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Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade

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ABSTRACT

The effect of reading an electronic storybook (e-book) on Israeli children's language and literacy was examined in kindergarten children ($N = 40$; age 5:2–6:3) compared to first graders ($N = 50$; age 6:3–7:4). The children in each age group were randomly assigned to two groups: an intervention group which read the e-book five times and a control group which was afforded the regular school program. Pre- and post-tests included vocabulary and word reading measures. Post-tests included story comprehension and production. Children who read the e-book exhibited significant progress in word meaning and word reading compared to the control group. Kindergarten children progressed in word reading more significantly than first graders across treatment groups. This could be explained by the ceiling effect of the first graders' word reading level which did not leave much room for progress in this skill compared to the kindergarten children. No interaction was found between age and treatment groups. Kindergarten children exhibited a good level of story comprehension, similar to first graders, although their story production was lower. Implications for future research and education are discussed.

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1. Introduction

Reading a storybook to young children is regarded as an important activity that supports literacy development (Bus, Van IJzendoorn, & Pellegrini, 1995). However, although extensive evidence is available on the relationship between book reading and children's oral language (Bus et al., 1995; Sénéchal, 2006; Whitehurst & Lonigan, 2001), little evidence exists on the positive relationship between this activity and children's early print knowledge (Korat, Klein, & Drori-Segal, 2007; Leseman & de Jong, 1998). One of the explanations offered for this state of affairs is that neither parents nor teachers generally emphasize print while reading to children (Dickinson & Tabors, 1991), and children do not focus on print when looking at books (Evans & Saint-Aubin, 2005; Yaden, Smolkin, & MacGillivray, 1993).

Children of today who live in a highly technological era may be exposed to books not only through an adult's reading, but also by independently activating electronic storybooks (e-books) which are available on the internet or on CD-ROMs. In Israel, 42% of middle socioeconomic status (SES) mothers reported that their pre-school children have e-book software at home (Or, 2009). E-books usually include multimedia effects such as oral reading, written text, oral discourse, music, sound effects, and animations. Most e-books include optional hidden hotspots, which are devices embedded in various screen locations and are intended to provide additional information about the characters, repeat or elaborate text (words or themes), explain a word, duplicate a sound, switch screens (equivalent to flipping pages containing pictures or animation) or provide entry into games and other activities meant to promote the story's understanding. Clicking on a glowing word in the text will sometimes give the children an explanation of the word, an explanation that may be less frequently heard and less well-known to the young child. Built-in dynamic visuals may also elaborate on the story content beyond what appears in the original text and may support better story comprehension. For example, in the e-book *Itamar the Hunter*, Itamar's image runs on the beach with a scary shadow chasing him and making scary sounds as the narrator talks about Itamar's fear of the ghost. Furthermore, before Itamar goes to sleep, his father gives him a lantern and says, "Take the lantern; it will help you illuminate the ghost." This does not appear in the story's written text. Such an activity has the potential to expand the children's knowledge of the story's events beyond the original story text.

The oral reading of the text by the narrator, accompanied by the highlighted text, can provide insights into the nature of the written text by allowing the children to carefully follow the written words, phrases, or passages which are being read to them. In some e-books,

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hotspots may relate to the written text. For example, when clicking on specific words, phrases, or sentences, the children can hear the written text again. Activating e-books that incorporate a built-in dictionary and highlighted text may offer young children the opportunity to learn not only the meaning of new words but also word recognition and word reading.

The current study was based on the assumption that providing children with developmentally appropriate learning experiences may influence their language and literacy learning. We agree with Haugland and Wright (1997) who claimed that software designers should take children's literacy knowledge at different ages into account when developing material to support their language and literacy. We focused on an educational e-book that we developed, which was aimed at supporting the early literacy development of preschoolers who have not yet formally learned reading and writing as well as of school beginners who have already begun this process of learning at school. We assumed that the vocabulary meaning enrichment function, the word tracking option and the hotspot animations can facilitate preschool children as well as school beginners' language and literacy. However, this support could lead to a different progress in each age group. Thus we asked: (1) whether our educational e-book can support young children's vocabulary, story comprehension and early word reading, and (2) whether this support differs for kindergarten children compared to first graders.

