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The educational electronic book as a tool for supporting children's emergent literacy in low versus middle SES groups

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Abstract

The effects of an educational electronic book (e-book) on 149 five- to six-year-old kindergarteners' emergent literacy levels were researched in two SES groups: low (LSES) (79 children) vs. middle (MSES) (70 children). In each SES group, children were randomly assigned to four groups. Three groups were assigned to work individually in one of three e-book activity modes: "Read story only", "Read with dictionary", or "Read and play" during three similar activity sessions and the fourth group served as a control which received the regular program of the kindergarten. Pre- and post-intervention emergent literacy measures included word meaning, word recognition, and phonological awareness. Results show that word meaning of children from both middle and low SES improved following the educational e-book activity, regardless of mode. Second, LSES children's emergent literacy levels showed relatively greater improvement rates than did those of the MSES children. Third, children in the "Read with dictionary" and "Read and play" activity modes showed more improvement in their emergent literacy levels than did those in the "Read story only" mode. Implications for future research and for education are discussed.
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1. Introduction

Young children today have access to numerous types of software developed by commercial or educational designers in their homes and schools. One type of software is the electronic storybook. Educators and researchers alike view the lively and attractive multimedia effects of such CD-ROM storybooks as having great potential for supporting young children's literacy and language development. Yet, the extant body of research on the efficiency of the e-book as a support for literacy development is neither consistent nor satisfactory. Taking into consideration the reported disadvantages of available CD-ROM storybooks, yet being aware of the great potential of such software, we developed an educational e-book specifically to support young children's emergent literacy development.

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The evidence that young children's literacy knowledge starts early in the preschool years and that the gap between low and middle SES children's emergent literacy is evident even at this early age makes this a focal issue for educators and researchers. Our purpose in the current study was to examine whether the computerized educational book we developed can serve as a supporting tool in developing kindergarteners' emergent literacy. In addition, we were interested in whether the degree of improvement in children's emergent literacy levels, following the use of this e-book, was related to their families' socioeconomic status – low vs. middle SES.

1.1. Literature review

Reading to young children is regarded as one of the more promising ways to foster their language (Bus, van Ijzendoorn, & Pellegrini, 1995; Whitehurst & Lonigan, 2001; Van Kleeck, 2003) and emergent literacy development (Haden, Reese, & Fivush, 1996; Leseman & de Jong, 1998; Reese, 1995). The high availability of electronic books in the market today poses a novel situation in which kindergarteners no longer need either for adults to "read" to them or to listen to storybooks because they can do so independently via the use of an electronic book. This development holds great promise and makes it imperative to determine how much the use of this new type of software affects young children's language and emergent literacy levels.

This digitized form of a book usually includes multimedia effects, such as written text, oral reading, oral discourse, music, sound effects, and animations. The oral reading of the text by the narrator, accompanied by the highlighted text, can provide the users 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 out to them. Sometimes e-books include optional hidden hotspots, which can be activated by the user and which elaborate on the illustrations or the text. For example, when the user clicks on a character or on an object, which appears on the screen, this figure starts to talk. Such activity has the potential to expand the children's knowledge of the story's events by adding information that does not appear in the original story text. In some e-books, 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. Sometimes clicking on a glowing word of the text might give the children an explanation of the word, one that may be less frequently heard and less well known to the young child.

As mentioned above, educators and researchers believe that these lively and attractive features of e-books might present a useful means for supporting young children's literacy and language development (de Jong & Bus, 2003; Labbo & Kuhn, 2000; Lefever-Davis & Pearman, 2005). This assumption is based on the premise that the e-book type of software provides a more authentic reading experience rather than the more traditional drill or exercise method of fostering literacy (Labbo & Reinking, 1999). It is also believed that the exposure to this type of software can be similar to that provided by adult mediation (Dixon-Krauss, 1996; Zellermier & Kuzulin, 2004) when adults engage in joint book reading with children using hardcover books.

Research on the efficiency and value of the e-book for literacy development has shown promising results in several domains. For example, word recognition skills of school beginners (Miller, Blackstock, & Miller, 1994) and of kindergarteners (de Jong & Bus, 2002; Lewin, 2000) were improved following activity with e-books. E-books were also found to contribute to the enhancement of children's phonological awareness (Chera & Wood, 2003; Wise et al., 1989). For example, Chera and Wood found that kindergarteners aged 3–6 who were exposed to e-books during a four-week program were more advanced in their phonological awareness than the children in the control group. In addition, it was found that children's verbal knowledge was extended after using electronic storybooks (Lewin, 2000; Segers & Verhoven, 2002). Furthermore, good quality CD-ROM storybooks, which include hotspots that are congruent with and integrated into the content of the story, fostered children's understanding of the story line (Labbo & Kuhn, 2000) and their story recall ability (Underwood & Underwood, 1998). Equally important was the finding that in Head Start kindergartens which used e-books in their curriculum, children showed significant improvement in their emergent literacy levels (Talley, 1994).

However, in two recent content analysis studies of e-books for young children, one in Holland with Dutch e-storybooks (de Jong & Bus, 2003) and the second in Israel with Hebrew e-books (Korat & Shamir, 2004), the authors reported that most e-books available for children aged 3–8 are not very satisfactory as tools for supporting literacy. In our 2004 study, the 43 Hebrew e-books we examined had limited multimedia features for

supporting children's literacy development. For example, only 4.3% had the dictionary option, only 28% allowed the children to follow the text while it was being read aloud by the narrator. In addition, 28% included distracting games in the reading mode and used hotspots, which were incongruent with the story content. de Jong and Bus reported similar findings regarding the 55 Dutch e-books they analyzed.

