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The Efficacy of Multimedia Stories in Preschoolers' Explicit and Implicit Story Comprehension

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Abstract
Oral language provides a foundation for reading comprehension. Story comprehension is a fundamental oral language skill; it covers making inferences, identifying main ideas, monitoring, perspective-taking, and applying working memory capacity. Complex reasoning and perspective-taking are key factors in deep reading comprehension. Preliterate children's deeper story comprehension skills can be initial indicators of their later reading comprehension. Thus, the purpose of this research is to investigate preliterate preschool children's story comprehension skills in detail. This study focuses on the additional multimedia features of digital storybooks and whether they hinder or promote young children's explicit and implicit comprehension in a small group reading activity. The findings revealed that (a) children in the multimedia-enhanced storybook group outperformed the print storybook group in terms of both explicit and implicit story comprehension, (b) explicit story comprehension was higher than implicit story comprehension for both groups, and (c) the children recalled significantly more story elements and the length of the story retellings was greater with the aid of animated illustrations. The findings indicate that a digital storybook provides close temporal contiguity of text and visuals and may enhance story understanding by concretizing the narration. The study provides evidence that multimedia stories can foster children's implicit story comprehension and inferential thinking about the content of the story.

Keywords Multimedia · Electronic · Printed storybooks · Story comprehension · Explicit · Implicit

Introduction

Language has a relatively complex structure, and it is through the mediation of their complex language that humans communicate with others, construct and code their knowledge, express their ideas, emotions, and imaginings, and transfer their knowledge, experience, and culture to the next generations (Cohen 2010; Otto 2006; Owens 2012; Pence and Justice 2008). To adapt successfully to a society, children need to develop a wide range of language competencies (UNESCO 2013). Language is composed primarily of oral and written forms (Soderman et al. 2005; Storch and Whitehurst 2002). Oral language includes both receptive (listening) and expressive (speaking) skills. The journey of oral language begins with a newborn's reflexive cries and continues as the child becomes more sophisticated and intentional in the use of language and communication (Soderman et al. 2005; Spencer and Koester 2015; Wermke et al. 2007). Oral language is an important tool for learning, because children learn both about and through language (Halliday 2004). Language is an important resource for children as they obtain and construct knowledge; it also serves as the basis of literacy (Alberta Learning 2000; Malec et al. 2017; Rudman and Titjen 2018; Scarborough 2009).

Snow (1983) clarified the distinction between *oral language* and *literacy skills*: literacy is composed of skills directly linked to written language, especially reading and writing; in contrast, oral language includes all oral forms of communication, speaking, and listening. Snow (1983) proposed that oral language and literacy development are interrelated. The ultimate goal of the reading process is to comprehend written text (Coltheart 2005). The simple view of reading (SVR) model indicates that reading comprehension emerges from listening comprehension and decoding (Dombey 2009). Therefore, investigation of these early childhood antecedents to reading skills is essential (Hood et al. 2008; Lervåg et al. 2017; National Early Literacy Panel

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2008; Oakhill and Cain 2012; Schaughency et al. 2017; Uchikoshi et al. 2018). Oral language is composed of phonology, grammar, morphology, vocabulary, discourse, pragmatics, and auditory verbal information processing (Cohen 2010; Morrow 2009; Tannock 2010). It seems likely these oral language areas are brought together in story comprehension and story retelling.

Story Comprehension and Story Retelling

While preliterate children are dependent readers, they are active listeners and meaning-makers of the story-reading process (Beaty and Pratt 2003). The SVR theoretical framework establishes that children's story understanding is the comprehension of written text read aloud (Hoover and Gough 1990). Story comprehension includes identifying characters, recognizing relationships between characters, monitoring, perspective-taking, making inferences, deciphering main ideas, and applying a working memory capacity (Chaturvedi 2016; Dempsey and Skarakis-Doyle 2017; Hannon and Frias 2012; Isbell et al. 2004; Lepola et al. 2012; Paris and Paris 2003; Strasser and del Río 2013; Tompkins et al. 2013). Story comprehension is also associated with children's early cognitive and language development (Kim 2016; Yang and Wu 2012). Story comprehension tasks, in which children retell a story and orally respond to comprehension questions related to it, enable the assessment of children's language skills beyond decoding (Paris and Paris 2003; Spencer et al. 2017).

LaRusso et al. (2016) proposed a deep reading comprehension model and criticized SVR (Gough and Tunme 1986) for excluding the broader cognitive abilities involved in reading comprehension, such as perspective-taking, complex reasoning, and academic language. Story characters have different experiences and responses in the same plot, and grasping the characters' varying perspectives is associated with psychological causality and evaluating events (LaRusso et al. 2016). The theory of mind focuses on perspective-taking as a complex interpersonal skill required to understand the mental state of others (Giménez-Dasí et al. 2016; Gonzales et al. 2017; Longobardi et al. 2016; Pelletier 2006). Biancarosa (2006) found that good comprehenders are better able than poor comprehenders to follow characters' perspectives. Storybook-reading experiences provide enriched context and conversations for preschoolers to advance their perspective-taking skills (Collins 2016; Martucci 2016). Preliterate children's deeper story comprehension skills can be initial indicators of their later reading comprehension. Thus, preliterate children's story comprehension skills should be investigated in detail.