2. E-books as a support for oral language

2.1. Vocabulary

Children's rich vocabulary is considered to be one of the important vehicles for reading comprehension and academic achievement (Beck & McKeown, 1999; National Reading Panel, 2000). Children's vocabularies grow rapidly during early childhood, and the vocabulary level at kindergarten age predicts children's reading and comprehension in school (Hiebert & Kamil, 2005). It is well-known that there is an enormous difference in the vocabulary volume between young children, and that this affects their future literacy and academic progress (Chall, Jacobs, & Baldwin, 1990; Hart & Risley, 1995; Snow, Burns, & Griffin, 1998).

The National Panel (NICHD, 2000) in the USA, being aware of this evidence, has suggested several important principles for vocabulary instruction. These include direct teaching of new words, repetition of word learning, embedding new words in a meaningful context and offering children an active role in this process. It was also suggested that technology tools should be used for fostering children's vocabulary.

In the current study we used an e-book which we developed and which has already been examined (see Korat, 2009; Korat & Shamir, 2007; Korat & Shamir, 2008) and was found to incorporate all these principles. We offered the children a book which is aimed at their age group and includes a dictionary that supports rare word understanding. Children encounter these words automatically after listening/reading the screen. The words appear in visual format depicting their meaning, including a short oral explanation and the written form of the word. Previous studies which we conducted on kindergarten children who worked independently with this software showed that a short period of activating this software significantly improved their word meaning knowledge (Korat, 2009; Korat & Shamir, 2007; Korat & Shamir, 2008). These results support other recent evidence about the ability of e-books to foster kindergarten children's vocabulary (Segers, Takke, & Veroeven, 2004; Segers & Verhoeven, 2002; Segers & Verhoeven, 2003; Verhallen, Bus, & de Jong, 2006) among kindergarten children as well as among school beginners (Lewin, 2000). When children enter school and begin formal learning of reading they are exposed to different types of texts which might enhance their vocabulary (Cunningham & Stanovich, 1991). This could lead to the thought that first graders have a better knowledge of word meaning than kindergarten children and may also progress faster following e-book reading. On the other hand, if kindergarten children already know the meaning of several words in the e-book, their progress might be the same or even faster than the first graders. One of the questions in the present study was therefore whether the software we offer to the children supports first graders' vocabulary as it does kindergarteners', and if so, whether its support for these two age groups is similar or different.

2.2. Story comprehension

One of the problematic issues that were raised regarding e-books is that the rich interactive and amusing effects, and especially hotspots which are not congruent with the story-line (Labbo & Kuhn, 2000), may distract the children's attention from the story's content and interfere with their story understanding (Okolo & Hayes, 1996; Underwood & Underwood, 1998). For example, Okolo and Hays found that the low comprehension levels of poor second-grade readers who used CD-ROM storybooks resulted from inconsistencies between the animations and the story-line in the e-books. In another study, fourth graders who read an interactive e-book recalled the story's events structure better than those who were engaged in the e-book's play version (Trushell, Maitland, & Burrell, 2003).

Good quality CD-ROM storybooks that contain hotspots which are congruent with and are integrated into the content of the story (called "considerate" e-books, see Labbo & Kuhn, 2000) were found to foster children's understanding of the story-line (Labbo & Kuhn, 2000) and story-recall ability (Underwood & Underwood, 1998).

The e-book we offered the young children was created using the "considerate" principles by embedding hotspots in pictures which support the story-line. For example, the story's protagonist Yuval, a young boy who tends to be confused, finds it difficult to get dressed properly. When the child clicks on one of Yuval's toys, the child will hear the toy saying: "Yuval, pay attention, the collar of the shirt should be in front". This comment does not appear in the original story text and is not said by the narrator. It was added to the e-book and appears as a hotspot which might support the child's story-line understanding.

We implemented only five hot spots in each screen in order to raise the children's enjoyment while keeping them moving with the story. de Jong and Bus (2004) suggested that kindergarten children in their study understood the story since in their software, only five hotspots were included in each screen. This was compared to Labbo and Kuhn (2000) who found that kindergarten children had difficulties in following the story-line when they had about 19 hotspots in each screen. Our results yielded a good level of story understanding of kindergarten children using two different e-books developed with the same design. The children who participated in these studies were asked to answer yes or no questions regarding the story content. These questions were aimed at factual information of the story as well as referential questions regarding the characters' actions and motivations. Story comprehension may be measured at several levels, beginning with a more simple behavior of answering simple (yes/no or true/false) questions and by a more active and demanding level of story production (Carlisle & Rice, 2002). In the current study we included these two measures for evaluating the children's story comprehension.