As researchers who focus on young children's literacy development and who adopt the idea of multiple literacies using traditional and the new technologies (Kellener, 1998), we concluded that more needs to be done in creating appropriate e-books for young children. We believe that educational e-books need to take advantage of the attractive features of such electronic and interactive media and, at the same time, should serve as a support for children's story understanding and their exploration of the written text. For this reason, we designed an educational e-book in keeping with these ideals. We included three different modes in the CD storybook that children could activate separately: "Read story only", "Read story with dictionary", and "Read story and play". The "Read story only" mode contains an oral reading of the printed text by the actor together with automatic dynamic visuals that dramatize story scenes as well as extra music and film effects. The "Read story with dictionary" mode provides the same oral reading of the text but also includes explanations for difficult words that appear automatically after the narrator has completed reading the whole page. The "Read story and play" mode was aimed at enhancing children's story understanding and their phonological awareness by inviting the children to activate hotspots appearing on the screen. As with the dictionary option, the hotspots could be activated only after the children completed reading/listening to the text on each page. All three modes were developed to foster children's emergent literacy growth using principles of amusement as well as educational goals, focusing especially on word meaning, phonological awareness, and text tracking.

Today, it is widely acknowledged that young children cognitively process the written language long before school age and that these developing abilities are embedded in the socio-cultural context (Whitehurst & Lonigan, 2001). Many researchers have found that kindergarteners' phonemic awareness (Lonigan, Burgess, Anthony, & Baker, 1998), letter name knowledge (Levin, Patel, Margalit, & Barad, 2002; Share & Gur, 1999), and word recognition (Korat, Bahar, & Snapir, 2003; Ferreiro and Teberosky, 1982) are important skills in their early literacy development as well as good predictors of children's reading and writing in elementary school (Shatil, Share, & Levin, 2001). Other studies indicate that children's emergent literacy level in kindergarten and in first grade is an important predictor of reading success in school (Scarborough, 2001; Whitehurst, 1999). For these reasons, our educational e-book was aimed at fostering children's emergent literacy by focusing on letter names, phonological awareness, emergent word reading, and knowledge of vocabulary.

The children who participated in this study came from two different socio-economic communities: low SES and middle SES. Over the last few decades, a rich body of research in different countries reports on clear differences between low and middle SES children's literacy achievements (Burgess, Hecht, & Lonigan, 2002; Korat, Bachar, & Snapir, 2003; Shatil et al., 2001). A recent report on children's literacy levels in Israel and other countries generated great concern among educators about such SES differences (Kramavsky & Mevarech, 2003). We also have rich evidence that this gap emerges at the kindergarten age and is grounded in the poorer home literacy environment among low SES families, especially regarding the availability of literacy tools (e.g., books, educational games) and literacy activities (e.g., frequency of parental book reading to the child), as well as the lower levels of parental mediation (Aram & Levin, 2002; Heath, 1983; Korat and Levin, 2002; Wells, 1985). According to recent research in Israel (Korat, Klien, & Segal-Drori, submitted for publication), low SES children have fewer children's books at home and make fewer trips to the library with their parents. Yet, almost all homes which were visited for the study (95% of the 94 homes) had computers and had at least five software items for children. Significant differences were found between maternal levels of mediation while reading books to their children; low SES mothers supported their children's development at a lower level than did middle SES mothers. Whereas maternal mediation contributed 9% to the variation in middle SES children's emergent literacy, it contributed nothing to the low SES children's emergent literacy levels. Thus, according to the results of our study, low SES children not only are read to less often and have fewer books at home but, in addition, when read to by their mothers, they do not receive efficient maternal mediation during this joint activity to support their literacy development.

1.2. The present study

In the research reported on here, we examine another way of reading to young children – the CD-ROM storybook, and investigate the extent to which the educational e-book can support children's emergent literacy in two different SES groups. It should be noted that we do not view the emergence of the e-book in the young child's world as diminishing the importance of adults reading to children, an activity which we, as early childhood researchers and educators, see as a paramount cognitive and emotional event. Nevertheless, we believe it is warranted to examine how and whether such software, whose operation usually arouses motivation and curiosity and which can be operated by the children themselves independently, can provide additional literacy support to young children. Therefore, going beyond its potential for being amusing and enjoyable, the question that needs to be asked is whether book reading software, if developed specifically for use by young children, can contribute to their emergent literacy development.

To summarize, in this study we examined the impact of an educational e-book developed by the authors on the emergent literacy knowledge of low and middle SES kindergarteners. We posed the following questions: (1) Will there be a significant improvement in the children's emergent literacy scores from pre- to post-test across SES groups after using the educational e-book? If yes, in which emergent literacy skills will the improvement appear? (2) Will there be any difference in the degree of improvement in the children's levels of emergent literacy as a function of their SES group? If yes, in which emergent literacy skills will this progress appear? and (3) Will there be any difference in the degree of improvement in the children's emergent literacy levels as a function of the mode of their e-book activity? If yes, in which emergent literacy skills will this progress appear?

Regarding the first question, we hypothesized that the whole sample will show progress in their emergent literacy levels since the software was aimed at their proximal developmental zone (Vygotsky, 1978). Second, we hypothesized that low SES children, who usually are less advanced compared to their middle SES peers, will benefit more from this software because of the relatively fewer literacy activities and materials available to them in their homes. Third, we hypothesized that the "Read story only" mode will be less effective than the "Read story and play" and the "Read story with dictionary" modes.

