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Publication Date

2022-12-01

DOI

10.1016/j.compedu.2022.104622

Peer reviewed



The role of bilingual discussion prompts in shared E-book reading

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ARTICLE INFO

Keywords:

Early years education
Mobile learning
Distributed learning environments
Informal learning
Human-computer interface

ABSTRACT

This randomized controlled trial study examined the effects of bilingual discussion prompts with feedback within a multimedia interactive e-book on parent-child shared reading for young English language learners aged 3–7 in China. Sixty-four parent-child pairs read a multimedia English storybook with bilingual discussion prompts in the treatment condition, and forty-three pairs read the same multimedia storybook without discussion prompts. After reading the storybook twice, children in the discussion-prompt group outperformed the control group on story comprehension and retelling measures. However, children in both groups showed comparable gains in English vocabulary. According to our qualitative analysis of parent-child responses on discussion pages, when parents follow the question-response-evaluate-feedback flow of the discussion sessions, they tend to practice dialogic reading strategies and scaffold children's learning naturally and effectively without explicit training. With the learning facilitation from both the storybook and parents, children received more comprehensible input, produced more English output, and became active storytellers instead of passive learners. Moreover, the e-book with a built-in questioning avatar established children's parasocial relationship with the story characters. These findings suggest an exciting potential for multimedia interactive e-books, powered by bilingual discussion prompts, as an effective educational tool for families from diverse linguistic backgrounds.

1. Introduction

There is considerable evidence that parent-child shared reading promotes children's language and literacy development (for recent reviews, see [Lacour, McDonald, Tissington, & Thomason, 2013](#); [Noble et al., 2019](#)). One evidence-based approach to shared reading is dialogic reading, in which parents ask story-related questions and otherwise provide scaffolding to enrich their children's verbalizations and facilitate comprehension ([Blom-Hoffman et al., 2006](#); [Chow et al., 2008](#); [Hargrave & Sénéchal, 2000](#); [Lever & Sénéchal, 2011](#)). Dialogic reading has been shown to support language and literacy among native English speakers as well as language minority children developing English proficiency in English-majority settings such as the United States ([Fitton et al., 2018](#)). However, the effects of shared reading of English stories in contexts where English is a foreign language (EFL) remain unclear, especially in home settings where parents have limited English language skills. Dialogic reading in English may be particularly challenging for parents and children in EFL settings due to their limited English proficiency, low self-efficacy in English, and the linguistic differences between their home language and the English language ([Chow et al., 2010](#)).

New forms of technology may alter shared-reading opportunities and practices. Touchscreen devices and literacy apps have become ubiquitous in children's home lives ([Rideout and Robb, 2020](#)). Storybook apps with interactive features have dramatically changed the

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landscape of children's home literacy environments and practices (Kucirkova, 2019). Although storybook apps can support young children's language and literacy development, interactive multimedia features may impede children's learning (Furenes et al., 2021; Reich et al., 2016; Takacs et al., 2015). Storybook apps often have interactive features, such as games and animations, to make the reading experience more entertaining for young learners. However, these features may distract children from story-relevant information and impede comprehension and learning (Furenes et al., 2021; Reich et al., 2016; Willoughby et al., 2015). Further, most storybook apps include audio narration to enable children to use them independently, without parental engagement (Munzer et al., 2019). With limited attentional skills, young children may easily get distracted by the interactive features in the e-book without parents' guidance. Further, parents play a crucial role in children's story comprehension, vocabulary learning, and language development during story-reading activities. If the literacy apps are not designed to create a space for parent-child joint engagement, parents may not fully utilize this valuable family time to promote children's deep cognitive engagement and improve children's social-emotional skills and parent-child bonds (Doyle & Bramwell, 2006).

Unlike most interactive features, discussion prompts (note: discussion prompts and questions are used interchangeably in this paper) can facilitate dialogic reading and parental engagement, especially for families of low socioeconomic status (Troseth et al., 2020). In EFL contexts, using bilingual discussion prompts may empower parents with limited English proficiency to overcome the language barrier and engage in bilingual shared-reading activities at home. By prompting children and parents with bilingual story-related questions with audio and visual cues, evaluating children's responses, and providing contingent feedback, the technology-enhanced e-book may facilitate dialogic reading and improve children's digital learning outcomes. To the best of our knowledge, no studies have investigated the applicability and effectiveness of bilingual discussion prompts in facilitating dialogic reading in EFL settings. Thus, the current study aims to examine and understand the role of bilingual e-book discussion prompts with English narration and print text in both English and Chinese in parent-child shared digital reading in an EFL context. The following research questions guided the study design and implementation:

1. What is the impact of embedded bilingual discussion prompts with immediate feedback on children's story comprehension, prompted story retelling, and English vocabulary learning?
2. To what extent are the user activities on the discussion pages (including the number of closed-ended discussion questions that users attempted to answer, the number of questions answered correctly at the first trial, and time spent on discussion pages) correlated with children's story comprehension, prompted story retelling, and English vocabulary scores for the children in the treatment group?
3. What are the main ways that parents respond to discussion prompts, and how do they appear to affect children's learning?
4. What are parents' and children's self-reported experiences and perceptions of the embedded discussion prompts in the bilingual e-book?