We aimed at investigating how two age groups: non-readers (kindergarteners) and reading beginners (first graders), understand a story presented to them in a considerate e-book using two levels of story comprehension.

3. E-books as a support for word reading

Word reading is considered a fundamental ability required for fluent reading and reading comprehension (Ehri, 1995). Young children can develop rich knowledge on print and make an effort to read words. Ehri (1995) distinguished four phases that occur in the development of sight word learning that are characterized by the involvement of the alphabetic system; prealphabetic, partial alphabetic, full alphabetic, and consolidated alphabetic (see also, Farrington-Flint, Coyne, Stiller, & Heath, 2008). Researchers have found that kindergarteners' word reading is an important skill in their early literacy development (Aram & Levin, 2004; Ferreiro & Teberosky, 1982) and a good predictor of reading and writing in elementary school (Authors, 2003; Shatil, Share, & Levin, 2001).

Reading e-books could be an activity that supports young children's knowledge on print, including their word reading. One of the dynamic options included in many e-books is text tracking, namely a printed text that changes by highlighting and coloring as it is narrated. Some e-books allow the reader to follow the text tracking in each screen as many times as they like and tracking of text appears in units of sentences, phrases or separate words. According to Ehri and Sweet (1991), children's orthographic knowledge might be supported by pointing to the text while reading. Indeed, some evidence has been presented that word reading of school beginners (Lewin, 2000; Miller, Blackstock, & Miller, 1994) and of kindergarten children (de Jong & Bus, 2002) improved following reading highlighted texts in e-books. de Jong and Bus (2002), who researched children aged 4–6, found that those who had a higher level of letter knowledge and word recognition improved their word reading level following the activity with an e-book (6 times) more than others. The improvement in children's word reading can be explained by being exposed to the written words several times. Importantly, taking into consideration that text tracking may appear in units of sentences, phrases or words, it could be claimed that this position might partially explain children's improvement in word reading. The assumption will be that the highlighted text at the word level is a better support for word reading than sentences or phrases. Unfortunately, no information on the level of highlighting used in the above-mentioned studies' software is available.

The e-book we developed was designed by taking into consideration that word level exposure by highlighting will support a better word reading ability of young children: each word in the text was colored stimulatingly with the narrators' reading. Studies we conducted to monitor kindergarten readers showed inconsistent findings. In one study children aged 4–6 improved significantly in frequent words that appeared in the e-book (Korat, 2009; Korat & Shamir, 2008), whereas other studies conducted with the same age group (Korat & Shamir, 2007) did not find any improvement in word reading following the e-book reading. These results might indicate that word reading improvement after reading e-books is possible for children who already have good orthographic knowledge and less for beginners. This question could be investigated by comparing kindergarteners' and first graders' use of our software.

4. Focus of this study

In the present study we investigated the extent to which a considerate e-book can support kindergarten children's language (vocabulary and story comprehension) and word reading compared to first graders. We hypothesized that: (1) children from both age groups would benefit from the activity with the e-book compared to the control group; and (2) children from the older group would exhibit greater progress in vocabulary learning and word reading than those in the younger group. We also hypothesized (3) that first graders would exhibit higher story comprehension, especially in the story production task.

4.1. Method

4.1.1. Participants

The sample consisted of 90 Israeli children from ten classes: five kindergarten classes ($n = 40$; 19 girls and 21 boys) and five first grade classes ($n = 50$; 27 girls and 23 boys). Eight to 10 children were chosen randomly from each class, after consent was obtained from their parents. The children's age in the sample was 5:2–6:3 in kindergarten and 6:3–7:4 in first grade. All schools which participated in this study are located in middle SES neighborhoods. Neighborhood SES levels were determined according to the Israeli The Israeli The Israeli The Israeli Municipalities (1995) Statistical Report, which includes data such as the parents' education level, income level, housing density, PC ownership, etc.