2. Method

2.1. Participants

The sample consisted of 149 children from eight kindergartens; four kindergartens were from low SES (LSES) communities ($n = 79$) and four from middle SES (MSES) communities ($n = 70$). The number of children from each of the four kindergartens in the LSES group was between 17 and 22; in the MSES group it was between 16 and 20. The mean age of the children in the sample (in months) was 70.08 (SD $= 4.54$) for the LSES children and 71.10 (SD $= 5.20$) for the MSES children. All kindergartens are located in various neighborhoods in Tel-Aviv. The SES measure in this study reflects the degree of affluence (or poverty) at the neighborhood level. The SES levels of the neighborhoods were established according to The Israeli Municipalities' (1995) statistical report, which includes such data as number of school years completed, income level, housing density, PC ownership, etc. These criteria are used by the Ministry of Education to define schools and kindergartens serving children at risk. According to the information in this report on the neighborhoods included in this study, the number of school years completed for the LSES group was $M = 10.6$ vs. MSES $M = 16.7$; the percentage of workers in prestigious occupations in the LSES group was $M = 3.8$ vs. MSES $M = 35.6$; the average income per capita in the LSES group was $M = 1,497$ Israel Shekels vs. MSES $M = 3,138$; the percentage of P.C.-owning households in the LSES group was $M = 14.0$ vs. MSES $M = 63.0$, and the housing density (average number of persons per room) in the LSES group was $M = 0.92$ vs. MSES $M = 1.19$. It is important to note that neighborhoods in Israel, including the areas investigated in the current study, are usually homogenous. Thus, in only a very few cases would a child with a LSES background live in a MSES neighborhood and attend a MSES school, and vice versa. All the children who participated in the study were Hebrew speakers and had not been diagnosed with learning disabilities.

Since the research was conducted in Israeli kindergartens, a brief description of the local literacy program and environment, which applies to all the kindergartens visited, is relevant. Israeli kindergarteners are usually about 5–6 years old. Formal instruction in reading and writing begins on entry to elementary school, when children are typically 6–7 years old. In kindergarten, children are frequently read to from storybooks and voluntarily browse through books. Most kindergarten classes have one or two computers and children are used to working with different types of software, including e-books, as was also the case in the six kindergartens we visited for our study. Children in this age group in Israel usually recognize their written names and write them on their artwork. Displayed around the room in the kindergarten are magnetic or other similar types of Hebrew letters, printed texts for functional use (e.g., a list of the names of children who are on duty), as well as other texts. Children participate in games aimed at promoting phonemic awareness, such as segmenting words into syllables, counting syllables, and rhyming. Invented spelling and grapho-phonemic awareness are encouraged in some kindergartens, but not in all. Little time is devoted to the recitation of the alphabet or to letter naming. Work sheets for training visual discrimination (including letter discrimination) and letter copying are also available (Shatil et al., 2001).

E-books typically tend to include several formats or modes. To check for the effectiveness of the different modes in the software we developed, children in each kindergarten were randomly assigned to four different groups. The first group was assigned to work on the "Read story only" mode, the second on the "Read story and play" mode, the third on the "Read story with dictionary" mode, and the fourth was a control group which did not work with the e-book software at all and received only the regular program of the kindergarten. In the LSES group, 20 children were assigned equally to each of the three e-book modes and 19 to the control group. In the MSES group, 16 were assigned to the "Read story only" mode, 19 to the "Read story and play" mode, 20 to the "Read story with dictionary" mode, and 15 to the control group. Within each SES group, close to equal numbers of boys and girls were represented in each of the three e-book modes. All children who participated in the study had had initial experiences with computers individually and in small groups as part of the curriculum.

2.2. The electronic book

The 25-page book on which we chose to base our e-book, *The Tractor in the Sand Box* (in Hebrew *Hatractor Beargaz Hachol*), was written by a well-known author, Meir Shalev. Each page of the chosen book has a big colored drawing, which covers more than half of the page, and 3–5 written sentences (of about 40 words). It includes illustrations and written text which is printed in pointed letters (in Hebrew "*nekudot*"), so that children can also relate to the text.

The book relates the story of an old farmer (Uncle Aharon) and his special relationship with an old tractor. It takes its users on Uncle Aharon's adventures and exposes them to the touching relationship between the old man and his tractor. Taking into account the readers' ages in our study, we chose this book because of its story's structure and simple narrative elements: setting, characters, goal/initiating event, problem, and solution/ending (Mandler & Johnson, 1977). In addition, we established that its written register – lexicon (word frequency), syntax, and grammatical complexity – is appropriate for kindergarteners. We also chose it because of its potential to arouse young children's reading motivation and curiosity, as the story problem, presented via the characters and their actions, seemed to us to be germane to young children's experiences. In developing the educational e-book, we integrated features that use the potential of electronic and e-interactive media to motivate and amuse children, on the one hand, as well as features we believed would support children's emergent literacy and language, on the other. A pilot study conducted with 10 LSES children who were read to by their teacher using the hardcover edition of the same story indicated that most of them (8 children out of 10) were well able to understand the story's plot.

2.2.1. Main functions of the e-book

The introductory screen of the e-book looks just like the cover of the hardcopy, with the title and the author's name appearing as they would in print. The different options for the activation of the story are explained by an animated figure, that of Uncle Aharon. The software offered four modes or options: "Read story only", "Read story with dictionary", "Read story and play", and "Printing". It is important

to note, as mentioned earlier, that all activities offered in the ''Read story and play'' mode were presented only after the children had completed reading the text on each page. The 25 pages of the e-book were scanned from the printed book to keep the text in it as close as possible to that of the original hardcopy book.