2. Literature review

2.1. Dialogic reading

Shared reading, the practice whereby parents read books together with their children, is an effective home literacy practice that is beneficial for children's literacy and language development (Crain-Thoreson & Dale, 1992; Lonigan et al., 1999). Although shared reading may take many forms, dialogic reading is an evidence-based approach that uses strategic and structured prompts to promote children's verbalization, participation, and comprehension (Chow et al., 2008; Lever & Sénéchal, 2011; Pillinger & Wood, 2014). During the dialogic reading process, parents can transform their children from passive listeners to active learners and storytellers (Whitehurst et al., 1988) by asking story-related questions, elaborating on new vocabulary, and scaffolding for comprehension, encouraging children to ask their own questions. These verbal interactions promote children's cognitive skills (Twait et al., 2019), narrative skills and language development (Arnold & Whitehurst, 1994; Lever & Sénéchal, 2011), vocabulary learning (Blewitt et al., 2009; Strouse & Troseth, 2014), and story comprehension (Robb, 2010; Strouse et al., 2013).

Two commonly used dialogic reading principles are "PEER" and "CROWD", initially developed by Whitehurst and colleagues (Lonigan & Whitehurst, 1998; Whitehurst et al., 1994). "PEER" refers to the four steps of dialogic reading: prompt, evaluate, expand, and repeat. "CROWD" refers to the five types of prompts that parents can practice, including completion prompts, recall prompts, open-ended prompts, wh-questions, and distancing prompts. The use of the "PEER" and "CROWD" strategies in parent-child shared-reading practices is believed to enhance meaningful discussion about the story and promote children's literacy and language learning (Whitehurst et al., 1988).

2.2. Parent-child dialogic reading in a second language

Recent studies have extended the benefit of shared book reading to children's literacy development from monolingual to second language settings. A recent meta-analysis examining 54 studies of shared reading for English learners conducted in the United States found an overall significant positive effect on English learners' oral language and literacy-focused measures (Fitton et al., 2018). However, this meta-analysis included only studies conducted in the United States, a developed English-speaking country. In non-English-speaking countries, particularly developing countries, children may not have access to rich English-language environments and educational resources for English language practices (Yu & Ruan, 2012). Also, most studies included in the meta-analysis were interventions implemented by researchers and service providers, with only 10 out of the 54 studies addressing shared reading

with family members. The dynamics and effectiveness may differ when trained researchers versus parents implement shared-reading interventions. Therefore, we cannot assume that the positive findings of shared-reading interventions in this meta-analysis can be generalized to the parent-child shared-reading practices in EFL settings.

A study conducted by [Chow et al. \(2010\)](#) revealed that although dialogic reading can facilitate English reading skills in Chinese children, second language dialogic reading in EFL settings tends to be less effective than dialogic reading in monolingual settings in enhancing oral vocabulary skills. Researchers suggest that there may be some differences in the nature and function of dialogic reading in acquiring the first language versus the second language, especially for parent-child shared reading in EFL settings ([Chow et al., 2010](#)). Parents whose first language is not English may experience challenges when reading an English story with their children. These challenges may result from parents' limited English proficiency, low English self-efficacy, and linguistic differences between the first and second languages. These potential difficulties may be more salient for parents from lower educational and socioeconomic backgrounds and impact how children benefit from home literacy practices.

2.3. Shared reading using e-books

E-books in general show promise in facilitating children's engagement ([Richter & Courage, 2017](#)) and promoting emergent literacy skills ([Shamir & Korat, 2007](#)), phonological awareness ([Chera & Wood, 2003](#)), and comprehension and vocabulary skills ([Smeets & Bus, 2015](#)). Many storybook apps include multimedia and interactive features such as audio narration, sound effects, animation, and interactive games ([de Jong & Bus, 2003](#); [Guernsey et al., 2012](#); [Korat & Shamir, 2004](#)). Many of these features are designed to engage children and support their independent use of the app without parental involvement. For example, the audio narration and multimedia features enable pre-literate children to make sense of new vocabulary, and "read" independently ([Kucirkova & Littleton, 2016](#), pp. 380–387).

