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RESEARCH ARTICLE

What Contributes to Word Learning and Story Retelling of Arabic-speaking Children? Investigation of an E-book Reading Intervention

Ofra Korat[a], Nareman Mahamid[a], Safieh Hassunah Arafat[b], and Carmit Altman[a]

[a]School of Education, Bar Ilan University, Ramat –Gan, Israel; [b]Beit Berl College, Arab Academic Institute of Education, Kfar Saba, Israel

ABSTRACT
Learning words in Modern Standard Arabic (MSA) and story retelling was tested using an e-book with dictionary. One hundred and sixty-three Arabic-speaking kindergartners were randomly divided into 5 groups. The experimental groups read the e-book with a dictionary: (1) with a dynamic illustration and a request to vocalize the word; (2) with a dynamic illustration without a request to vocalize the word; (3) with a static illustration and a request to vocalize the word; (4) with a static illustration without a request for vocalization. The control group read the book without a dictionary. Receptive and expressive meaning of the e-book's words and story retelling skills were tested pre- and post-intervention. Children who read the e-book with a dictionary with dynamic presentation of target words and repeated vocalization of the words showed improvement in target words meaning and story retelling. Children with a lower initial level progressed more. Educational implications are discussed.

KEYWORDS
Comprehension; vocabulary; technology; early/emergent literacy

Introduction

Vocabulary knowledge constitutes a major factor in language development and literacy at school (Verhoeven & Perfetti, 2011). Current evidence shows that in diglossic languages such as Modern Standard Arabic (MSA), called alfusha, the vocabulary of kindergartners and first graders is particularly low compared to their knowledge of Spoken Arabic Vernacular (SAV), called al-ammiyya (Saiegh-Haddad & Spolsky, 2014). Diglossia exists in other cultures as well. For example, in the German-speaking parts of Switzerland, "high German" (Hochdeutsch) is used for writing, while Swiss German (Schweizerdeutsch) is used in daily talk.

The two varieties of Arabic are used for socially distinct functions: MSA for reading, writing, and formal speech functions (e.g., religious sermons, news broadcasts) and SAV for everyday conversation at home and even in the classroom (Almusa, 2003). Experts claim that this gap makes the process of acquiring MSA more difficult for children (Saiegh-Haddad & Schiff, 2016), and some refer to it as learning another language (Ibrahim, Eviatar, & Aharon-Peretz, 2005). Difficulty in MSA learning may hinder higher education success, and consequently taking an active part as a future citizen (PISA, 2018).

CONTACT Ofra Korat korato@biu.ac.il School of Education, Bar Ilan University, Ramat –Gan, Israel 529002

Observational studies over the years in kindergartens and elementary classrooms showed that despite research evidence on the importance of vocabulary teaching using a narrative (Manyak, Michelle, & Latka, 2019), or an informational text on health, science and mathematics (Neuman, Newman, & Dwyer, 2011), teachers typically provide limited, quick and spontaneous vocabulary instruction (Carlisle, Kelcey, & Berebitsky, 2013). This may be seen as a missed opportunity, since books are considered as a good source for vocabulary enrichment and text comprehension (Cain, Oakhill, & Lemmon, 2004; Hu & Nation, 2000). Following the importance of vocabulary growth in early childhood, the National Reading Panel in the US (National Institute of Child Health and Human Development [NICHD], 2000) suggested several principles, including direct teaching of words, repetition, embedding words in a meaningful context, providing children with an active role in the learning, and using technological tools for this purpose.

In the current research, we used an e-book in Arabic which we developed based on previous research (Korat & Shamir, 2007, 2012), that incorporates all the Panel's principles. We investigated word learning of Arabic-speaking kindergartners following an activity of reading an e-book which includes a dictionary that supports learning word meanings. We tested which e-book format supports students' acquisition of Modern Standard Arabic (MSA). Beyond teaching the children new target words, our aim was to investigate whether the acquired vocabulary may positively affect children's ability to retell the story content. This is based on the idea that understanding the story vocabulary is an important component of text comprehension (Cain et al., 2004; Lenhart, Lenhard, Vaahtoranta, & Suggate, 2020; Lepola, Kajamies, Laakkonen, & Niemi, 2020), storyline and content (Smeets & Bus, 2014). This investigation compared static versus dynamic illustrations, which are pictorial animated presentations of target word meaning support, as well as use of vocalization versus no vocalization of the target words.

Theoretical background

E-books as support for word learning and story retelling

This section will ground the "Dual Coding" and the "Cognitive Load" theories and the model for "Working Memory" through the literature as a theoretical basis for this study. In our technological era, young children are exposed to learning language and literacy in diverse ways, including use of e-books. Many e-books for children are digital versions of classic printed books, and may include static or dynamic pictures and animations, background music, sounds, written text, oral narration, hotspots for activation and more. Reading well-designed e-books (without distraction from irrelevant hotspots or games) (Korat & Shamir, 2007; Smeets & Bus, 2014) can be effective for supporting vocabulary learning (Roskos, Sullivan, Simpson, & Zuzolo, 2016; Segers & Verhoeven, 2003) and story comprehension. However, these results are not always consistent (Smeets & Bus, 2014).

