keene & Zimmerman, 1997; Wilhelm, 2001). Proficient readers maintain an inner monologue while reading to actively make meaning and clarify misunderstandings, whereas lower-level readers typically do not (Keene & Zimmerman, 1997; Wilhelm, 2001). Often, lower-level readers are too focused on decoding words that they miss the larger meaning of the text. By expressing their thoughts aloud, the participants in this study demonstrated that they were able to enter into and engage with the story world to support comprehension (Wilhelm, 2001).

A few participants in the Read-to-Me mode demonstrated behavior that may be construed as fatigue, boredom, or disengagement from the learning process (D'Mello & Graesser, 2010; Graesser & D'Mello, 2012). The results suggest that the lesser degree of participant-involvement in the Read-to-Me mode might have led students to feel disconnected from the text and experience gaps in their understanding of the story.

Another outcome of this exploratory study was to determine the affordances and constraints of reading eBooks in the Read-to-Me and Read-and-Play modes. Data was collected through observations and participant interviews. Students, especially lower-level readers, might benefit from various features of interactive software that support them in making meaning. Participants discussed various design features that decreased cognitive loads through auditory narration, enabled user control, provided additional narration through speech bubbles, and supported visual processing of information through animations.

The read aloud feature of the Read-to-Me and Read-and-Play modes afforded a lighter cognitive load, allowing readers to attend to specific events within the stories. The read aloud

feature is key for lower-level readers, as students do not have to decode the text for themselves, thus reducing cognitive load and facilitating the construction of meaning (Mayer & Moreno, 2003). The narration itself is expressive, thus enriching the reading experience for users (Cahill & McGill-Franzen, 2013). Furthermore, the read aloud feature provided a constraint because it forced the reader to attend to the complete narrated text before enabling the interactive features, which could positively impact comprehension.

The eBooks chosen for this study contained meaningful interactive games that were intentionally designed to reinforce major story events and extend readers' understanding of the narratives (Cahill & McGill-Franzen, 2013), especially in the Read-and-Play mode. Jewitt (2005) and Mayer and Moreno (2003) emphasized the power that user control has on meaning making since readers are the ones manipulating images, sounds, and animation within a story's narrative. Furthermore, participants are afforded the freedom to actively participate in the reading experience and self-direct their own learning trajectories (McLoughlin & Lee, 2007; Pearman & Lefever-Davis, 2006). Thus, the interactive games directly involve the reader in the stories, which, in turn makes the reading process come alive and help readers internalize what they are reading (Anderson, 2012; Dalton & Proctor, 2008; Gee, 2007; Kress, 2003). The emphasis on user-control in the Read-and-Play mode might allow participants to feel more autonomous and actively involved in the overall reading experience, leading to positive comprehension outcomes.

These findings are consistent with research by deJong & Bus (2002), Grimshaw et al., (2007), Moreno & Mayer (2007), Pearman (2008), Seyit (2010), Shamir (2009), and Vehrallen et al. (2006), who suggested that the two-way action of interactive multimedia experiences enable children to be more active readers, which improves literacy outcomes.

Previous researchers have concluded that the interactivity present in eBooks could detract from reading comprehension (deJong & Bus, 2002; Delaney & Landow, 1991; Trushell & Maitland, 2005; Trushell, Maitland, & Burrell, 2003), a findings inconsistent with the outcomes of the dissertation study. It is important to note, however, that in comparison to students of even a few years ago, students of the age who participated in the study have greater access to multimedia in their everyday lives through the use of the Internet, video games, smartphones, and personal tablets, and are frequently required to synthesize information across mediums. Furthermore, there has been an increase in the quality and quantity of published interactive eBooks and apps since the earliest studies were conducted. In fact, the two eBooks chosen for the dissertation study won numerous design awards for their innovative integration of narrative story lines and multimedia.

Features such as the speech bubbles and additional narration in both modes gave readers more information about other factors within the story, including a character's innermost thoughts. Characters are the driving forces of fiction; understanding a character allows readers to think deeply about how that character's actions, motives, and conflicts shape narratives (Emery, 1996; Roser, Martinez, Fuhrken, & McDonnold, 2007). Moreover, proficient readers deepen their comprehension beyond the text by taking note of a character's core, particularly in light of the author's implicit message (Fountas & Pinnell, 2006; Lehr, 1991; Roser, Martinez, Fuhrken, & McDonnold, 2007).

Another feature that provided an affordance was the animation, which gave readers an additional modality for constructing meaning through verbal and non-verbal representations (Moreno & Mayer, 2007; Serafini, 2011). Well-designed animations offered numerous affordances; they enhance the overall reading experience, assist readers with interpreting story

ideas through visual means, support vocabulary, and augment understanding (Cahill & McGill-Franzen, 2013; Serafini, 2011).

In summary, the results of the dissertation study suggest that the features of interactive eBooks might have impacted participants' engagement and, possibly, their ability to build knowledge around texts (Grimshaw et al., 2007; Kennewell, 2001; Pearman, 2008; Seyit, 2010; Shamir, 2009). The indication that these gains occurred regardless of mode could be a result of the overlapping features between the Read-to-Me and Read-and-Play modes. The findings from the dissertation study are significant for lower-level readers, especially because reading is a cognitively demanding task. Lower-level readers often need support to encourage active participation while reading, facilitating deeper text analysis and comprehension. Thus, it is critical to understand how interactive eBooks impact readers as involved contributors to the storytelling process.