Each e-book mode contains an oral reading of the printed text by an actor who reads the story. Also included were automatic dynamic visuals that dramatize story details, fragments, and the complete story scene as well as extra music and film effects to transform the e-book into a living book. For example, when uncle Aharon invites the children to join him on a trip to the fields on the tractor's wagon, the users see the enthusiastic scene and hear the joyful voices of children climbing onto the tractor. The music creates an atmosphere of joy while the vivid objects and characters appearing on the colorful screen help the users to be cognitively involved in the events. To stimulate the children's reading orientation and involvement in reading, the e-book includes 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, thereby allowing the children to return to previous screens or to continue onto the next one (*note*: in Hebrew, the direction of reading is from right to left). The children can also use a function that allows them to re-read/re-listen to the text by clicking on an arrow that repeats the text. The children's attention is focused on the relationship between text and oral reading by the highlighting of written phrases as the text is uttered by the actor, a function that supports exposure to written text and might support word recognition (de Jong & Bus, 2002). In addition, an overview screen is available to show all optional screens in reduced format and each screen is numbered. This enables the users to choose the screen they would like to re-read/re-listen to. These functions may contribute significantly to a pro-book orientation, as well as to their concepts of print and emergent reading knowledge, all of which have been reported as important for children during early literacy development (Clay, 1989; Levin, Share, & Shatil, 1996; Shatil et al., 2001; Tunmer, Nesdale, & Wright, 1987).

2.2.2. Description of the main modes

The ''Read story only'' mode contains an oral reading of the printed text by the actor together with automatic dynamic visuals that dramatize story scenes as well as extra music and film effects. The ''Read story with dictionary'' mode provides an oral reading of the text as well as explanations for difficult words that appear automatically after the narrator has completed reading the whole page. Each difficult word appears written on a big cloud, is pronounced clearly by the narrator, and is associated with pictures that support its meaning (see Fig. 1). At first, the words appear automatically on the screen; later, the children can reactivate this function by clicking on the words as often and for as long as they choose.

Although the dictionary option, that is, the activity of explaining the meanings of words, is an important vehicle for supporting vocabulary richness and story understanding, this function was found to be lacking in most of the available commercial Israeli and Dutch e-books evaluated by Korat and Shamir (2004) and de Jong and Bus (2002), as reported above. The 12 words included in this e-book's dictionary option were chosen based on their difficulty level for kindergarteners, following the recommendations of three judges: two kindergarten teachers and one expert in children's literature. The decision to present the dictionary words automatically the first time around was intended to ensure that the children would be exposed to them since, based on the results of our pilot study, we found that the LSES children's knowledge of these words was limited. Since we had 25 pages, we decided to present only about half (12) of the words identified as difficult so that we would not over-load the children's reading with too much new information.

The ''Read story and play'' mode was aimed at enhancing children's story understanding and their phonological awareness. It includes interactive functions that allow the children to activate the story by clicking on hidden hotspots (represented by a colored kite) as they appear on (a) characters or objects and (b) on words that appear in the text. However, as noted earlier, to prevent the children from being distracted from listening to or reading the story, this function was programmed so that hotspots could be activated only after reading/listening to the text on each page. All activation of characters or objects in this CD-ROM story-book was aimed to enrich story comprehension, mainly by including discourse between the main characters and by including voices and sounds effects. For instance, following the scene showing the different activities that Uncle Aharon and the tractor do together, when the narrator reads the text on page 3 and says: ''Uncle Aharon and the tractor worked together'', the children can click on a hotspot

הַדּוֹד אַהֲרוֹן הָיָה הַטְּרַקְטוֹרִיסְט שֶׁל הַכְּפָר.
הוּא עָשָׂה לַטְּרַקְטוֹר אֶת כָּל הַתִּיקוּנִים וְהַטִּיפּוּלִים:
כִּוֵּן לוֹ אֶת הַמָּנוֹעַ, הֶחֱלִיף לוֹ אֶת הַשְּׁמָנִים, חִזֵּק לוֹ אֶת
הַבְּרָגִים וְגֵרֵז לוֹ אֶת הַצִּירִים.

גֵּרֵז

Fig. 1. Example for "Read story with dictionary".

of the figure of Uncle Aharon. This results in an expansion of the text via the following comment by Uncle Aharon: "The tractor and I are not just ordinary friends, we are friends in body and soul". Hotspots of words were also designed to promote children's phonological awareness of syllables and sub-syllabic levels. For example, a big flower appears with the word divided into its syllables and sub-syllables (see Fig. 2) and the actor reads these aloud.

Ten words from the book's text were chosen for this syllabic activity. They are all common Hebrew words constructed of two syllables. For example, g*adol* ("big") is divided into two syllables: *ga-dol*.

2.3. Measuring children's emergent literacy level

Children's emergent literacy level was assessed using several measures before and after the activity with the e-book.

2.3.1. Word meaning

Children were asked for the meanings of the 12 words which appeared in the Dictionary mode in the electronic book. These words were judged to be relatively difficult for children of this age by two kindergarten teachers and one expert in children's literature and were the most difficult words in the book. Each word was orally presented to the children and three optional meanings were suggested. The children were asked to choose the best meaning. For example, the children were asked: "What is the meaning of the word 'container' (in Hebrew *meihal*)? (A) Is it a big truck? (B) Is it a big bottle? or (C) Is it a mail box?" The children were given two examples in which the researchers provided the answer before they were tested. The total score for this task ranged from 0 to 12. The alpha score for this measure was .63.