Children in each age group were randomly assigned to two different groups; 20 children in each group in the kindergarten and 25 children in each group in the first grade. One intervention group participated in five e-book reading sessions and one group received the regular kindergarten/first grade program and served as the control group. Formal reading and writing instruction in Israel begins in school, at the age of 6–7. The main method of teaching is based on learning alphabetic skills as well as reading and writing of words, short texts and storybooks. In kindergarten, children are exposed to the written system, including storybooks and educational games. Activities such as phonological awareness (e.g., rhyming games or segmenting words into syllables), letter discrimination, or letter copying are part of the repertoire of many kindergarteners (Shatil et al., 2001). All children who participated in the study had initial experience with computers individually and in small groups as part of the curriculum.

The children's activity with the computer took place in their classes, working three at a time in a separate room. Each child was shown how the software operates and was given instructions on the different functions of the e-book. He or she was told: "We've brought you an e-book that you can work and play with on the computer. You're invited to work with it. After you finish working with the computer, we'll ask you some questions." The children were given technical support as needed and some were encouraged to go on and finish their session. Each session lasted about 20–25 min. No other adult support was given during the sessions.

4.2. Considerate electronic book

The e-book used in this study is an electronic version of the printed book *Yuval Hamebulbal* (Confused Yuval) by Roth (2000). The printed book was examined by four experts on children's literature who have a master's degree and was found to be a good book for work with

children. The story's structure and simple narrative elements – setting, characters, goal/initiating event, problem and solution/ending (Mandler & Johnson, 1977) – appear eminently suitable for the participants' age. The e-book based on the printed book was designed by the authors to capture principles that were found to be especially beneficial for developing literacy, while avoiding drawbacks identified in standard e-books (Korat & Shamir, 2004; Shamir & Korat, 2006; de Jong & Bus, 2003). The story's protagonist is Yuval, a young boy who tends to be confused and forgetful until his grandmother makes a special hat for him to help him remember. A large colored drawing covering more than half of the page appears on each of the book's 15 pages, as do 3–5 written sentences totaling about 40 words. The written text is printed in dotted letters (*nekudot* in Hebrew), so that the children can also relate to the printed text.

4.2.1. Main functions of the e-book

We scanned the pages from the printed book for the e-book in order to maintain similarity between the versions. An animated figure explains the different options for activating the story in the electronic version. The children are offered three modes or options: (1) Read story only, (2) Read story with dictionary, (3) Read story and play. The children in this study worked only on the "Read story with dictionary" mode. All modes, including the "Read story with dictionary" mode, included an oral reading of the printed text by an actor. It also incorporates automatic dynamic visuals that dramatize story details, fragments and the complete story scene as well as extra music and film effects that may "bring the story content to life". The e-book has a forward button (a colored arrow that points to the right) and a backward button (an arrow that points to the left) on each screen in order to stimulate the children's reading orientation and involvement, thereby allowing them to return to previous screens or continue to the next one. A function that allows the children to re-read/re-listen to the text is also available. The highlighting of written phrases as the text is declaimed helps focus the children's attention on the relationship between the text and the oral reading, thus supporting their exposure to the written text and perhaps word recognition (de Jong & Bus, 2002). The "Read story with dictionary" mode also offers explanations of difficult words that appear automatically on the screen after the entire page has been read by the narrator (the children can reactivate these words). Each difficult word is pronounced clearly by the narrator as it appears on the screen and is associated with pictures that support its meaning (see Fig. 1).

5. Research tools

5.1. Children's measures

The children's vocabulary and word reading of the e-book's target words were measured before and after the activity with the e-book. Story comprehension and production were measured only following the activity. All tests were administrated to the children individually.

5.1.1. Vocabulary

The children were asked for the meanings of 10 words from the e-book's text, which appeared in the dictionary mode of the e-book activity. These words were judged by four teachers of this age group as relatively difficult for kindergarten children compared to other words in this book. The children were asked to choose the picture that best illustrates the word's meaning out of a set of four pictures. All non-target pictures represented words from a similar category. For example, for the word "stretching" the non-target pictures were playing with a ball, running, and jumping. The total score for this task ranged from 0 to 10. The alpha score for this measure was .68.

"Yuval, get up, its time, get dressed quickly
and go to kindergarten!"
Yuval yawns, he is still tired,
He collects his clothes very slowly
Straightens …
Stretches …
Stretches an arm and a leg
And suddenly remembers: he is already STRETCHING"

Fig. 1. Example of "Read story with dictionary" mode.

Table 1
Means (and standard deviations) of children's pre and post literacy scores by age and treatment group.