However, there are few extant assessment tools and frameworks used to assess young children's story comprehension and oral narrative skills (Korat and Shamir 2012; Paris and Paris 2003; Spencer et al. 2017; Strasser et al. 2010; Van den Broek et al. 2005). While most assessment tools include questions related to explicit story comprehension, Paris and Paris (2003) developed a narrative comprehension task to assess young children's explicit and implicit story comprehension skills. According to their classification, explicit story comprehension (ESC) is related to the identification of the story elements (characters, setting, initiating event, problem, and solution). Implicit story comprehension (ISC) includes making inferences about the feelings of the story protagonists, causal relations, predictions, and theme. ISC requires deeper story comprehension skills. The aim of the present study was to examine the efficacy of digital storybooks in young children's ISC and ESC. Paris and Paris's (2003) narrative comprehension task was used in the study.

Digital Storybooks

Children were born into a digital world, one in which technology is evolving rapidly, creating new forms of knowledge and requiring new skills and abilities (Cooper 2005; Yang et al. 2015). Children use new devices, from smartphones to tablets to digital toys, and they are exposed to digital literacy environments from an early age (Bers et al. 2014; Marsh et al. 2005; Parette et al. 2010). They experience digital storybooks along with printed ones (Altun 2017; Rideout 2011). Digital storybooks provide multimedia enhancements: animated pictures, background sounds, music, hotspots, games, and dictionaries (Bus et al. 2015; Korat 2010; Verhallen et al. 2006). Previous studies have reported the efficacy of the additional features of digital storybooks in promoting children's story comprehension (de Jong and Bus 2004; Doty et al. 2001; Ihmeideh 2014; Korat 2010; Labbo and Kuhn 2000; Roque et al. 2017; Verhallen et al. 2006), vocabulary (Korat 2009; Korat and Shamir 2012; Roque et al. 2017; Segers et al. 2004; Verhallen and Bus 2010; Verhallen et al. 2006), and phonological awareness (Chera and Wood 2003; Ihmeideh 2014). Overall, these researchers advocated for the additional multimedia features of digital storybooks to facilitate children's learning. Mayer's (2005) multimedia learning framework and Paivio's (2007) dual coding theory supported the efficacy of digital storybooks in children's language and literacy development.

According to Paivio (2007), the human mind simultaneously processes two types of information, logogens (verbal) and imagens (nonverbal). Digital storybooks can facilitate information processing and support learning. Written text accompanied by synchronous dynamic visuals and sounds, such as multimedia effects, may enhance story content and facilitate children's mental imagery of the story (Algozzine and Douville 2004; Bus et al. 2015; Boerma et al. 2016;

Korat 2010). Mental imagery skills are associated with reading comprehension for school-aged children (Boerma et al. 2016; De Koning and Van der Schoot 2013; Snow 2002). Considering that mental imagery skills are also likely to correlate with reading comprehension for preliterate children, it is important to understand how preliterate children comprehend stories in digital versus printed storybooks. The depictive representations may facilitate young children's understanding of the protagonist's perspective and emotions, allowing the children to predict and explain the protagonist's actions in the content of the story.

However, other studies found that digital storybooks were not more effective than traditional printed storybooks in supporting children's story comprehension (Krcmar and Cingel 2014; Lauricella et al. 2014; Parish-Morris et al. 2013; Richter and Courage 2017) and phonological awareness (Willoughby et al. 2015). These findings can be explained by Sweller's (1994) cognitive load theory. Because working memory has the capacity to process information items one at a time (Baddeley and Hitch 1974), additional features may distract children from tracking the story line, thereby disrupting their story comprehension (Leu 2000; Rideout 2014).

There is no consensus on the efficacy of digital storybooks in promoting young children's story comprehension. The findings vary depending on the digital features used in these studies, such as static versus motion pictures and hotspots versus simple CDs. The environment (home or school) and the engagement of the parents in the storybook-reading process also differed among the studies. Takacs et al. (2015) synthesized data from 2147 children in 43 studies to present empirical evidence about the contribution of digital storybooks to children's language and literacy development. They found that certain aspects of digital storybooks—multimedia motion pictures, sounds, and music features—were helpful aids for story comprehension, whereas hotspots, games, and dictionaries were not.

Previous studies mainly investigated how digital storybooks affect children's ESC. There is a research gap relating to the influence of multimedia-enhanced stories on children's ISC. The additional features of multimedia stories may also be helpful in communicating complex plots, concretizing complex and abstract ideas, and conveying protagonists' feelings. Studies have also investigated parent–child shared reading activities (e.g., Krcmar and Cingel 2014; Lauricella et al. 2014; Parish-Morris et al. 2013) or a child's individual sessions (e.g., Richter and Courage 2017; Takacs and Bus 2016; Verhallen and Bus 2010). The aim of this study is to examine the influence of multimedia stories on children's story comprehension in the context of a small-group naturalistic classroom reading activity. In recent years, some concern has arisen regarding the efficacy of digital storybooks in small-group or individual activities (Gómez et al. 2013; Lauricella et al. 2014). Storybook-reading activities are generally conducted as small-group and whole-group activities in naturalistic classroom settings. However, the interaction and collaboration among children in such settings may alter their reading comprehension. The availability of technological equipment may also limit children's ability to use the devices individually. Therefore, this study focuses on the additional multimedia features of digital storybooks and considers whether they hinder or promote young children's ESC and ISC in a small-group reading activity in a classroom. The following research questions were investigated:

- Does the story presentation format differentially affect preschoolers' ESC and ISC?
- Does the story presentation format affect preschoolers' story productivity?