Fig. 2. Example for syllables and sub-syllabic hot-spots.

2.3.2. Word recognition of words from the e-book

The children were asked to read nine words, each of which appears with high frequency (4–7 times) in the e-book. For each word, scores ranged from 0 to 2 (from high to low), as follows: 2 = correct reading of the word, 1 = partial reading, saying one correct sound of the word, 0 = reading another word or saying "I don't know". Thus, the total range of scores for this task is 0–18. Across two raters, the inter-rater reliability for this measure, using Cohen's kappa, was .80. The alpha score for this task was .92.

2.3.3. Phonological awareness

Phonological awareness was measured using 12 two-syllable words. Six of the words appeared in the target CD-ROM storybook and the other six words were frequently used Hebrew words. The words were orally presented to the children one at a time and the children were asked to repeat it in a sub-syllabic way, breaking it into three parts (e.g., the word *gadol* [big] should be divided into *ga-do-l*). The sub-syllabic level is a conjunction of a phoneme (consonant) and a vowel, which, according to Hebrew grammar, is sometimes considered a syllable, and sometime as less than one syllable. This unit is between a syllable and phoneme; it is smaller than a syllable but bigger than a phoneme. We decided to ask the children to segment words only into sub-syllables (and not also into its phonemic component) since this super-phonemic level – the sub-syllable (e.g., *gadol* to *ga-do-l*) – is more accessible for segmentation in Hebrew than are the phonemes (e.g., *g-a-d-o-l*) (see Share & Blum, 2005). Before testing, children were allowed to practice the task with two examples presented by the researchers. Each correctly repeated word received a score of 1; incorrect answers were scored 0. Thus, the total range of scores for the 12 words was 0–12. Across two raters, the inter-rater reliability for this measure, using Cohen's kappa, was .88. It should be noted that although the phonological activity in our e-book software enabled children to work on syllabic and sub-syllabic segmentations, we did not measure children's syllabic skills in this study since Hebrew-speaking children at the age group we focused on in this research (5–6 years) usually gain high scores on this task.

2.4. Procedure

2.4.1. The pre-intervention stage

The children's emergent literacy level was assessed prior to the e-book activity. Since the participants are young, we conducted the tests in two sessions, no more than five days apart. In the first session, the children were tested with the "word meaning" and "word recognition" measures; in the second session, the children were tested with the "phonological awareness" measures. The order of the tests in the sessions was the same for all children. In addition, no more than three weeks elapsed between the assessment of the first and the last child in the sample.

2.4.2. The activity with the e-book

Children worked individually in three e-book activity sessions and experienced one e-book mode only ("Read story only", "Read story with dictionary", and "Read and play") to which they were assigned randomly by the researchers. The children worked for about 30 (range 20–35) minutes in each session. We decided upon only three sessions based on a pilot study using the same e-book which showed that children's (aged 5–6) motivation to work in the same mode decreased significantly after they had done so three times. No more than five days elapsed between one session and the next. After the participants were shown how the software operates they were given the following general instructions: "We've brought you a new e-book and you're invited to work with it. After you finish working with the computer, we'll ask you some questions about the story. That's why we not only want you to look carefully at the pictures, but at the text as well. You are invited to work on the _____mode (the name of the mode to which the child was assigned). Please work on this mode only". If children changed their mode while working on the computer, the experimenter asked the children to return to work on their assigned mode. This happened in several cases, mainly in the first session.

2.4.3. The post-intervention stage

Following the three-session e-book reading activity, the children's emergent literacy levels were assessed using the same emergent literacy tasks administered in the pre-intervention phase. The order of the sessions was the same as in the pre-test phase. The post-tests in both groups were administered 1–4 days after the intervention, and no more than 3 weeks elapsed between the assessment of the first and the last children in the group.

3. Results

Our study was designed to address three research questions. The first question addressed the benefits of the educational e-book activity for the emergent literacy levels of the children in the entire sample (across SES). The second question addressed differences in the children's emergent literacy improvement rates as a function of their SES status. The third question addressed differences in children's emergent literacy improvement rates as a function of the three types of e-book activity modes.

Our first hypothesis assumed that children across both SES groups would show progress after working on the educational e-book. A MANOVA of 2 Times (pre vs. post) × 4 Groups (Read story only, Read story and play, Read story with dictionary, and Control) with repeated measures of children' scores on the emergent literacy measures was performed. The means and standard deviations of the children's scores appear in Table 1.

The results indicated a main effect for Time (pre- to post-activity) for children's scores on all three emergent literacy measures across both SES groups ($F[3,143] = 29.07$, partial eta square = .38, $p < .001$), and a significant interaction between Time and Group ($F[9,348] = 5.02$, partial eta square = .09, $p < .001$). Significant improvement from pre- to post-test was found in children's scores on all three measures of emergent literacy: word meaning ($F[1,134] = 44.64$, partial eta square = .23, $p < .001$), word reading ($F[1,131] = 40.93$, partial eta square = .22, $p < .001$), and sub-syllabic segmentation ($F[1,161] = 29.34$, partial eta square = .16, $p < .001$).