Children's ability to retell stories is an important part of story comprehension and was also measured following reading e-books (Korat & Shamir, 2007; Smeets & Bus, 2014). It was usually measured by counting the frequency of words and by telling the main ideas focused on the story's problem and solution. These components may capture the child's cognitive ability to comprehend the story's main idea by representing the causality between the problem and the solution presented in the story (Applebee, 1978).

Static versus dynamic dictionary in an E-book

Previous studies that included a dictionary in an e-book with auditory and visual elements showed that children benefitted from the simultaneous presentation of a static picture together with a vocal explanation (Korat & Shamir, 2007). This supports Paivio's (2007) Dual-Coding Theory, according to which a person has two systems in working memory, a verbal and a visual-spatial one, and learning becomes more effective when both systems are involved in processing the information simultaneously. Thus, the nonverbal visual presentation may contribute to more effective coding in memory and may promote learning by preventing memory overload in the system (Clerkin, Hart, Rehg, Yu, & Smith, 2017; Gladfelter, Barron, & Johnson, 2019). Visual presentation together with verbal word explanations may help focus children's attention, thus requiring less effort in the learning process (Hegarty, Kriz, & Cate, 2003) and may be maintained better in memory (Movallali, Rezaiyan, Adibsereshki, & Bakhshi, 2020).

Children's e-books include not only static, but also dynamic illustrations. For example, the representation of the word "blossomed" in the static dictionary could be a figurative static flower, while the dynamic illustration shows an animation of a bud slowly turning into a flower (see Korat, Levin, Ben-Shabat, Shneor, & Bokovza, 2014). Several studies found that dynamic illustrations are particularly effective (more than static illustrations) for enriching children's receptive and expressive level (Korat et al., 2014; Verhallen & Bus, 2010). Dynamic illustrations may be especially effective when children have limited vocabulary, such as Arabic-speaking children in the case of MSA (Silverman & Hines, 2009). This is also true for second language learners who learn more words after repeatedly hearing an e-book with animations compared to static illustrations (Verhallen, Bus, & de Jong, 2006).

It was claimed that animations are particularly effective for learning new words and concepts, since they require less effort during the learning process. The animations may draw the observer's attention and help them focus on word meaning (Hegarty et al., 2003). On the other hand, temporal presentation via animations may cause cognitive load in the learning process, and lead to less effective learning (Baddeley, 1986). According to the Cognitive Load Theory (Kirschner, 2002), instructional formats that impose high demands on working memory capacity may result in ineffective transfer of information to the long-term memory store, due to unavailable cognitive resources. As a result of this limitation, instruction should be designed such that working memory is capable of processing the information.

In the current research, we used short vocal word presentation of the target words and their meanings with minimal visual animation, since we are aware that the addition of animations may cause distractions to the story flow (Bus, Takacs, & Kegel, 2015). We aimed to examine whether a well-designed e-book with suitable word meaning support (Korat & Shamir, 2007, 2012) may facilitate not only children's vocabulary learning, but also their ability to retell the story (Roskos, Carroll, Brueck, & Widman, 2009).

Children's word vocalizations

Previous studies with English speakers (Beck & McKeown, 2007, 2013) showed the beneficial effect of shared book reading on children's word learning, particularly when "tutoring" techniques were provided, such as saying the new words and their meanings (Hadley,

Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2016) and repetition (McKeown & Beck, 2014). Vocalization of a word involves reconstruction of items in phonological memory, and this may support its consolidation and later retrieval from memory. When words are repeated vocally, there is facilitation of the phonological signs together with the lexical representation, and this may lead to increased effectiveness in internalization of word meanings (Alt & Spaulding, 2011; Ellis & Sinclair, 1996). Previous studies have shown that short-term phonological memory is associated with children's vocabulary and predicts future vocabulary development (Gathercole, Willis, Emslie, & Baddeley, 1992). Thus, the ability to learn the sound patterns of new words depends on the ability to preserve this representation in short-term phonological memory. Based on Baddeley's (1986) model, working memory includes three components: the central executive, the visuospatial sketch-pad and the phonological loop. The component which is important for lexical acquisition is the phonological loop. It stores the phonological representation in short-term memory and rehearses it through a verbal repetition mechanism. When a person absorbs a new word, he or she rehearses its phonological representation automatically and repeatedly. The length of time that the phonological representations remain in short-term memory can be prolonged by using the vocal rehearsal mechanism (Baddeley, Thomson, & Buchanan, 1975). The phonological loop therefore facilitates acquisition of new words by saving them in working memory until they are consolidated in long-term memory (Baddeley, Gathercole, & Papagno, 1998).

Word vocalization strategy for establishing the learning of new words was found to be effective among adults (Ellis & Beaton, 1993) and children. Children as young as four used a verbal strategy of vocal rehearsal spontaneously in serial memory tasks, such as repetition of a series of letters or numbers (Henry, Turner, Smith, & Leather, 2000). Studies that focused on the use of this strategy and its effectiveness for new word learning via rapid mapping of words showed that this way is used spontaneously during learning and benefits from using vocal rehearsal, particularly in word recognition tasks (Alt & Spaulding, 2011). Based on existing literature, the innovation of the study is in that the children were not only exposed to novel target words (static or dynamic visual representation) and their meaning in the e-book, but were also asked to say the word and its meaning out loud several times. This study is unique in the context of research available today, by using a well-designed e-book with a dictionary to enrich vocabulary. More specifically, to the best of our knowledge, this is the first time that word learning is tested by comparing the teaching strategies of a vocal explanation, a pictorial representation (static/dynamic) and word vocalization, focusing on the uniqueness of each parameter separately, while all these teaching strategies are tested on Arabic-speaking students and by using an e-book.