Method

The study had a quasi-experimental pre-test/post-test matched-comparison design. A matched-comparison design aims to control extraneous variables by composing both the experimental and the control, or comparison, groups of similar individuals; members are not assigned to a group randomly. This basis of two equal groups produces more accurate information about causality (Engel and Schutt 2014; Fraenkel et al. 2012; Stuart 2010). Thus, in the pre-intervention, children were read a printed book to assess their initial story comprehension scores; these were then transformed into z-scores (range -2 to $+2$). Children were grouped according to five levels (Wang et al. 2007) by using z-scores ($z = \pm 1$, $z = \pm 2$) with matching scores equally distributed across both groups.

In the present study, experimental and comparison conditions were constructed to examine the influence of book types on children's ESC and ISC. The experimental group listened to an electronic version of two stories, whereas the comparison group heard a printed version of the same stories.

Participants

Five-year-old children were recruited from eight classrooms in four public preschools in a large suburban area. The data were collected during the 2016–2017 fall education term (March–April 2017). After the university ethics committee and the Ministry of National Education provided official permission, I visited six public preschools to describe the aim of the study and seek permission from the principals to let their students participate; four agreed to take part. I met eight volunteer preschool teachers to share the aim and the

process of the study as well as the data collection schedule. I sent informed consent forms to parents through the preschool teachers. These forms included detailed descriptions of the aim and process of the study to the parents, who were asked to provide written permission for their children to participate. One hundred and ten consent forms were distributed, and 78 parents signed. Six children were excluded for developmental delays, reluctance to participate, or attendance problems.

The final participants consisted of 72 children (42 girls, 30 boys) with a mean age of 64.18 months (SD = 4.58, range 55–70 months). All children were monolingual Turkish speakers. Parents' reports and the researcher's examination showed that the children were preliterate; in Turkey, formal reading instruction begins in first grade. The preschools were located in a middle-class area. Most parents (65%) had graduated university. Parents reported parent–child shared reading activities for 65.25 min (SD = 28.70) weekly. The majority of children (94%) did not have any digital storybooks in their home.

Procedure

The study was conducted in two phases (see Table 1). In the first phase, children listened to the printed version of *The Red Apple* (*Kırmızı Elma*) to assess their initial story comprehension. *The Red Apple* was written in Turkish by Feridun Oral; it was selected Best Picture Book of the Year (IBBY Turkey 2008) and won the 2016 USBBY Outstanding International Books award. Detailed information about the book is presented in Table 2.

Table 2 The trade storybooks used in the study

Book name	Pages	Words	Words/page
The Red Apple	36	341	9.47
Who Stole the Moon?	40	541	13.52
Swimmy	32	239	7.46

Book reading sessions took place at school in a spare classroom which contained a child-sized table and five chairs. The small reading activity groups consisted of four children, to whom the researcher read the book. The sessions were recorded ($M = 5.01$, SD = 0.06). Children retold the story to the researcher individually and then answered Paris and Paris's (2003) comprehension questions. The children's answers were audio-recorded and transcribed. To ensure rating consistency, 25% of the data was randomly selected for an inter-rater reliability check. The second trained rater was blinded and had a PhD degree in early childhood education. The Pearson product–moment correlations between the scores of the two coders were 99% for ESC and 94% for ISC.

In the second phase, the experimental group (23 girls, 13 boys) was presented with electronic versions of Swimmy by Leo Lionni and Who Stole the Moon? by Helen Stratton-Would on an iPad. The comparison group (19 girls, 17 boys) listened to a reading of the printed version of the books. The children simply watched or listened to the storybooks and did not otherwise engage with them. In neither group did the researcher provide mediation by, for example, answering questions about the story or discussing the images. The Who Stole the Moon story application has hotspots, but a previous meta-analysis study showed that hotspots hinder comprehension (Takacs et al. 2015). Thus, neither the children

Table 1 Phases of the study

Phase I Pre-intervention measures			Phase II Interventions and measures	
Printed version of *The Red Apple* was read to determine study group			I. Reading section II. Reading section	
Preschoolers (n = 72)	Experimental group (n = 36)		The experimental group listened to an electronic version of two stories	
		a. Sub-experimental group (n = 18)	e-book *Swimmy* Post-test	e-book *Who Stole the Moon?* Post-test
		b. Sub-experimental group(n = 18)	e-book *Who Stole the Moon?* Posttest	e-book *Swimmy* Post-test
	Comparison group (n = 36)		The comparison group listened a printed version of the two stories	
		a. Sub-comparison group (n = 18)	Printed *Swimmy* Post-test	Printed *Who Stole the Moon?* Post-test
		b. Sub-comparison group (n = 18)	Printed *Who Stole the Moon?* Post-test	Printed *Swimmy* Post-test

in the experimental group nor the researcher used the hotspots. Small sub-experimental and sub-comparison groups consisted of four children, and the order of the books was randomized for each group.

To enhance experiment fidelity, the reading sessions were video-recorded. The duration of the story-reading sections was standardized, and the researcher read printed versions of the books to each comparison subgroup. The duration of *Swimmy* was approximately 5 min, and *Who Stole the Moon?* was 7.5 min. After each story reading section, the children retold the stories and answered story comprehension questions. Their responses were audio-recorded. To check interrater reliability, the trained coder rated a randomly selected 25% of data. The Pearson product–moment correlations were ESC 98% and ISC 94% for *Who Stole the Moon?* and ESC 99% and ISC 96% for *Swimmy*.