The interaction between Time × Group appeared for word meaning ($F[3,121] = 13.44$, partial eta square = .21, $p < .001$) and for word recognition ($F[3,121] = 3.28$, partial eta square = .06, $p < .001$). In order

Table 1
Children's emergent literacy scores (means and standard deviations) on the pre-test and post-test by group and mode

Measure	Group							
	Read the story		Read and play		Read with dictionary		Control	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Word meaning	3.75 (2.04)	3.97 (2.18)	3.76 (1.80)	4.90 (2.20)	3.65 (1.90)	7.10 (3.60)	3.60 (2.03)	4.20 (3.16)
Word recognition	5.00 (11.80)	5.86 (5.25)	4.90 (4.55)	5.48 (5.15)	5.57 (5.28)	7.47 (5.50)	7.05 (4.61)	8.38 (4.90)
Sub-syllabic awareness	9.22 (3.92)	10.33 (3.16)	7.53 (4.48)	9.15 (3.94)	6.63 (4.25)	8.95 (3.80)	7.23 (4.17)	8.08 (4.50)

to locate the source of this interaction, a repeated-measures ANOVA was performed for each of the four groups separately. Results indicated that word meaning improved for children in the "Read story and play" group ($F[1, 1] = 11.76$, partial eta square = .23, $p < .001$) and for those in the "Read story and dictionary" group ($F[1, 39] = 56.63$, partial eta square = .59, $p < .001$), but not for those in the "Read story only" and the control groups. Furthermore, word recognition significantly improved for children in three of the four groups: the "Read story only" mode ($F[1, 35] = 8.00$, partial eta square = .18, $p < .01$), the "Read story with dictionary" mode ($F[1, 39]=26.80$, partial eta square = .41, $p < .001$) and the control group ($F[1, 33] = 6.65$,
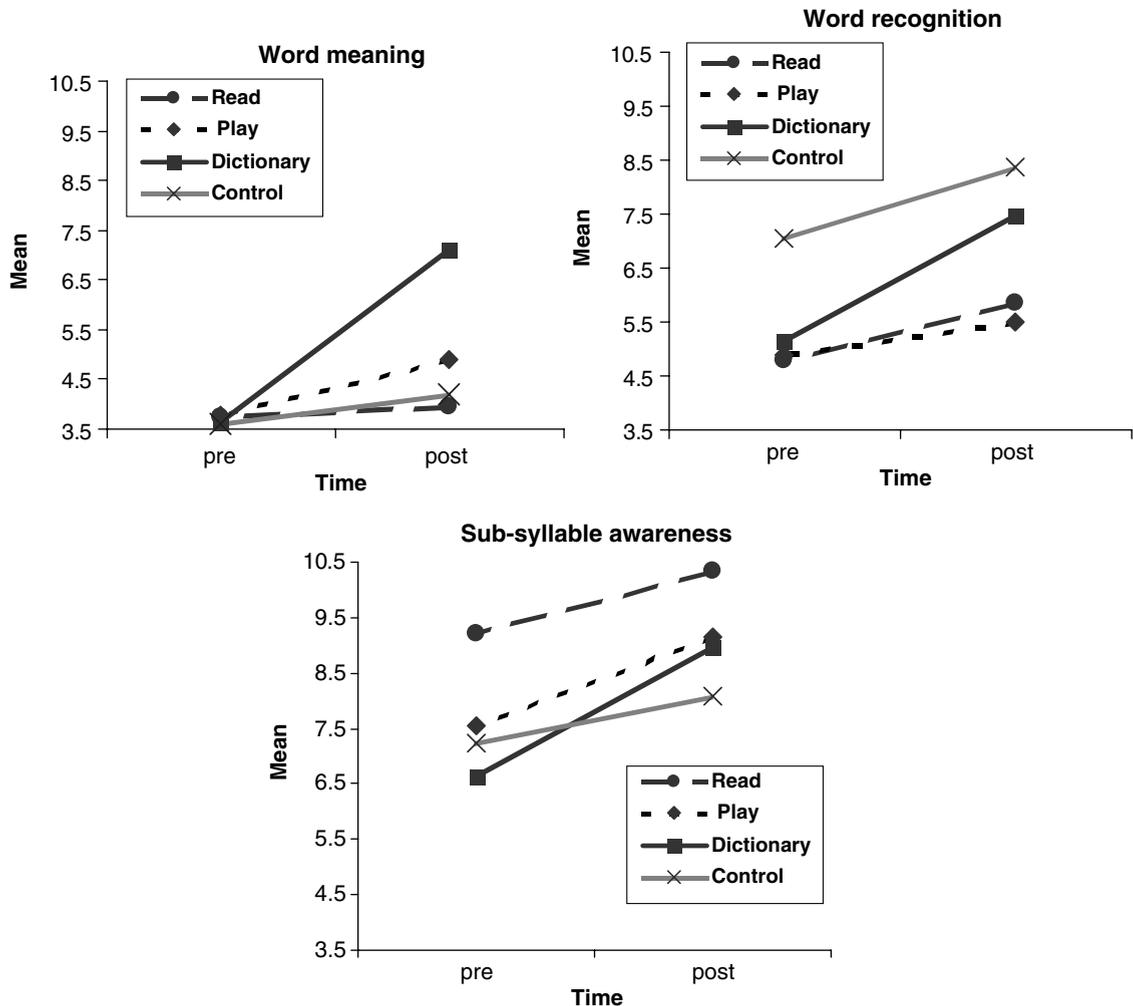

Fig. 3. Pre- and post-emergent literacy levels in the four groups.

partial eta square $= .16$, $p < .01$); they did not improve for children in the "Read story and play" group. Fig. 3 presents the results of the pre- and post-tests of the children's emergent literacy levels pertaining to the four groups.