The present study

We used a randomized controlled trial to test an e-book we developed, that applies vocalization of words and their meanings within the context of the story, in a repeated e-book reading activity. Based on the above literature, we proposed an e-book intervention program using four channels: (a) presentation of a dynamic illustration for word meaning while the child vocalizes the target word and its meaning that appear in the dictionary; (b) presentation of a dynamic illustration without vocalization of the word and its meaning; (c) presentation of a static illustration for word meaning while the child vocalizes the target

word and its meaning; (d) presentation of a static illustration without vocalization of the word and its meaning; and (e) continuous reading without a dictionary (control group). Our research questions were: (1) How will children's initial linguistic level contribute to word learning in the different research groups? (2) Will children learn novel words and their meanings better after exposure to dynamic illustrations with word vocalization compared to dynamic illustrations without repeated vocalization, static illustrations with repeated vocalization, and static illustrations without vocalization? (3) Will learning novel words and their meanings support children's story retelling?

Our hypotheses were:

(1) Children's initial linguistic level will contribute to word learning. An interaction is expected such that children with a high initial level who are exposed to animations with vocalization will benefit more in learning new words compared to children in other groups.
(2) Learning novel words and their meanings will produce better gains following dynamic illustration with word vocalization. This will be followed, in descending order, by dynamic illustration without repeated vocalization, static illustration with repeated vocalization, and static illustration without vocalization. The least progress is expected to be observed following reading the e-book without a dictionary.
(3) Learning novel words and their meanings will support children's story retelling. The effectiveness of the support will be similar to those above regarding word learning.

Method

Participants

This study took place in Israel, during April-May 2017. The participants included 163 Israeli Arabic-speaking kindergartners, of whom 64 are boys (40%) with a mean age of 71.26 months (SD = 3.66) (range 68.71–74.36). A χ^2 test showed that there is no gender dependency on research group, $\chi^2(4) = 5.85$, $p > .05$.The participants had no developmental or language difficulties, based on the teachers' reports. Six randomly-sampled kindergartens participated in the study: three from an Arab Muslim town and three from a Muslim neighborhood in a mixed Jewish and Muslim town. All kindergartens are under the central supervision of the Ministry of Education and all work according to a similar language and literacy curriculum. Each kindergarten class was divided randomly and equally into five groups: four experimental and one control group.

The E-book

We used the e-book *The Doll's Nose* by Miranda Haxhia (2006) which was translated into Arabic by Espanioly, and was turned into an electronic version (Korat et al., 2014). The book tells the story of a girl who was unable to play with her friends since she had no doll of her own, and how she overcame the problem with her mother's support. The e-book includes 13 screens, and in each screen 1 novel word is explained. After the screen is read by the narrator, an automatic explanation of the novel word is provided, and a picture

Figure 1. A page from the e-book *Anf Al Domia* in the channel with a dictionary.

representing the target word appears. When a dictionary definition is provided, the story flow is stopped and moving to the next screen is not possible (Figure 1).

Thirteen target words were chosen carefully, seven were nouns (for example,ةنطة-/ hent`a/- wheat) and six were verbs (i.e.,مطتإر- irtat`ama/collided). Initially, four experts chose the 7 most novel nouns and 7 verbs from the story. Two early childhood MA students confirmed the choice of words after reading the book "*The Doll's Nose*" to 30 five-year-old children in small groups (3–4 children). Table 1 presents the target words included in the e-book in literary and oral Arabic and in English. The pilot study showed that the children's familiarity with the words was low.

The study involving the e-book included five separate reading channels: four channels with a dictionary and one without a dictionary (control). In all channels, the narrator reads the text of the story, and in all except for the continuous reading channel (the control group), a bubble presenting an illustration that represents the meaning of the new word appears automatically.

The dictionary channel differs in the manner of the visual illustration (dynamic or static) and in whether vocalization of the novel word and its meaning is required (see Appendix 1). The channels are: (a) reading with a dynamic dictionary and vocalizing the word and its meaning (N = 32). At the end of reading each page, a bubble appears automatically in which the written target word is presented, accompanied by a dynamic illustration representing its meaning. For example, in one of the screens, the literary Arabic word تسلم (in English smoothed) appears in the bubble and the narrator says a short oral meaning of the word (1) (مسّدت to 3 words). It should be noted that in the

Table 1. Target words in literary Arabic, their English translation, and their definitions which appear in the dictionary in spoken Arabic.