	Kindergarten				First grade			
	Control		E-book reading		Control		E-book reading	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vocabulary (0–10)	6.20	6.65	6.50	8.90	6.48	6.80	6.90	8.90
	(1.28)	(1.60)	(0.8)	(1.10)	(1.38)	(1.44)	(1.55)	(1.41)
Word Reading (1–36)	26.00	27.30	26.25	30.2	33.52	33.56	34.00	35.12
	(4.50)	(4.60)	(6.47)	(4.74)	(2.23)	(1.82)	(2.25)	(1.36)

Table 2
Means (and standard deviations) of children's improvement in literacy scores by age and treatment group.

	Kindergarten		First grade	
	Control	E-book reading	Control	E-book reading
Vocabulary (0–10)	0.45	2.40	0.32	2.00
	(1.45)	(1.23)	(1.30)	(1.68)
Word Reading (1–36)	1.25	3.95	0.00	1.12
	(2.40)	(1.12)	(1.74)	(2.47)

5.1.2. Word reading

The children were asked to read nine words, each of which appears with high frequency (4–7 times; out of the 9 words, 2 appeared 4 times, 3 appeared 5 times, 2 appeared 6 times and another 2 appeared 7 times) in the e-book. The scores for each word ranged from 1 to 4 as follows: 4 = correct reading of the word, 3 = partial reading, saying two correct sound or letters of the word, 2 = partial reading, saying one correct sound or letter of the word, 1 = reading another word or saying "I don't know." The total range of scores for this task was 1–36. The inter-rater reliability for this measure across two raters, using Cohen's Kappa, was .80. The alpha score for this task was .92.

5.1.3. Story comprehension

The children were asked eight right/wrong questions pertaining to the e-book. Four questions dealt with information that appears clearly in the story (e.g., "when Yuval gets up in the morning he stretches his arms, collects his clothes and gets dressed") and the other four dealt with information that could be inferred from reading/listening to the story (e.g. "All the things that happened to Yuval were caused because he is not well organized"). Each correct answer received a score of 1. The alpha score for this task was .65.

5.1.4. Story production

The children were asked to read the printed version of the e-book *Yuval Hamebulbal* which they worked on in the intervention. They were told: "Here is the book *Yuval Hamebulbal* that you already know. Please read the book to me. Do it as best as you can". The children's reading was audio-taped and later transcribed. The transcriptions were analyzed by relating to each page as a unit. Three measures were used: (1) the number of words that the child read/said which were written on the page; (2) the number of expressions (a string of at least three words) that the child read/said which are written on the page; (3) the extent of similarity between the meaning of the child's talk/reading and the page he read. For this measure we used a scale from 0 to 2: 2 = very similar to the story content, 1 = only partially similar to the page content, 0 = not similar to the story content at all. The inter-rater reliability for these three measures across two raters using Cohen's Kappa was .90 for number of words, .86 for number of strings, and .82 for content similarity ($p < .001$). The alpha score for the number of words was .97, for the number of strings .97 and for content similarity .95 ($p < .001$).

6. Results

Preliminary analyses of the pre-intervention overall literacy scores using a 2-way MANOVA of 2 (age group; kindergarten vs. first class) × 2 (intervention group; e-book reading vs. control) were conducted. The dependent variables were children's scores in word meaning and word reading. The means and standard deviations of the children's scores are presented in Table 1 (pre-test columns).

The results showed no significant differences between the pre-test overall emergent literary scores of the children in the two groups (F [2, 85] = .86, partial eta square = .02, p = ns) and no interaction between age group and type of intervention group (F[2, 285] = 0.4, partial eta square = .01, p = ns). However, there was a significant difference between the children's scores in the two age groups (F [2, 85] = 38.50.00, partial eta square = .47, $p < .001$).

A univariate test with Bonferoni corrections for each of the two pre-test measures of literacy separately showed significant differences in word reading (F[1,86] = 41.83, partial eta square = .26, $p < .001$), and no significant difference in word meaning (F [1,86] = 1.55, p = ns.).

Addressing the extent of improvement in the children's literacy levels as a function of their age group and intervention group, we executed a 2-way MANOVA on the children's improvement scores. The means and standard deviations of the improvement in the children's literacy scores in the two age groups and in each of the intervention groups are presented in Table 2.