Our second and third questions addressed the extent of improvement in children's emergent literacy levels as a function of their SES and the activity mode groups. A two-way ANOVA of two SES (LSES vs. MSES) $\times 4$ Groups (Read story only, Read story and play, Read story and dictionary, and Control) was performed. The means and standard deviations of the improvement in children's emergent literacy scores in the two SES groups and in each of the four groups appear in Table 2.

A significant difference was found between LSES children's ($M = 2.08$, SD $= 3.47$) and MSES children's ($M = .87$, SD $= 3.06$) emergent literacy improvement scores ($F(3, 139) = 2.85$, partial eta square $= .10$, $p < .001$). A test of between-subjects effects showed significant differences in children's emergent literacy improvement scores between the two SES groups in word reading ($F(1, 141) = 4.70$, partial eta square $= .03$, $p < .03$) and in sub-syllabic awareness ($F(1, 141) = 5.08$, partial eta square $= .03$, $p < .02$).

Significant differences in children's emergent literacy improvement scores were also found as a function of treatment group ($F(9, 139) = 5.20$, partial eta square $= .24$, $p < .001$). An ANOVA for each of the four groups separately showed that these differences in improvement scores appeared in word meaning ($F(3, 141) = 13.86$,

Table 2
Children's emergent literacy improvement scores (means and standard deviations) by group and SES

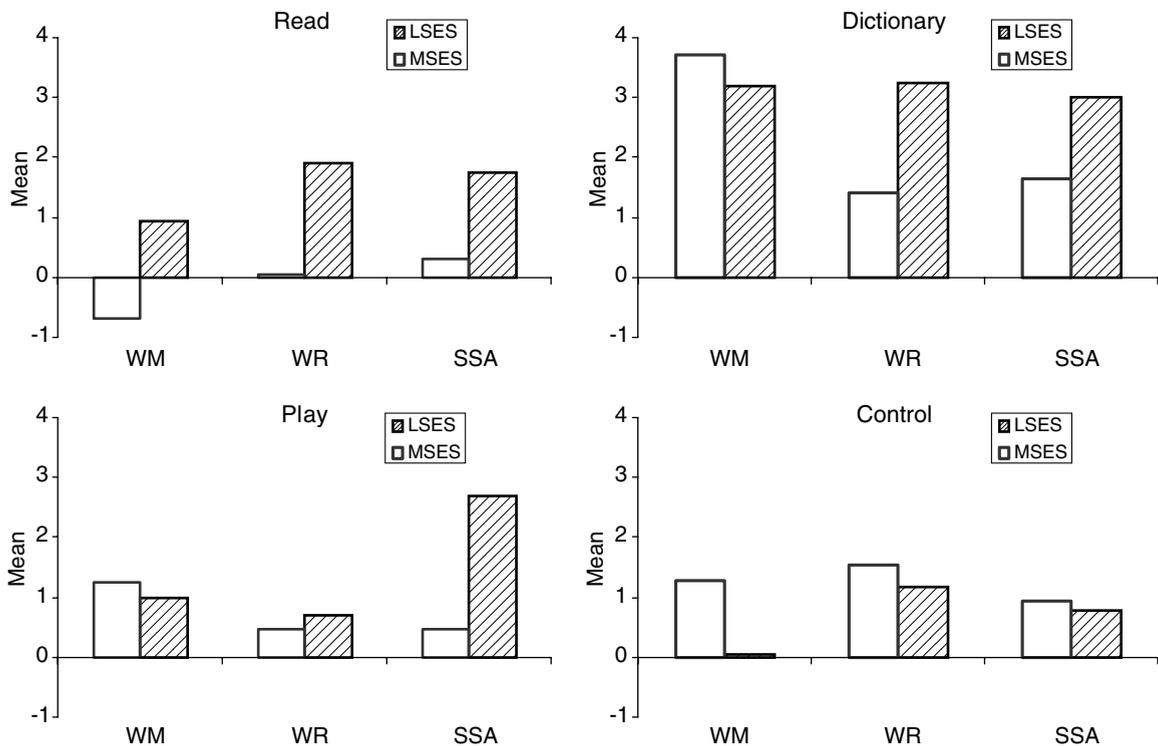|	LSES group				HSES group			
	Read only	Read and play	Dictionary	Control	Read	Read and play	Dictionary	Control
Word meaning	.95 (2.11)	1.00 (1.94)	3.20 (3.17)	.00 (2.00)	−.68 (2.52)	1.26 (2.20)	3.70 (2.65)	1.26 (2.40)
Word recognition	1.90 (2.42)	.70 (2.05)	3.25 (3.19)	1.15 (2.03)	.00 (1.70)	.47 (1.74)	3.19 (.20)	1.53 (3.96)
Sub-syllabic awareness	1.75 (4.12)	2.70 (3.52)	3.00 (3.58)	.78 (2.12)	.31 (3.71)	.47 (1.50)	1.65 (3.63)	.93 (3.03)

Fig. 4. Improvement level on the emergent literacy test by SES and Mode.

partial eta square = .22, $p < .001$) and in word recognition ($F(3, 141) = 3.55$, partial eta square = .07, $p < .01$). A post-hoc Scheffé test analyzing the source of the differences among the four groups showed that improvement in word meaning scores was higher significantly for children in the "Read story with dictionary" mode group than in the other three groups (Read story only, Read story and play, and Control) ($p < .001$), while improvement in word recognition scores was significantly higher for children in the "Read story with dictionary" mode than in the "Read story and play" mode ($p < .001$). Fig. 4 presents the level of improvement on the emergent literacy tests in the LSES group compared to the MSES group for each mode separately.