Instrument

Ten prompted comprehension questions (Paris and Paris 2003) were employed to assess preschoolers' story comprehension. Five questions were related to explicit comprehension (characters, setting, initiating event, problem, and outcome or solution) and five to implicit comprehension (feelings, causal inference, dialogue, prediction, and theme). Each question was scored on a scale from 0 to 2. The explicit questions were intended to assess surface story comprehension, and the implicit questions addressed deeper comprehension.

After they had heard the readings, the children were asked to relate each story to the researcher in their own words. The children's retellings were audio-recorded and later transcribed to examine the length of the stories (word count). The total number of retold words, that is, the knowledge the child acquired form the story, has been used as a measurement of productivity (Heilman et al. 2010; Muñoz et al. 2003).

Results

Phase 1: Pre-intervention

The pre-intervention phase of the study involved an assessment of the children's initial story comprehension and an analysis of their story retellings.

Story Comprehension

Children answered five ESC and five ISC questions related to the printed version of *The Red Apple* to determine their study group. Figure 1 shows the percentages of the experimental and comparison groups scoring 0, 1, and 2 points on each question.

Table 3 presents the descriptive statistics for the pre-test scores. An independent samples t-test was conducted to compare the mean pre-test story comprehension scores of the experimental and comparison groups. The assumptions of the t-test, normal distribution, and levels of measurement were not violated. There was no significant difference between the ESC scores of the experimental ($M = 6.50$, SD = 2.41) and comparison ($M = 6.83$, SD = 2.23; $t\ (70) = 0.593$, $p > .05$, $\eta^2 = 0.005$) groups.

Similarly, there was no significant difference between the ISC scores of the experimental ($M = 4.65$, SD = 2.75) and comparison ($M = 5.45$, SD = 1.98; $t\ (70) = 1.053$, $p > .05$, $\eta^2 = 0.02$) groups.

Retelling

Children's retellings were examined regarding the number of retold words in the story, which ranged from 40 to 123 for the comparison group and 26 to 119 for the experimental group. Table 4 shows that there was no significant difference between the retold words in the story for the experimental ($M = 78.02$, SD = 14.80) and comparison ($M = 80.05$, SD = 15.24; $t\ (70) = 0.455$, $p > .05$, $\eta^2 = 0.002$) groups.

Phase II: Intervention and Post-Tests

Story Comprehension

The effect of the digital storybooks on ESC and ISC was tested via independent samples t tests. Figure 2 presents the percentages of the experimental and comparison groups scoring 0, 1, and 2 points on each ESC and ISC question for *Swimmy*.

Independent samples t-tests revealed that the experimental group outperformed the comparison group on ESC and ISC. Table 5 shows a significant difference between the ESC scores of the experimental ($M = 7.94$, SD = 1.24) and comparison ($M = 7.05$, SD = 1.16; $t\ (70) = 3.128$, $p < .05$, $\eta^2 = 0.12$) groups. ISC scores are also higher for the experimental group ($M = 6.80$, SD = 1.56) than the comparison group ($M = 5.91$, SD = 1.31, $t\ (70) = 2.876$, $p < .05$, $\eta^2 = 0.10$).

Figure 3 displays the percentages of the experimental and comparison groups' scores on each ESC and ISC question for *Who Stole the Moon?* An independent samples t-test was conducted to compare the ESC scores of the experimental and comparison groups. There was a significant difference between the ESC scores of the experimental ($M = 7.61$, SD = 1.10) and comparison ($M = 6.61$, SD = 1.67; t (70) = 2.988 $p < .05$, $\eta^2 = 0.11$) groups.