A significant difference was found between age groups (F (2,85) = 23.43, partial eta square = .35, $p < .001$) and between treatment groups (F (2,85) = 5.82, partial eta square = .12, $p < .001$), whereas no significant interaction was found between age group and treatment group (F (2,85) = .98, p = ns.).

A test of between-subject effects with Bonferoni corrections for each of the two measures separately showed differences between the two treatment groups. The children in the experimental group improved their word meaning (F (1,86) = 35.13, partial eta square = .29,

Table 3
Means (and standard deviations) of children's literacy in story production by age group.

	Kindergarten		First grade			
	M	*SD*	*M*	*SD*	*t*	*P*<
Words (21–457)	115.15	(82.36)	347.52	(112.07)	8.10	.001
Expressions (17–119)	25.10	(17.45)	68.32	(51.58)	3.90	.001
Similarity to the Story (0–30)	18.10	(8.23)	28.36	(3.37)	5.24	.001

$p < .001$) and word reading ($F(1,86) = 9.22$. partial eta square = .10, $p < .003$). The improvement in word meaning was greater in the experimental group ($M = 2.17$; $SD = 1.49$) than in the control group ($M = 0.37$; $SD = 1.37$). Similarly, the improvement in word reading was greater in the experimental group ($M = 2.37$; $SD = 3.80$) than in the control group ($M = 0.57$; $SD = 2.12$).

A test of between-subject effects with Bonferoni corrections for each of the two measures separately showed differences between the two age groups in word reading ($F(1122) = 10.53$, partial eta square = .10, $p < .002$). The improvement in word reading was greater in the kindergarten group ($M = 3.95$; $SD = 1.12$) than in the first grade group ($M = 1.12$; $SD = 2.47$) (see means in Table 2).

The children's story comprehension was assessed only following the book reading activities using questions (range of scores 0–8). Test results showed no significant differences between age groups in story comprehension. The children exhibited an overall 80% level of success in their responses to the seven story comprehension questions.

Story production included three measures: frequency of words that the child read from the book, idioms said from the book and the level of story similarity to the original story. The means and standard deviations of the children's scores in the two age groups are presented in Table 3.

T-test results show that first graders significantly outperformed kindergarten children in the three measures: frequency of words that the child read from the book ($t[38] = 7.74$, $p < .001$), idioms from the book ($t[38] = 3.57$, $p < .001$) and the level of similarity to the original story ($t[38] = 5.68$, $p < .001$).

7. Discussion

In the current research we investigated the effectiveness of a considerate electronic book which was developed by the authors and which aimed at supporting kindergarten and first grade children's language (vocabulary and story comprehension) and word reading development. We assumed that: (1) the children from both age groups would benefit from the activity with the e-book compared to the control group; (2) first graders would exhibit greater progress than kindergarten children in vocabulary learning and word reading; (3) first graders would demonstrate higher story comprehension, especially in the story production task.

Our results confirm our first assumption. Indeed, both age groups benefitted from the e-book software we developed compared to the control groups who did not work on this software and received their school's regular literacy program. These results confirm our previous studies in which we found that kindergarten children benefit in vocabulary as well as in word reading after working on the considerate e-book.

(Korat, 2009; Korat & Shamir, 2007; Korat & Shamir, 2008; Korat et al., 2007). These results support other recent evidence about the ability of e-books to foster kindergarten children's vocabulary (Lewin, 2000; Segers & Verhoeven, 2002; Segers & Verhoeven, 2003; Segers et al., 2004; Verhallen et al., 2006). They also expand our previous results regarding the effectiveness of the suggested e-book for first graders who have already begun their formal learning of reading and writing at school, and not only for kindergarten children.

It should be noted that we found that first graders were better in reading the frequent words from the e-book than the kindergarten children before beginning their work with the e-book. This is not surprising, since these children already had 6 months of learning to read at school. However, we were surprised that the first graders did not present a better understanding of the meaning of the rare words in the e-book. These results may indicate that word meaning knowledge depends on the children's exposure to specific literature or context and not only on the child's age group or being a student in the first grade.

A second important and interesting result is that both age groups exhibited good progress in their word meaning knowledge from the e-book, while the kindergarten children exhibited more significant progress in word reading than the first graders. These results do not support our second hypothesis, that the first graders would exhibit greater progress than the kindergarten children in vocabulary learning and word reading. The findings could be explained by the ceiling effect of the word reading level of these middle SES first graders which did not leave much room for progress in this skill, while in the word meaning skill the situation was different. Both age groups began from a similar level before the intervention and gained between 2 and 3 new words after working with the software five times.