Word definition in the dictionary in spoken Arabic	English translation	Target word in literary Arabic
Nouns		
حومرة	Lipstick	أحمر الشفاه
لعبة	A doll	دُمية
مال	Money	نقود
طوق	Headband	شريط
محرمة	Handkerchief	منديل
قمح	Wheat	حنطة
وقت الظهر	Noon time	الظهيرة
Verbs		
نظرت	Observed	راقبت
جرت	Dripped	سالت
ملست	Smoothed	مسّدت
فتحت فمها واسعا	Yawned	تثاءبت
ضحكت	Smiled	ابتسمت
إصطدمت	Collided	ارتطمت

static channel, the picture shows a girl putting her hand on a cloth. In the dynamic channel, the picture shows the same girl moving her hand on the cloth presenting the movement that represents the action of "smoothing". This is aimed at creating a more coherent mental representation of the spoken word and the picture. The narrator utters the target word and provides a short meaning of the word. Afterward, the narrator asks the child to vocally repeat the target word and its meaning. (b) Reading with a dynamic dictionary without vocalization ($N = 31$). The display in this channel is the same as in the reading with a dynamic dictionary (a), but the child is not asked to vocalize the word and its meaning. (c) Reading with a static dictionary and vocalizing the word and its meaning ($N = 33$). In this channel, the illustration of the target word is static, and the narrator says the word and its meaning and asks the child to vocalize it. (d) Reading with a static dictionary without vocalization ($N = 34$). The display in this channel is the same as in the reading with a static dictionary (c), but the child is not asked to vocalize the word and its meaning. (e) A channel of continuous reading without a dictionary and without vocalization ($N = 33$). In this channel, there is continuous narration of the written text only, without the presentation of a dictionary and without vocalization of the word and its meaning.

Data collection

Children's knowledge on the target words of the research and their retelling of the focal story was tested pre- and post-intervention. The children's general vocabulary level (PPVT) was assessed only in the pretests.

Peabody picture vocabulary test – PPVT

Children's vocabulary was tested using an Arabic version of a receptive test, adapted by Hassunha-Arafat and Saiegh-Haddad (2010) to Dunn and Dunn's (1981) PPVT. The test includes 50 items, where each item has four illustrations. The child is asked to point to the picture that is most suitable for the target word. Cronbach's alpha reliability for the test in this study was 0.82.

Target receptive word meaning

This word test (including tests B and C) was developed by the researchers for this study. The children were asked for the meanings of the 13 words from the e-book's text, which appeared in the e-book's dictionary. These words were judged to be relatively difficult for children of this age. The children were asked to choose the picture that best illustrates the word's meaning out of a set of 4 pictures. Pictures for each target word were from the same semantic field. For example, the focal picture for the word "doll" was a girl doll. The other pictures were: a toy teddy bear, a ball, and a building block. For the word "collided", the target picture shows a child bumping into a toy. The other pictures showed a child dancing, running, and sleeping. The total score for this task ranged from 0–13. The alpha score for this measure was .62.

Target expressive word meaning

This test includes the 13 target words in the e-book's dictionary. Each word was vocalized for the children one at a time, and they were asked to provide the meaning of the word. This test was based on similar effective tests used by Aram and Levin (2004) and Snow, Cancino, Gonzalez, and Shriberg (1989) in previous studies which tested young children's expressive vocabulary. The directions to the children were as follows: "I will tell you a word that appears in the book, and I would like you to tell me what the word means". Coding ranged from 0–5 and was based on children's answers as follows: 0 points for an incorrect answer; 1 point for a phonological substitution (for example, for the word nukud/نقود/money, the child answers "mab" instead of -/mal' – the answer includes a change in one sound of the expected meaning of the word while preserving the rest); 2 points for a semantic substitution (for example, for the word nukud/نقود/money, the answer is "dollar/shekel", where the answer refers to another word from the same semantic category to which the target word belongs); 3 points for an answer that does not offer the complete meaning of the target word, where the meaning refers to a category and/or use and/or traits that characterize the indicated word (for example, for the word nukud/نقود/money, the child's answer is "coin" where the reference is to a category, or an answer that refers to usage "it is used to buy things with", etc.); 4 points for an answer in spoken Arabic (for example, for the word nukud/نقود/ money, the child answered the spoken form مصاري/masari); 5 points for an answer that reflects the word's meaning (for example, the meaning in the dictionary in literary Arabic for the word nukud/نقود/money is نقود/mal). The maximum score on this test is 65 points. The scale was constructed based on the answers of 30 Arabic-speaking kindergartners in a pilot study. Cronbach's alpha reliability for word meaning in this research was .85. The inter-rater reliability of coding the characteristics for this test was Cohen's kappa = .94.

Story retelling

The retelling task enabled us to measure word frequency, the expression of the main problem and its solution. The researcher told the child: "I brought the book that was read to you on the computer. Now, please tell me the story." Children's accounts were audio-taped and transcribed. The three measures used for story retelling skill were: (1) Children's story word frequency (Berman & Shen,); (2) Expression of the story's main problem; (3) Expression of the story's solution. The story's problem was coded using four levels: 0 = story does not mention the story's problem, 1 = there is reference to one aspect of the problem (Mary, the story's hero, has no doll), 2 = there is reference to a more severe problem (Mary

wanted to play with the children but she could not), 3 = there is mention and a connection between both aspects of the problem. The story's main solution was coded using four levels: 0 = story does not mention the story solution, 1 = there is reference to one aspect (Mary prepared a doll), 2 = there is reference to the fact that Mary told her mother about her idea of preparing a doll, 3 = there is mention and a connection between both aspects of the solution. Validation of the story retelling process by two raters coding 13% of the protocols showed 90% agreement.