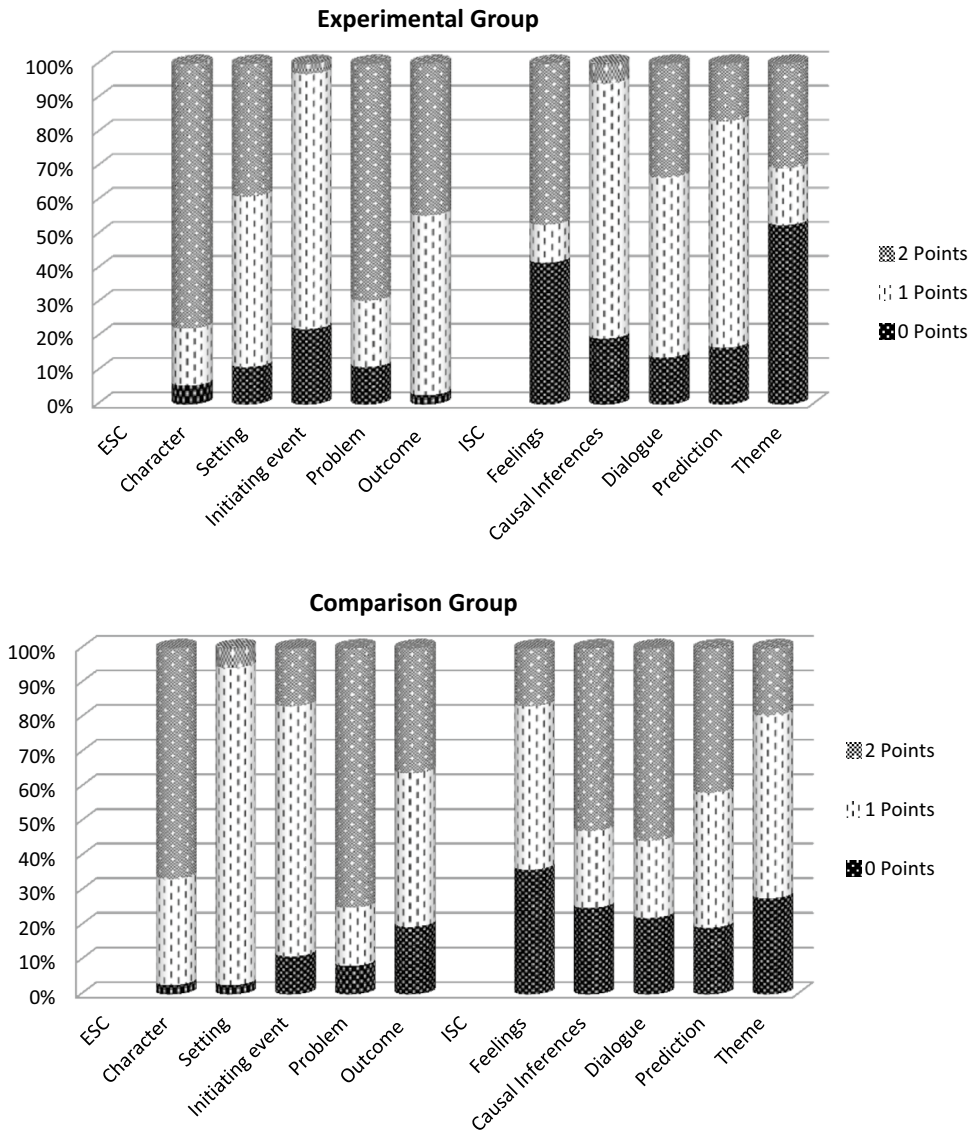

Fig. 1 Percentages of the experimental and comparison group scores for each prompted story comprehension question

Table 3 Results of independent samples t-test comparing story comprehension

Story comprehension *The Red Apple*	Experimental group e-book				Comparison group print book					
Pretest	n	M	SD	Shapiro–Wilk	n	M	SD	Shapiro–Wilk	t	p
Explicit	36	6.50	2.41	0.055	36	6.83	2.23	0.083	0.60	0.55
Implicit	36	5.02	2.60	0.066	36	5.72	1.98	0.075	1.27	0.20

Table 4 Results of independent samples t-test comparing story retelling

Story retelling	Experimental group e-book				Comparison group print book					
Pretest *The Red Apple*	N	M	SD	Shapiro–Wilk	n	M	SD	Shapiro–Wilk	t	p
Number of words	36	78.02	14.80	0.57	36	80.05	15.24	0.52	0.455	0.65