Limitations

While the study demonstrated positive results, there were limitations that should be mentioned. For one, the sample size was small and lacks the statistical power to make strong conclusions. Moreover, the participants were second grade students in the same suburban school in New Jersey. As a result, the results may not be transferable to differing populations. Another limitation was that same company published the two interactive eBooks used in this study. I chose these eBooks because most of the interactivity directly relates to the stories' narrative. The findings may not be generalizable to other eBooks that utilize more sensationalized interactivity.

In addition, many children are familiar with the main storylines of *Cinderella* and *The Three Little Pigs*. A study of unfamiliar stories could offer more conclusive outcomes.

Moreover, the before-reading background knowledge information, retellings and post-reading comprehension questions were used to assess participants' comprehension. Additional qualitative and quantitative measures of comprehension could be applied to provide further data. The reliability of some of the measurement instruments (retellings and post comprehension questions) is not as high as it could be because of the low number of testing items. Piloting the measurement instruments would help increase reliability.

A final limitation centered on a technical malfunction that occurred during a few research sessions. Snippets of a several research sessions were not recorded and some of the participants' responses were not audible. This malfunction was not detected until the videos were being transcribed. This loss of data could have an impact on the study's findings.

Implications

The outcomes of the dissertation study shed light on actionable knowledge surrounding new literacies and multimodal learning. The rapid increase and adoption of technology in schools has led to a change in the definition of literacy (Barton et al., 2000; Bruce, 2003; Jewitt, 2005; New London Group, 1996). Policymakers, educational leaders, and practitioners are urged to think deeply about the *why* behind technology integration. To make this integration meaningful, educators must participate in professional development to first understand how new technologies like interactive eBooks impact knowledge building (Schugar et al., 2013) as well as possible challenges of using eBooks in the classroom. Educators should be trained on how to identify high-quality interactive eBooks that support literacy learning, and develop whole-group and small-group lessons and units that maximize the affordances of those eBooks. In addition, interactive eBooks, such as the ones used in the dissertation study, contain distinct text features designed to support meaning making. Based on this research, I recommend that readers,

including lower-level ones, be explicitly taught what the eBook text features are and how to use them in ways to access content. Practitioners must also be able to model for students how to use the interactive features to build knowledge before gradually releasing responsibility and allowing students to read interactive eBooks independently (Allington, 2001; Harvey & Goudvis, 2000; Schugar et al., 2013).

In my practice as an elementary Reading Specialist, I have the opportunity to turn the dissertation study's findings into actionable knowledge. After exploring the literature regarding the benefits of using iPads in the classroom, I formed an iPad committee consisting of the school principal, the district technology coach, and fellow teachers. The iPad committee meets regularly to review apps, discuss protocol, and share iPad lessons and student products. In addition, we secured grant funding for sixty iPads. These iPads are housed in two carts within the school and are available to any K-5 teacher for classroom instruction. Thus far, teachers have created literacy-based lessons including podcasts, sight word instruction, screencasts, writing tasks, book-making, and webquests using QR codes.

Moving forward, I plan on sharing the results of this study with my colleagues at a faculty meeting. I will also collaborate with the BSI and Special Education teachers to support them in integrating iPads into literacy instruction to support lower-level readers. First, we will analyze assessment data to determine specific areas for student growth. From there, teachers will explore iPad literacy apps designed to strengthen decoding, fluency, vocabulary, and/or comprehension skills. It is critical that the teachers themselves take time to get familiar with the iPad, interactive eBooks, and apps, and determine for themselves how to utilize the apps through small group instruction. Finally, we will continuously evaluate the implementation plan, provide

scaffolding for teacher support, and seek out new interactive eBooks and literacy apps to best support student needs.

Recommendations for Future Research

The results of the dissertation study provide insight into the impact of interactive eBooks on comprehension, help to identify specific reading behaviors, and highlight specific affordances and constraints of this new technology. Based on the findings and limitations of this study, there are clear recommendations for future research.

First, there is a need for more quantitative studies on how interactive eBooks affect comprehension, especially with struggling readers. Looking at differing populations, such as students with special needs and English Language Learners, would also add to the richness of the research field. Similarly, research might be conducted on varying grades, including upper elementary, middle school, and high school. Readers of all ages have different literacy expectations (learning to read versus reading to learn) and fully understanding how interactive multimedia impacts knowledge building would be a tremendous asset.

This study focused on fiction. It would be beneficial to determine how readers make meaning from nonfiction interactive eBooks, particularly due to the increased emphasis on expository texts within the Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Finally, researchers might further explore the specific affordances and constraints outlined in the dissertation study to fully understand how much of an impact eBooks have on comprehension.