Procedure

Two experimenters who are Arabic-speaking educators from the Arab community specializing in early childhood collected the data. Each experimenter collected pretest and posttest data and conducted the intervention.

Pretest

All participants were tested in general vocabulary (via PPVT), a receptive word meaning test and an expressive word test of the target words. Within the framework of the pretests, all groups first read the e-book in the continuous reading channel. After the reading, the children were asked to retell the story, while looking through a printed illustrated book. This story was used to test word frequency of the children's story retelling, expression of story problem as well as its solution. Prior studies showed that one reading of a book is not sufficient for thorough word learning and story comprehension (Robbins & Ehri, 1994; Sénéchal, 1997). Thus, the possibility that the children will progress following the reading during the pretests is small.

Intervention

The children in each kindergarten class were randomly divided into five groups. The experimenter sat with each child separately, and provided technical support if needed. The children in each group read the book in three separate sessions, at intervals of 1–3 days between sessions. The experimental groups that worked with the dictionary (static or dynamic, with or without vocalization) were automatically presented with the target words on each page while reading. For example, the narrator uttered the word "masadat" (slipped) and provided its meaning,/malasat. "Masadat" is a word in literary Arabic in a high register, and the word "malasat" is the spoken word in a lower register. After the meaning was provided automatically, the experimenter said: "On each page, after the novel word appears, you should click on the bubble, and the novel word and its meaning will appear again". Thus, in one reading the child was exposed to the target word and its meaning twice, and after three separate sessions the child was exposed to the word and its meaning six times. This intervention option presented the child with a repeated auditory and visual representation of the target word. In the "with vocalization" channel, the child was also asked to vocalize the target word and its meaning. The narrator asked the child to repeat the word that was presented and its meaning out loud. For example, the child said: حنطة ("wheat" in literary language) means قمح ("wheat" in oral language). This option existed both in the dictionary with static illustrations and in the dictionary with dynamic illustrations. The child thus verbally repeated each word six times after three separate sessions with the book. The control group read the e-book in a continuous manner in three separate sessions, without a dictionary.

Posttests

All participants were tested again on the target novel words of the study via five tasks focused on: receptive word test, expressive word test, word frequency in the retold story, and expression of story problem and its solution.

Results

Children's pre-intervention level

Several one way univariate ANOVA models were conducted in order to investigate the first research question addressing the differences between word recognition, word meaning pre- and post-intervention. Table 2 presents pre-intervention measures by group, and it can be seen that there were no differences between the groups.

However, a difference was found in the children's initial vocabulary PPVT measure level, $F(4,158) = 2.83$, $p < .05$, $\eta_p^2 = .07$, and in production of the solution, $F(4,158) = 3.67$, $p = .007$, $\eta_p^2 = .08$. For the PPVT, a pairwise comparison with a Bonferroni correction ranking test resulted in a difference between the control group that scored lower ($M = 39.33$, $SD = 7.74$, the letter "a") than the experimental group that read the e-book with a dynamic dictionary and vocalization ($M = 43.06$, $SD = 3.09$, the letter "b"). The PPVT values of all other groups did not differ from each other (the letters "ab"). For the production of solution, a pairwise comparison with Bonferroni correction ranking test showed a difference between the group that read the e-book with a dynamic dictionary without vocalization ($M = 1.16$, $SD = .25$, the letter "a") and the group that read the e-book with a static dictionary with vocalization ($M = 2.21$, $SD = .24$, the letter "c") and the group that read the e-book with a dynamic dictionary with vocalization ($M = 2.19$, $SD = .25$, the letter "b"). The control group and the group that read the e-book with a static dictionary without vocalization did not differ from the group that read the e-book with a dynamic dictionary without vocalization or from the group that read the e-book with a dynamic dictionary with vocalization.

Receptive and expressive target word meaning

In order to address the second research question, we tested the learning of target words and their meanings after exposure to dynamic illustrations with word vocalization compared to

Table 2. Means (*SD*) and *F* values of the pre-intervention measures by group.

	Range	Control group	Static w/o vocalization	Static + vocalization	Dynamic w/o vocalization	Dynamic + vocalization	*F*	η_p^2
PPVT	0–50	39.33[a] (7.74)	41.88[ab] (3.23)	42.52[ab] (4.47)	41.68[ab] (4.25)	43.06[b] (3.09)	2.83*	.07
Receptive word meaning	0–13	7.68 (1.86)	7.76 (1.92)	7.94 (2.26)	7.37 (1.98)	7.46 (2.10)	.41	.01
Expressive word meaning	0–4	0.66 (0.54)	0.73 (0.62)	0.84 (0.53)	0.63 (0.68)	0.97 (0.75)	1.56	.04
Word frequency	0–238	67.52 (51.27)	60.65 (34.33)	66.00 (40.68)	61.65 (53.72)	64.41 (39.23)	0.14	.004
Problem	0–4	.94 (1.2)	.91 (1.26)	1.42 (1.34)	.77 (1.15)	1.37 (1.39)	1.76	.04
Solution	0–4	1.48[ab] (1.34)	2.09[ab] (1.29)	2.21[c] (1.6)	1.16[a] (1.42)	2.19[b] (1.35)	3.67**	.08

* $p < .05$, ** $p < .01$; Standard error in parentheses; Latin letters for post hoc ranking, "a" for the lowest mean and so on, based on pairwise comparisons with the Bonferroni correction for multiple comparisons.

dynamic illustrations without repeated vocalization as well as static illustrations with repeated vocalization versus static illustrations without vocalization. The main analysis results are presented in Table 3. For control, we added the pre-intervention value and the pre-intervention PPVT. Group comparison was carried out with respect to the control group as the reference. The post hoc marginal mean ranking shows the order of change between the post- and the pre-intervention values.