4. Discussion

Three important results emerged from our research. First, children from both middle and low SES communities showed improvement in their word meaning skills following the activity with the educational e-book. Second, as expected, LSES children's emergent literacy levels showed relatively greater improvement rates than did those of the MSES children, specifically as related to word recognition and sub-syllabic segmentation skills. Third, "Read story with dictionary" and "Read story and play" were the most efficient modes in the software used in this research. Children in the "Read story with dictionary" mode group showed the greatest improvement in their word meaning compared with all other groups; children in the "Read story with dictionary" and "Read story and play" mode groups showed the greatest improvement in their word recognition skills compared with the other two groups. Children in the "Read story only" mode group (which had no special activities) showed no improvement in their emergent literacy skills as measured in this study.

Our results indicate that children from very different demographic backgrounds – affluent vs. poorer SES families (e.g., in terms of number of P.C.-owning homes, parents' education, occupation, and income levels) can make significant progress in their emergent literacy levels after a limited time of activity with specifically developed e-books or educational software.

The extant literature has reported on the possible disadvantages of the available CD-ROM storybooks in the market and their potential for distracting children's attention from reading the story. However, the results of this study show that an e-book, designed carefully by educational professionals, can have a positive impact on children's development in such diverse and important literacy abilities as word meaning, word recognition, and phonological awareness (sub-syllabic). Our findings support those of some previous studies which reported on improvement in children's literacy skills following use of CD-ROM storybooks, especially in word recognition (de Jong & Bus, 2002; Lewin, 2000), phonological awareness (Chera & Wood, 2003), and verbal knowledge (Lewin, 2000; Segers & Verhoven, 2002).

Being aware of the reported gap that exists between low and middle SES children even as early as at the kindergarten age (see, for example, Burgess et al., 2002; Korat et al., 2003; Shatil et al., 2001), the finding in the present study that LSES children showed a relatively greater degree of improvement in the assessed skills than the MSES children is very important. We are led to conclude that although children from low income families are disadvantaged in important literacy skills, compared to children from middle and high SES families, they are clearly able to make good progress in developing such skills after being involved in a short but motivating activity, such as using the educational CD-ROM storybook we presented to them. [For similar results concerning a short training period, see Segers and Verhoven (2002).]

Regarding the impact of the three different modes available through our educational e-book, the results show that children using the "Read story with dictionary" mode showed greater improvement in word meaning compared to children using the other two modes – "Read story only" and "Read story and play". Children in the "Read story with dictionary" and "Read story and play" modes showed greater improvement in word recognition compared to children using the "Read story only" mode and to those in the control group.

These results are not surprising given that the word meaning skill was specifically targeted in the "Read story with dictionary" mode and given that the children in this mode were exposed to word meanings at least three times via automatic activation, perhaps even more often if the children chose to engage in further activation on their own initiative. This finding indicates that young children can easily get the meaning of non-frequently used words not previously known to them if provided with the dictionary option when using well-designed educational e-books, even if they are exposed to the words only briefly through just three activations while reading the text.

Regarding the word recognition task, it is more difficult to explain why word recognition showed more improvement in the ''Read story with dictionary'' and ''Read story and play'' modes and not in the ''Read story only'' mode. It is important to note that the list of dictionary words was different from the list of frequently used words that were included in the pre- and post-word recognition tests and which the children were asked to recognize before and after the activity with the book. A cautious suggestion could be made that the activation of the dictionary in the ''Read story with dictionary'' mode which focused on word meaning and of the hotspots in the ''Read story and play'' mode (which were not available in the ''Read story only'' mode) had a ripple effect and had an impact on the children's sensitivity to the full range of written words in the e-book's text. This, in turn, enabled the children to also more readily recognize the frequently used words in the text and in the post-test. Further studies are needed to examine the validity of this suggestion.

In addition, we are aware that a different type of study and analysis is needed in order to understand the mechanisms underlying the process of the children's activation of this type of educational e-book. Further research should be conducted which would be geared to replicating the present study and providing further validity to our findings. Future studies should be designed to better understand the learning processes that the children are involved in while using this type of educational e-book. For example, how much does the children's self-initiated activation – beyond the automatic word meaning provided by the program – affect their word meaning skills? How often did the children on their own initiative activate the phonological hotspots in the ''Read the story and play'' mode and how did this affect the children's phonological awareness following the activity? Another important issue is to look carefully at whether and for how long the children's progress on their literacy skills lasts after the intervention by re-testing the effects of the book reading exposure after a reasonable period of time. This might also include testing for ''transfer effects'', that is, does the children's progress in the skills tested in the present study transfer to related skills (e.g., emergent writing which did not appear in the educational e-book used in the intervention).

The children's story comprehension, which has been examined in other studies (see, for example, de Jong & Bus, 2004; Doty, Popplewell, & Byers, 2001) is an important measure which should be tested within the context of the e-book experience. This critical measure, as well as the children's motivation to use this type of educational e-book, should be included in future investigations while examining the discussed electronic book.

In conclusion, the results of the current study suggest that the lively and attractive features of the e-book are a possible means for supporting young children's literacy and language development, as we had hoped would be the case (de Jong & Bus, 2003; Labbo & Kuhn, 2000; Lefever-Davis & Pearman, 2005). We believe that in designing software which presents a more authentic reading experience (Labbo & Reinking, 1999) and less practice or drill has good potential as a valuable tool for promoting young children's language and emergent literacy learning. This could be true for children from diverse demographic backgrounds and especially for those from low-income families.

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