Conclusion

The multimodal nature of interactive eBooks has been brought into the educational spotlight, particularly because they require literacy skills that extend beyond those needed for

static, print-only texts. Consequently, there is a strong need for researchers to better understand how interactive eBooks might serve as cognitive tools to impact comprehension and meaning making. It is also necessary to explore how particular features of interactive eBooks might serve as digital tools for higher-level literacy learning and, consequently, enhance comprehension for lower-level readers. It is my hope that this exploratory dissertation study provides insight into how lower-level readers use interactive eBooks to make meaning in an increasingly multimodal world.

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APPENDIX A

Before-Reading Interview Script

RESEARCHER (R): (Showing the participant a plain piece of white paper with the title written on the front). This story is called _____. Please tell me everything you already know about this story.

Participant __:

APPENDIX B

After-Reading Comprehension Questions

Questions about *Cinderella*:

Tell me what the story is about. (Recall)

1. Why do the two stepsisters and stepmother treat Cinderella the way that they do? (Inferential)
2. Why doesn't Cinderella follow her fairy godmother's warning to be home by midnight? (Inferential)
3. Why are the glass slippers important to the story? (Inferential)
4. Why do the stepsisters act like they own the glass slipper if they know that it does not belong to them? (Inferential)

Questions about *The Three Little Pigs*:

Tell me what the story is about. (Recall)

1. Why is the wolf able to blow down the first two pigs' homes? (Inferential)
2. How do you think the first two little pigs feel when the wolf comes knocking on their doors? (Inferential)
3. Why isn't the third pig scared when the wolf knocks on his door? (Inferential)
4. Using what you learned from this story, what would you build your house out of, if you were able to build a house, and why? (Inferential)

APPENDIX C

Reading Experience Questions

1. What did you like best about reading an interactive eBook?
2. What did you like least about reading an interactive eBook?
3. How is reading this type of book different from reading a printed book on your own?
4. Which do you like better and why?
5. Did reading an interactive eBook help you to understand the story better? Why or why not?
6. Is there anything else you want to tell me or think I should know?

APPENDIX D

Comprehension Codebook

BEFORE-READING COMPREHENSION CODES:

Before Reading Prior Knowledge (BR PK) – The knowledge the student shares about the respective story before the reading session begins.

(4) Proficient – The student includes all important story events from the beginning, middle, and end in sequence.

(3) Adequate - The student includes most of the important story events from the beginning, middle, and end, generally in sequence

(2) Partial – The student includes at least 3 story events, generally in random order

Example: "That Cinderella is a princess and she has a glass slipper and then when she went to the ball she lost the glass, her glass slipper, and then the prince found the glass slipper and he tried to see, see what person who, who fits the glass slipper."

(1) Limited – The student includes only 1 or 2 story events or details

Example: "I don't know anything…There's three little, there's three little pigs…They like…(shrugs shoulders) I don't – I never read this book."

(0) No Response/Off-Topic – Student does not respond or does not discuss the given story

AFTER-READING COMPREHENSION CODES:

After Reading Retelling (AR RT) – A post-reading activity where the student tells what he remembers or recalls about the respective story.

(4) Proficient – The student includes all important story events from the beginning, middle, and end in sequence

(3) Adequate - The student includes most of the important story events from the beginning, middle, and end, generally in sequence

(2) Partial – The student includes at least 3 story events, generally in random order

Example: "Cinderella and the prince…and then mouses and a pumpkin…and the stepmother and her children and the prince's dad. That's it! The glass slipper fell off her foot and the prince was searching for her. And……the fairy godmother gave her a dress and a carriage to go to the ball and what happen, they, it disappeared."

(1) Limited – The student includes only 1 or 2 story events or details

Example: "The story is about this um guy who wants to um find this girl named Cinderella, Cinderella because she really, because they wa, because she wan, he wants to, her to mar, marry him. And they would all have happily ever after."

(0) No Response/Off-Topic – Student does not respond or does not discuss the given story

After-Reading Comprehension Response (AR CompR) – The student's response to post-reading comprehension questions related to the respective story.

(4) **Extended Inference** – The student draws an insightful conclusion that further

explains his thinking beyond a surface inference

Example: When asked why the wolf is able to blow down the first two pigs' homes: "Because it wasn't built properly. It was just made out of sticks and straw. Because there was no, like, stuff that made it stick together."

(3) Surface Inference - The student makes a low-level conclusion that typically does not include a how or why

Example: When asked why Cinderella's two stepsisters and stepmother treat Cinderella the way that they do: "Um…because they didn't like her."

(2) Literal –The student only identifies facts directly stated in the text

Example: When asked why Cinderella's two stepsisters and stepmother treat Cinderella the way that they do: "Because they're mean."

(1) Some accuracy + some misinterpretation – The student's response is partially correct but includes some misinterpretation of the story

Example: When asked why the wolf is able to blow down the first two pigs' homes: "Because…um when it's like a storm and it's like, when it's, the wind is really a hard when the big bad wolf blows it and when it's a storm, it gets harder…and, and, and that's, and then they blew the houses down. And that's why I know."

(0) Incorrect – The student's response inaccurately answers the question, is off-topic, or does not respond at all

Example: When asked why the stepsisters act like they own the glass slipper when they know that it does not belong to them: "I think because they think they are so pretty.