A significant group main effect was found for the two measures of word recognition and word meaning (Wald's chi square = 13.68, $p < .001$ and 93.42, $p < .001$, respectively). In addition, pre-intervention levels of word recognition showed a negative effect on the post-intervention levels, also known as the regression to the mean ($b = -0.63$, $p < .001$). In other words, children who exhibited lower performance at the pre-intervention stage improved to a greater extent, and vice versa. In contradistinction, the general vocabulary skills (PPVT) showed a positive effect on performance in both measurements ($b = 0.11$, $p < .001$; $b = 0.02$, $p < .10$, respectively). Older children demonstrated greater improvement in word meaning ($b = 0.03$, $p < .05$) and children who lived in Arabic-speaking communities showed higher levels of word recognition ($b = 0.75$, $p < .001$) compared to children from mixed Arabic-Hebrew speaking communities.

As for the ranking across groups, in word recognition, the smallest improvement was found in the control group and the group that read the e-book with a static dictionary without vocalization (a), which did not differ from the group that read the e-book with a dynamic dictionary without vocalization ($p = .14$, $p = .28$, respectively), but the latter did not differ from the other two groups (a and b). The greatest improvement was found among the groups that read the e-book with a static or a dynamic dictionary with vocalization (b) compared to the control group ($p = .02$, $p = .002$, respectively). This ranking was consistent in word meaning, except that the two greatest improvements appeared in the groups with vocalization (c), who differed from the improvement in the two other groups which were without vocalization ($p = .000$, $p = .000$, respectively (b), with the least improvement found in the control group (a). Children's age was another variable which contributed to progress in word meaning.

Table 3. Model of the study measures in all 5 groups, including age, initial level, type of preschool and PPVT scores as covariates.

	Receptive word meaning	Expressive word meaning
Coefficients		
Intercept	2.96 (2.90)	−2.22* (0.95)
Group	Wald = 13.68***	Wald = 93.42***
Static without vocalization vs control	0.20 (0.44)	0.56*** (0.14)
Static with vocalization vs control	1.06* (0.45)	1.12*** (0.14)
Dynamic without vocalization vs control	0.67 (0.46)	0.58*** (0.14)
Dynamic with vocalization vs control	1.43** (0.46)	1.20*** (0.14)
Age	0.05 (0.04)	0.03* (0.01)
Initial level	−0.63*** (0.07)	−0.12 (0.08)
Type of preschool	0.75** (0.29)	0.10 (0.09)
PPVT	0.11*** (0.03)	0.02~ (0.01)
Marginal means		
Static without vocalization	0.97^{a} (0.30)	0.84^{b} (0.10)
Static with vocalization	1.84^{b} (0.31)	1.40^{c} (0.10)
Dynamic without vocalization	1.45^{ab} (0.32)	0.86^{b} (0.10)
Dynamic with vocalization	2.20^{b} (0.32)	1.48^{c} (0.10)
Control	0.78^{a} (0.32)	0.28^{a} (0.10)

*** $p < .001$, ** $p < .01$, * $p < .05$ ~ $p < .10$; Standard error in parentheses; Latin letters for post hoc ranking, a for the lowest mean and so on.

Story retelling: word frequency, expression of problem and solution

The analysis regarding the story telling measures, which include word frequency and mentioning of the problem and the solution, is presented in Table 4.

For control, we added the pre-intervention initial value and the pre-intervention PPVT. Similarly to the analysis presented in Table 2, group comparison was performed with the control group as the reference. However, the post hoc marginal mean ranking shows the order of change between the post- and the pre-intervention values. For both word frequency and problem mention measurements, a significant main effect was found for group (Wald's chi square = 10.03, p = .04 and 10.04, p = .04; respectively), contrary to mentioning of the problem's solution, which did not show a main effect for group (Wald's chi square = 6.46, p = .18). In addition, pre-intervention levels of word frequency and problem mention showed negative effects on the post-intervention levels, also known as the regression to the mean (b = −0.51, p < .001; b = −0.49, p < .001, respectively). In other words, children who showed stronger performance at the pre-intervention stage made a smaller improvement, and vice versa. There was no effect of general vocabulary skills, age or type of preschool attended.

As for the ranking across groups, in word frequency, the smallest improvement was found in the control group and the intervention group that read the e-book with a static dictionary without vocalization (a) (p = .48), which did not differ from the group that read the e-book with a dynamic dictionary without vocalization (p = .06). The greatest improvement was found among the groups that read the e-book with a static dictionary (p = .004) or a dynamic dictionary with vocalization (p = .04) (b), compared to the control group. For problem mention, the greatest improvement was found in the groups that read the e-book with a static (p = .007) or a dynamic group with vocalization (p = .04) and in the group that read the e-book with a dynamic dictionary without vocalization (c) (p = .03), which was better than the improvement in the group that read the e-book with a static dictionary without vocalization (b). Improvement in the control group was the lowest (a), but not

Table 4. Model of the study measures in all 5 groups, including age, initial level, type of preschool and PPVT scores as covariates.