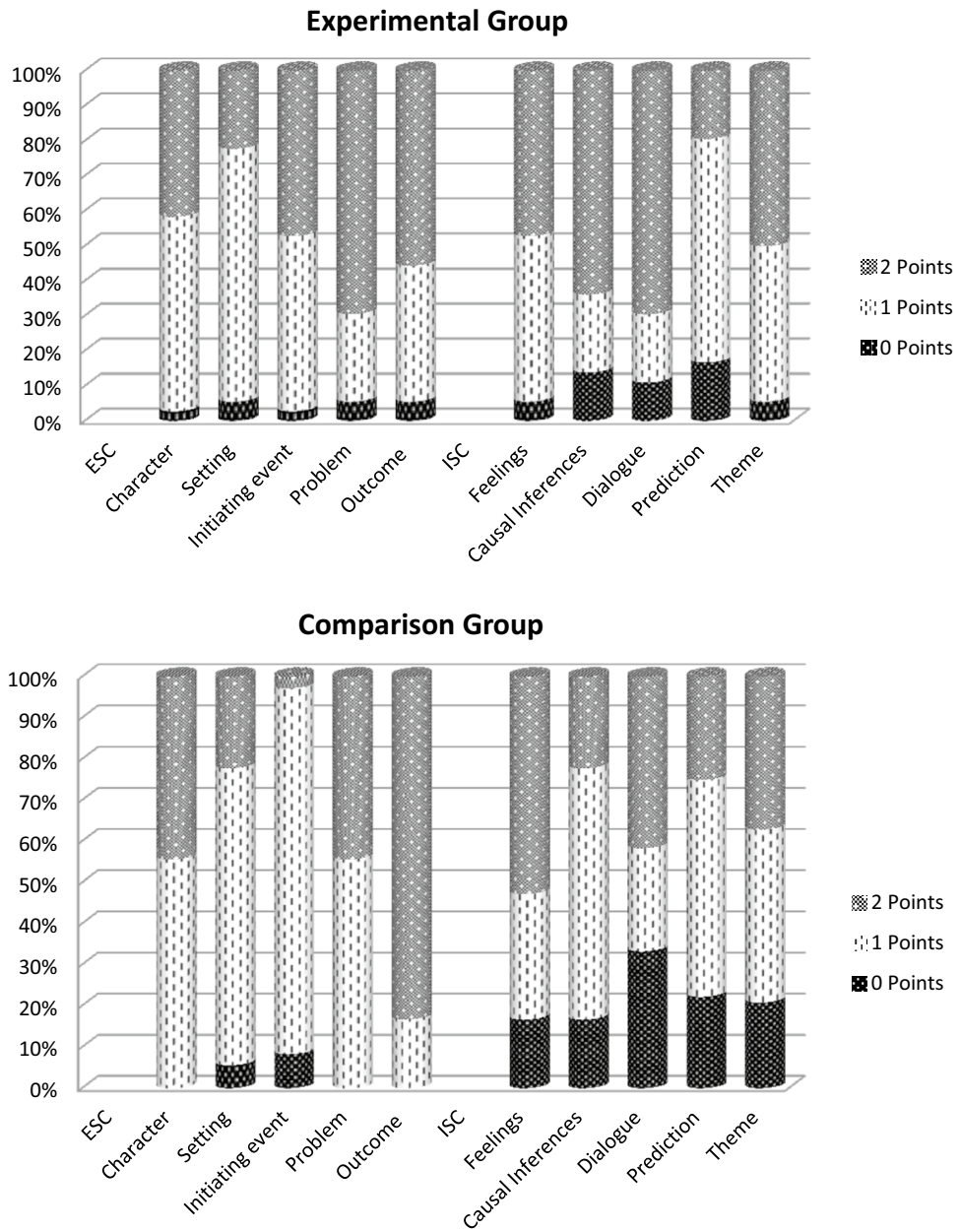

Fig. 2 Percentages of the experimental and comparison group ESC and ISC scores for the *Swimmy* story

Table 5 Results of independent samples t-test comparing story comprehension

Story comprehension	Experimental group e-book				Comparison group print book					
Swimmy	n	M	SD	Shapiro–Wilk	n	M	SD	Shapiro–Wilk	t	p
Explicit	36	7.94	1.24	0.061	36	7.05	1.16	0.070	3.128	0.003
Implicit	36	6.80	1.56	0.072	36	5.91	1.31	0.077	2.876	0.005

A significant difference was found in the ISC scores (t (70) = 2.939 $p < .05$, $\eta^2 = 0.10$), with the experimental group ($M = 6.66$, SD = 1.02) outperforming the comparison group ($M = 5.61$, SD = 1.98); see Table 6.

Retelling

To test whether children's retold word numbers changed by storybook type, independent samples t-tests were conducted.

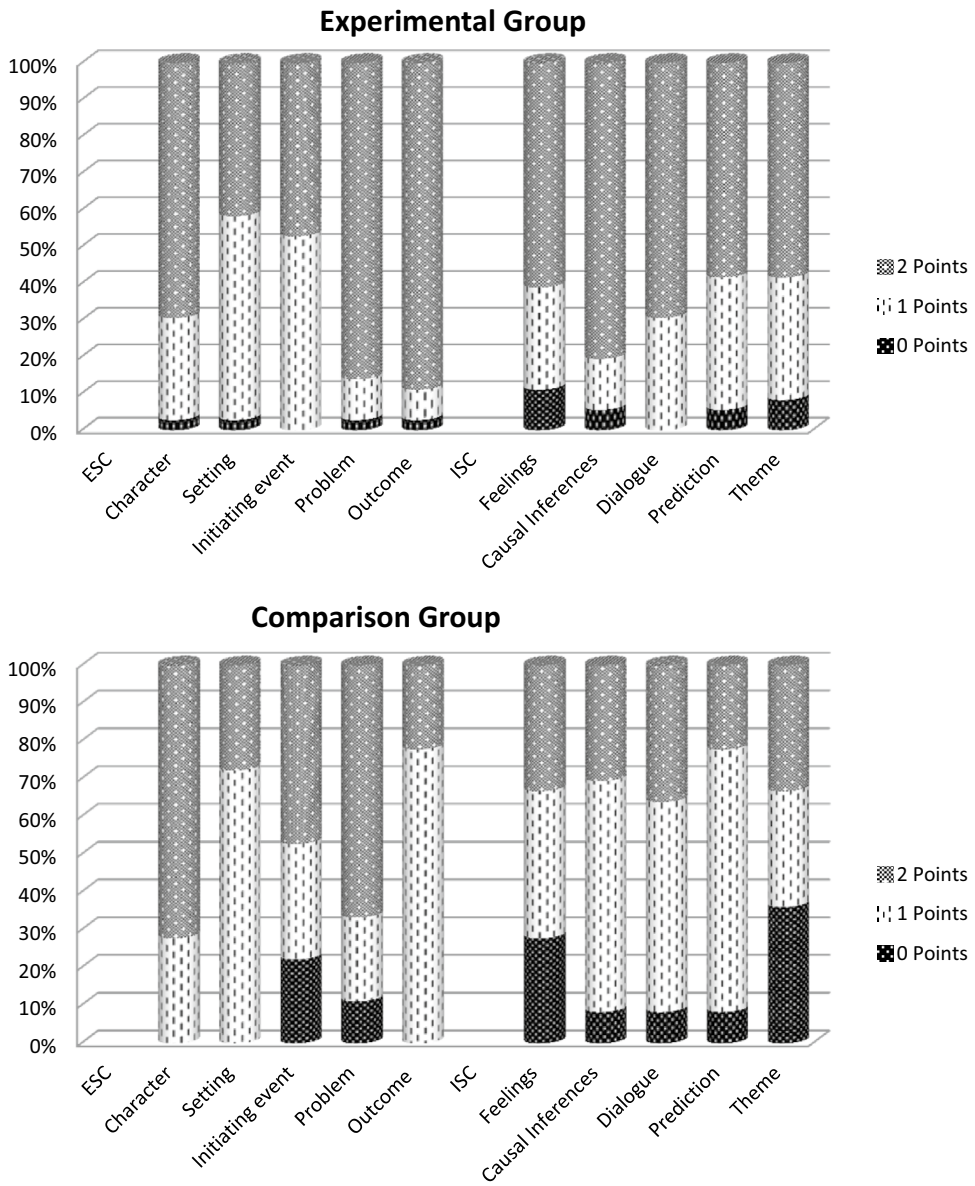

Fig. 3 Percentages of the experimental and comparison groups' ESC and ISC scores for *Who Stole the Moon?*