As for our third hypothesis, we found that both age groups showed a good story understanding level in the less demanding task of story comprehension (answering true/false questions), whereas first graders presented significantly higher results in the more demanding task of story production. The results concerning the story comprehension of the suggested e-book have already been presented in our previous studies (Korat, 2009; Korat & Shamir, 2007), whereas the results on story production are new. These results show that kindergarten children and first graders who work on the software individually five times are able to produce the story on which they worked in an impressive manner. They can say/read words from the e-book and can produce a story similar to the story presented in the e-book. It is also very clear that first graders can benefit more than kindergarten children in the more cognitively demanding task of producing the story. The first graders' new reading knowledge which was acquired at school, including their other rich new knowledge in book reading, can explain their higher ability to produce a better story than the kindergarten children. It should be noted that the children used the e-book while producing the story. This rules out the possibility of a confounding variable of memory according to age groups and storytelling (see also Grimshaw, Dugworth, McKnight, & Morris, 2007). Our results confirm the assumption that story understanding has several levels, and that children in different age groups function differently according to their age level (Carlisle & Rice, 2002).

Our results indicate complex findings from a developmental perspective. They indicate that children's literacy progress after being exposed to a certain teaching program could be similar (e.g., for word meaning and story comprehension) as well as different (e.g., for word

reading and story production) for children in different age groups. This depends on the combination that the program itself (in our case the e-book) can offer, the specific skill that the program promotes (word meaning, word reading, story comprehension or production), and the children's initial level of knowledge and their ability to learn in each skill.

8. Conclusion

In conclusion, independent e-book reading by children can be an enjoyable and fruitful activity. Similarly to others (Labbo & Reinking, 1999), we believe that this experience is more powerful when the reading activity is an authentic experience compared to the more traditional drill approach. How well e-books can do this depends on their quality and on how well they are designed to specifically meet children's developmental needs (Haugland & Wright, 1997; Shamir & Korat, 2006). Providing children with the written text together with synchronized narration accompanied by animated pictures and sound effects that relate directly to the storyline, providing a living dictionary with multimedia meaning of rare words, all seem to comprise good support for children's literacy development.

In this study we showed that kindergarten children as well as first graders benefit from this type of software even after a short intervention of five readings. Each age group progressed according to its knowledge and abilities. We assume that e-books that incorporate these features have the capacity to increase children's early literacy at a stage whose importance is not doubted (Snow et al., 1998; Whitehurst & Lonigan, 2001). It is important to note that this study has some limitations, and caution should be exercised when interpreting the findings. Replications with a range of e-books should be carried out to further establish our main findings. More specifically, taking into account the results regarding word reading, this task may not have been challenging enough for the first graders and may have been more appropriate for the kindergarteners. Further research with a more varied level of word reading might serve as a better tool for examining the different age group levels and their progress following the intervention. In addition, some confounding of variables is possible in our research, especially for story comprehension as well as production skills which were not tested prior to the intervention. A future study that will test these abilities beforehand might lead to more precise results regarding the gain in skills following the e-book activation. It is also important to note that the results of this study are limited to children from a middle SES. Since young children from a low SES lag behind children from a middle SES in terms of language and early literacy achievements (Whitehurst & Lonigan, 2001), it would be very important in future studies to learn if and how this new e-book technology supports kindergarten children and first graders from this socioeconomic group. Another limitation that should be mentioned is that the intervention group in this study received reading the e-book and the regular program of the kindergarten or school. It could therefore be argued that it is not clear whether their progress can be attributed exclusively to the e-book. However, since the children used the software independently, this provides evidence of an effective form of supplementary computer-assisted instruction. Future studies should take this limitation into account and control this possible influence. Future studies should also consider providing the control group with e-book reading sessions after completing the research, in order to avoid the ethical problem of depriving this group.

It should also be noted that the young children we researched were able to use the software with very little assistance. We do not suggest that early literacy will be promoted by technology alone, and adult support and mediation of language and literacy seems crucial to us. Nonetheless, we believe that well-designed technology tools carefully chosen by parents and teachers can provide children with an additional efficient and enjoyable learning experience.

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