	Word frequency	Problem	Solution
Coefficients			
Intercept	−24.73 (51.36)	−3.39 (2.07)*	4.31* (2.03)
Group	Wald = 10.03*	Wald = 10.04*	Wald = 6.46
Static without vocalization vs control	−5.48 (7.82)	−0.20 (0.30)	0.27 (0.29)
Static with vocalization vs control	16.40 (7.92)*	0.60* (0.31)	0.38 (0.30)
Dynamic without vocalization vs control	9.02 (8.11)	0.45 (0.31)	0.75 **(0.30)
Dynamic with vocalization vs control	10.32 (8.12)	0.42 (0.31)	0.39 (0.30)
Age	.38 (0.69)	0.04 (0.03)	−0.05 (0.03)
Initial level	−.51 (0.06)***	−0.49*** (0.08)	−0.50*** (0.07)
Type of preschool	9.28 (5.47)	0.34 (0.19)	−0.29(0.18)
PPVT	0.70 (0.54)	0.04 (0.02)	0.01 (0.02)
Marginal means			
Static without vocalization	-5.36^{a} (5.39)	0.23^{a} (0.21)	0.65 (0.24)
Static with vocalization	16.51^{b} (5.48)	1.03^{c} (0.21)	1.12 (0.24)
Dynamic without vocalization	9.14^{ab} (5.70)	0.87^{b} (0.22)	1.29 (0.25)
Dynamic with vocalization	10.43^{b} (5.60)	0.85^{b} (0.22)	1.36 (0.25)
Control	0.11^{a} (5.66)	0.42^{a} (0.22)	0.76 (0.25)

*** p < .001, ** p < .01, * p < .05 ~ p < .10; Standard error in parentheses; Latin letters for post hoc ranking, "a" for the lowest mean and so on, based on pairwise comparisons with the Bonferroni correction for multiple comparisons.

significantly different than the rest, except for group that read the e-book with a static dictionary with vocalization (p = .05).

Discussion

The main findings of this study show that Arabic-speaking kindergartners who read an e-book with a dictionary that incorporated a visual dynamic presentation of target words and executed repeated vocalization of the words showed significant improvement in the meaning of target words and in story retelling. The greatest progress was achieved following word vocalization. This was followed by visual dynamic presentation of target words, and the smallest progress was found in the control group, which was not exposed to the dictionary at all. In general, children's vocabulary level (measured by PPVT), age and type of school (Arabic-speaking or mixed Arabic-Hebrew) contributed less to their word learning and story retelling, except for a few specific cases. However, children's initial level in several measures was significant in explaining children's learning. Children who had a lower initial level progressed more.

Word vocalization and dynamic visualization

One of the important results in this study is the effectiveness of children's word vocalization, which appeared to contribute most, followed by dynamic visualization. Why was this activity the most efficient for word learning and story retelling? We assume that children's repetition of the target words, including their short meaning, supported the phonological representation of the word, thus strengthening its meaning in memory, and apparently also helped its lexical representation later on. These findings are in agreement with previous studies, which showed that vocal repetition of a word and its meaning serve as a strategy for the internalization of meanings of new words and their recognition (Alt & Spaulding, 2011; Ellis & Sinclair, 1996). According to Ellis and Beaton (1993), vocalization strengthens the phonological representation of the word, and thus arouses the learning mechanism and increases its effectiveness. This effectiveness is apparently caused by articular processes that take place in the phonological loop of short-term memory, and by the interaction between short-term storage and representation in the long-term memory (Ellis & Sinclair, 1996; Gathercole, 2006). These processes apparently supported the ability to allocate the suitable representation of word meaning in the receptive and expressive word test, more than in a situation where children were exposed to the visual representation of the word in the dictionary either dynamically or statically, without any vocalization.

Nonetheless, it is important to note that dynamic and static illustrations were efficient for novel word learning and story comprehension more than in the control group with no dictionary at all, with some advantage to the dynamic than to the static presentation. These results are in line with the Dual-Coding (Paivio, 2007) and the Cognitive Load (Kirschner, 2002) theories and the Model of Working Memory (Clerkin et al., 2017). The children in this study heard each new word and its short meaning (1 to 3 words only) and at the same time (the temporal proximity principle, Mayer, 2001). They saw a short visual representation of the target word with a coherent representation. It is important to note that in order to prevent cognitive load in the learning process (Baddeley, 1986), the oral explanation and visual presentation were presented very briefly. We assume that this combination led to the

reduction of overload in the short-term memory system, and caused the learning process to be particularly efficient. The combined integration of the received information apparently creates effective consolidation (Mayer & Anderson, 1992).