Table 6 Results of independent samples t-test comparing story comprehension

Story comprehension	Experimental group e-book				Comparison group print book					
Who stole the moon?	N	M	SD	Shapiro–Wilk	n	M	SD	Shapiro–Wilk	t	p
Explicit	36	7.61	1.10	0.87	36	6.61	1.67	0.97	2.988	0.003
Implicit	36	6.66	1.02	0.62	36	5.61	1.98	0.75	2.939	0.008

Table 7 Results of independent samples t-test comparing story retelling

Story retelling	Experimental group e-book				Comparison group print book					
Number of words	n	M	SD	Shapiro–Wilk	n	M	SD	Shapiro–Wilk	t	p
Swimmy (239)	36	95.47	24.68	0.63	36	80.20	32.53	0.57	2.181	0.04
Who Stole the Moon? (541)	36	105.58	18.24	0.89	36	92.41	29.80	0.61	2.261	0.02

For the *Swimmy* story, the comparison group ($M = 79.36$, SD = 30.53) retold fewer words than the experimental group ($M = 95.47$, SD = 24.68). Table 7 indicates a significant difference between the groups (t (70) = 2.181 $p < .05$, $\eta^2 = 0.06$).

Similarly, an independent samples t-test revealed that the experimental group ($M = 105.58$, SD = 18.24) outperformed the comparison group ($M = 92.41$, SD = 29.80) on retold word numbers for the *Who Stole the Moon?* story (t (70) = 2.261 $p < .05$, $\eta^2 = 0.06$).

A Pearson product–moment correlation analysis was conducted to identify the linear relationship between story comprehension and children's retold word numbers. Preliminary analysis revealed that the assumptions of normality, linearity, and homoscedasticity were met. The Pearson's correlation coefficient varied from 0.59 to 0.64 for ESC and from 0.44 to 0.47 for ISC (see Table 8).

Discussion

The goal of the study was to investigate the effects of multimedia-enhanced digital storybooks on (a) children's story comprehension and the (b) facilitation or hindering of children's story retelling.

Story Comprehension

A main finding is that multimedia-enhanced digital stories positively affect children's ESC and ISC. These effects are in line with the results of previous studies (de Jong and Bus 2004; Doty et al. 2001; Ihmeideh 2014; Korat 2010; Roque et al. 2017; Verhallen et al. 2006; Takacs et al. 2015). Takacs et al.'s (2015) meta-analysis revealed that animated illustrations, background sounds, and music promote children's story comprehension. Similarly, the present study found an advantage of the features of digital stories for story comprehension, with a medium effect size. The study findings may have great practical application for educators to exploit the usefulness of multimedia stories in actual small-group classroom reading activities. Future studies should examine the efficacy of multimedia stories in small-group reading activities versus whole-group and individual reading sections.

Previous research mainly focused on the benefits of d multimedia-enhanced stories to ESC; one of the important contributions of this study is the investigation of ISC. ESC questions cover easier factual information, whereas ISC questions place a greater demand on inferential thinking, predictions, and perspective taking. Therefore, ESC scores are higher for each story. This finding supports previous studies (e.g., John et al. 2003; Paris and Paris 2003) that indicated that many teachers emphasize story elements to assess children's story comprehension when they should instead prompt children's thinking about the protagonists' internal states, dialogues, and feelings. Developmentally appropriate narrative activities can reinforce children's deep story comprehension and inferential thinking (Collins 2016; Florit et al. 2011; Kendeou et al. 2007; Paris and Paris 2003; Tompkins et al. 2013).

The study findings provide evidence that multimedia-enhanced storybooks can serve as a tool to foster children's inferential thinking and ISC. One possible explanation is that features of digital storybooks elaborate on the story content, clarify dialogues between characters, and concretize complex plots (Algozzine and Douville 2004; Korat 2010; Takacs and Bus 2016; Zucker et al. 2009). Digital storybooks provide depictive representations of the protagonists' feelings and gestures. The extra features may supply a mental aid for children to understand the protagonists' state of mind and to predict and explain the protagonists' emotions and actions. The added multimedia features result in deeper story comprehension (Mayer 2005; Schnotz and Bannert 2003; Schüler et al. 2015). The format of digital storybooks allows synchronous display of illustration and text, which is not possible in printed storybooks (Ito 2009). Such synchronous presentation bolsters the connection between visuals and words, enables children's dual coding of verbal and nonverbal information, and scaffolds story comprehension, a finding that is consistent with Paivo's (2007) theory (Bus et al. 2015; Takacs and Bus 2016).

Further, compared to traditional printed storybooks, digital storybooks provide abundant and dynamic illustrations. Figure 1 shows the illustration for the same scene (many little fish forming a big fish) in static and animated illustrations in the *Swimmy* storybook. The printed book presents the process of creating a big fish as a single static illustration, whereas eight illustrations appear in the animated digital book. The digital storybook also provides additional illustration (see Fig. 4, picture 2a) of Swimmy's idea to form a big fish. The lavish illustrations in the digital book are effective for close temporal contiguity of text and visuals and can enhance story understanding by concretizing the narration (Bus et al. 2015).