The finding that the dynamic visualization usually had some advantage over the static visualization is in line with previous research that showed that e-books that include animations were more effective for language learning skills and story comprehension than e-books with static pictures (Smeets & Bus, 2014; Verhallen et al., 2006). As in previous cases (see Verhallen & Bus, 2010), we found that the dynamic illustrations were especially effective in word meaning and in the expression of the story problem. Both cases are more demanding tasks (compared to receptive word meaning or word frequency for story telling). Our results strengthen previous results on the effectiveness of the dynamic versus the static channel using dictionary support in different contexts and different languages, adding Arabic to Hebrew (Korat et al., 2014) and Dutch (Verhallen & Bus, 2010).

Receptive and expressive word meaning

Interestingly, vocabulary knowledge (measured by PPVT) supported children in the receptive acquisition of new words. These results did not appear in other measures (expressive word learning and story retelling). It can be assumed that the similarity in both measures underlies the same process of learning. Furthermore, children who studied in Arabic-speaking communities showed better receptive target word meaning. It seems that exposure to only Arabic benefited the kindergartners in the acquisition of new words in Arabic more than in mixed Arabic-Hebrew speaking communities. Children's chronological age did not explain their receptive word comprehension, whereas the initial target word level did contribute to it. The lower the children's receptive knowledge of the words, the higher their learning of new words. These findings go hand-in-hand with previous research on young children's use of well-designed e-books which illustrates that technological tools (dynamic visualization, narration) may be particularly effective in assisting children with especially low starting points (Bus et al., 2015; Korat et al., 2014). As for learning word meaning, the PPVT score, type of class and initial level did not make a special contribution. However, children's age did contribute. Older children tended to progress more in explaining word meaning. These results are in line with the children's age and the developmental importance of children's ability to learn new words, especially a high level of knowledge such as expressive words explanation (Orwenjo, 2009).

Story retelling: word frequency, problem and solution

Beyond the focus on the effect of e-books on teaching young children new focal words, our aim was to investigate whether this new vocabulary positively affects children's ability to retell the story content. We assumed that understanding the vocabulary of the story is an important component for story comprehension (Cain et al., 2004). Thus, learning new words may indirectly support story content comprehension (Smeets & Bus, 2014).

The children in our study were asked to retell the focal story before and after the e-book intervention. We counted the number of words, children's presentation of the story's main problem and its solution as presented in the story. The children were not given any specific support for story content beyond the dictionary which presented difficult focal words (except

for the control group, which read it without any additional support). Based on the above, the study results are interesting. All intervention groups made larger gains compared to the control group. Furthermore, the number of words used by the children in telling the story was most effective when children read the e-book with a dictionary with vocalization compared to the other channels. The dictionary channel with vocalization, including static and dynamic visualizations, contributed most to the expression of the main problem.

These results are important, since they show that direct teaching of difficult words that appear in a story can support children's production of a richer wordy story. They show that children can allocate the main problem in the story better when they are introduced to difficult words from the story. For the measures of number of words, presentation of the problem and the solution, the lower the children's initial level, the more progress they made. Similar results are reported above regarding receptive words meaning. These results do not support the principle of "the rich get richer" (Stanovich, 2000), and show that using effective strategies that incorporate technological tools may better support language learning and story retelling. The results are especially important in their application to young children with language and learning difficulties (Smeets & Bus, 2014), including children from low income families, immigrant children or second language learners. These findings seem, in our case, relevant for Arabic-speaking children who function in a setting with two dialects due to the diglossia phenomenon.

Research limitations

Some research limitations should be noted. First, measuring children's emergent literacy level could provide more information on possible predictors for new word learning. Second, using a straightforward yes/no questionnaire and/or open-ended questions may have provided us with another indication of children's story comprehension skills, beyond story retelling. Third, since we examined a diglossic language, which is a special context of word learning, more studies are needed to examine whether our results can be generalized for non-diglossic languages. Fourth, the statistical power for detecting effects in our study was below 80%. Therefore, our one-way ANOVAs for determining pre-experimental differences may not have been able to detect all the differences due to the low number of subjects. Future research should include more participants to better support our hypothesis. Finally, our participants were children from an Arab Muslim town and from a Muslim neighborhood in a mixed Jewish and Muslim town. Although our analysis showed no effect of this parameter on children's scores, future studies that will to pay attention to this aspect are suggested.

Conclusions and pedagogical implications

This study shows that an educational e-book which is adapted to learning can improve the vocabulary in the literary language among Arabic-speaking kindergartners, independent of an adult interactor, and can also support children's story retelling skills. It may be suggested that technological tools could be especially effective for Arabic-speaking young children, since they are exposed mainly to learning new words from oral communication, while for many of them written Arabic is almost a second language (see similar results in Silverman & Hines, 2009; Verhallen et al., 2006). Development of tools of this type and their use in the home environment, kindergarten and school frameworks may be effective for enriching

children's language and story comprehension. The field of e-books in Arabic is very limited (see, for example, Abd Elhadi, 2019; Atta & Abd El Wahab, 2015), and there is room for expansion in order to enable children an enjoyable and effective learning experience suitable to the new technological age. Furthermore, due to the evidence that parents as well as teachers in many cases miss the opportunity to provide adequate and suitable vocabulary support or instruction (Evans, Reynolds, Shaw, & Pursoo, 2011; Wright, 2012), we suggest using strategies supported by the results of this study: a short vocal explanation, a pictorial representation, repetition, and children's word vocalizations in a meaningful context as a possible efficient ways for fostering children's vocabulary.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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