Table 8 Bivariate correlations between story comprehension and retold word numbers

Word number	ESC	ISC
The Red Apple	0.59**	0.45**
Swimmy	0.62**	0.47**
Who Stole the Moon?	0.64**	0.44**

**$p < .01$

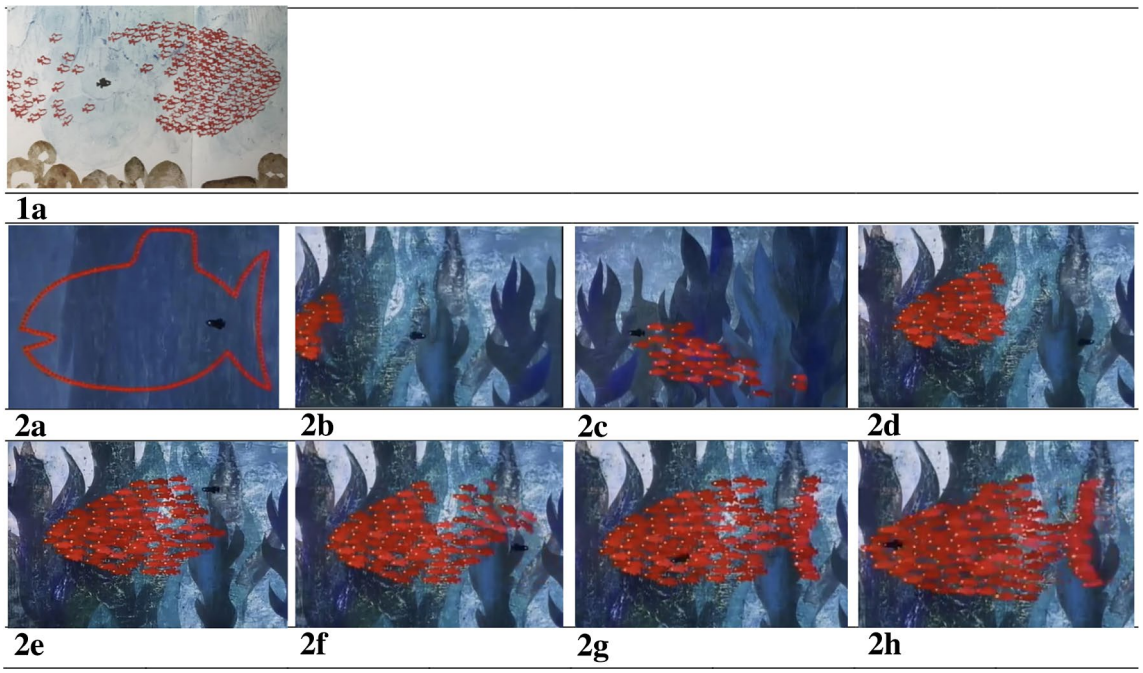

Fig. 4 Illustrations for the same scene in the printed book (first row) and still frames from the e-book version of the *Swimmy* storybook (second and third rows). Copyright © 1963, renewed 1991 by Noraeleo LLC & Penguin Random House LLC and Kaushik Bhattacharya (e-book)

Evans and Saint-Aubin (2005) found that preliterate children's eye fixations were mainly on the illustrations during the storybook-reading process. A recent eye-tracking study showed that children fixate more on animated illustrations than on static ones (Takacs and Bus 2016). Children's greater visual attention and engagement and longer duration of fixation can be interpreted as reflecting deeper information processing and story comprehension (Lauricella et al. 2014; Rayner 2009; Takacs and Bus 2016).

Story Retelling

Children who engaged with the digital storybooks used a greater number of words to retell the stories. Multimedia superiority is in line with the findings on story comprehension. Multimedia-enhanced stories include abundant animated illustrations, nonverbal information (sounds, music, and effects), and paralinguistic features (gesture, body language, prosody). The concreteness features of multimedia storybooks enable children to match visual and linguistic sensory modalities. The human mind processes information through two interdependent and interconnected sensory systems, logogens (verbal) and imagens (nonverbal), with referential connections between the systems. According to dual coding theory, enhanced representations connect to retrieve much greater detail in stories (Paivo 2007; Takacs and Bus 2016). Previous studies showed that multimedia-enhanced digital books support children's vocabulary acquisition (Korat and Shamir 2012; Roque et al. 2017; Smeets and Bus 2012). Story retelling and recalling is associated with vocabulary (Ouellette 2006; Strasser and del Río 2013; Uccelli and Páez 2007). Thus, children's story productivity is directly and indirectly supported by multimedia-enhanced storybooks. Future studies should examine these relations in detail.

There is also evidence that multimedia storybooks that include *edutainment* characteristics to attract children's attention can foster their attentiveness to and engagement with the story-listening process (Kamil et al. 2000; Moody et al. 2010; Richter and Courage 2017; Roskos et al. 2014; Takacs and Bus 2016; Verhallen and Bus 2009). Motivational factors may also be related to children's story productivity. It might be better to investigate cognitive and affective factors together to better explain the influence of multimedia-enhanced storybooks on children's learning and language development.

Limitations

Although the research was conducted with well-designed multimedia-enhanced storybooks for preschool children, there were several limitations. First, the majority of the children had no prior multimedia storybook-reading experience. This unfamiliarity with such storybooks may have

influenced the experimental group's engagement with and attention to the study. A second limitation was that the study was conducted as a small-group reading activity. The focus was on natural classroom activities rather than isolated laboratory conditions. The subgroups were matched based on their initial comprehension scores, but children's individual differences, such as motivation and temperament, may affect their story-reading processes. Finally, both groups of children listened to the books only once. The repetition of story-reading sections could alter young children's story comprehension regarding book type (Lauricella et al. 2014; Takacs et al. 2014; Verhallen et al. 2006), but this issue is beyond the scope of the present study. Future studies should test this repetition effect.

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