However, studies point to the benefits of parental engagement in children's reading of e-books ([Dore et al., 2018](#); [Stuckelman et al., 2021](#); [Troseth et al., 2020](#)). The additional benefits of providing high-quality social interactions and sustaining children's attention make parents irreplaceable in children's home literacy practices for printed or digital storybooks. While reading a story, parents can initiate meaningful conversations about the content, connect the story to children's life experiences ([Hassinger-Das et al., 2017](#)), ask and answer questions, and reward children's positive behaviors. These social interactions are crucial for maximizing learning opportunities in the practice of home literacy. Moreover, it may be challenging for young children to maintain focus while reading e-books with multimedia and interactive features, as they are still in the critical developmental stage of building cognitive and attentional skills ([Kent et al., 2014](#)). When children get distracted, parents may draw their attention back to reading by pointing to the illustrations, asking an interesting question, or activating hotspots. In addition to the cognitive and attentional challenges, a recent study from [Xu et al. \(2019\)](#) indicates that children also experience difficulties navigating e-books when reading independently; they struggle to determine and use the appropriate motion and timing for page-turning. These challenges are amplified for children under four years old and those who lack experience using digital devices.

Despite the established benefits of parental engagement in children's story-reading practices ([Lever & Sénéchal, 2011](#)), existing e-books may not support or enrich such interactions. For example, [Munzer et al. \(2019\)](#) found that parents and their toddlers have fewer high-quality interactions when reading e-books compared with reading printed books. Such high-quality interactions include asking story-related questions and commenting on the storyline, which literacy experts believe to be important learning moments for children ([Troseth et al., 2020](#)). These findings suggest that although storybooks have been widely adapted for digital use by children, their design may hinder parent-child joint media engagement.

2.4. E-book discussion prompts

Whereas e-book multimedia and interactive features such as audio narration, animation, or interactive games are unlikely to support and may hinder parental engagement, discussion prompts may have the potential to facilitate parent-child dialogic reading ([Strouse et al., 2013](#)). Embedding discussion pages in the e-book allows the app to prompt story-related questions for the readers, create space for parent-child joint engagement, and stimulate meaningful discussions about the story and vocabulary. Moreover, reading e-books with discussion prompts may improve parents' dialogic reading techniques, especially for parents from low socioeconomic backgrounds. For example, in an e-book experiment conducted by [Troseth, Saylor, and Archer \(2006\)](#), parent-child pairs from low socioeconomic families read a narrated e-book twice with or without questions. In the enhanced e-book condition, an avatar asked questions, which were more straightforward in the first reading and more challenging in the second reading. They found that parents with the enhanced e-books spoke more than three times more with their children, with a greater breadth of vocabulary than parents using the unmodified e-book. Despite the differences in parent-child interactions, children who used the enhanced e-books did not have better learning outcomes than those who used the unmodified e-books.

Although the literature illustrates the potential benefits of embedding discussion questions in e-books to facilitate dialogic reading, it is unclear how this design feature impacts parent-child shared reading in an EFL context. To this end, the current study will examine the role of bilingual discussion prompts with immediate feedback embedded in an English e-book on EFL children's literacy outcomes, how parents and children respond to this design feature, as well as their user experiences. The findings of this study may provide critical insights for educators, designers, and researchers on designing e-books for families in diverse linguistic settings.

3. Methods

This study is part of a larger study aimed to design and develop an interactive bilingual storybook app to facilitate parent-child shared reading and children's bilingual literacy development (Author's year, blinded for review). The current study focused on one design feature—bilingual discussion prompts, and its impact on children's learning. This experimental study used both quantitative and qualitative analysis. We conducted a randomized controlled trial to answer the first research question and examined how bilingual discussion prompts impact children's story comprehension, story retelling, and story vocabulary learning outcomes after two shared-reading sessions. We conducted a correlational analysis using the clickstream data to answer the second research question. Variables gleaned from the clickstream data included the number of multiple-choice questions that users attempted to answer, the number of questions answered correctly at the first trial, and time spent on discussion pages (including closed-ended and open-ended questions). For the third research question, we randomly selected 20 videos of the reading sessions from the treatment group and explored the parent-child interactions on discussion pages. Using qualitative analysis that is both inductive and theory-driven, we aimed to explore how parents and children respond verbally to the discussion prompts, as well as how these user behaviors might impact children's learning. To answer the last research question, we examined the self-reported experiences and perceptions about the e-book and the embedded discussion prompts based on the data collected through parent questionnaires and interviews with both parents and children after the two reading sessions. Details of the methods and an introduction of the e-book with the discussion prompt feature are provided below.

3.1. An introduction of the interactive storybook

The first author wrote the e-book "The Story of an Orange Oakleaf." It is a story of an oakleaf butterfly who dislikes its dry-leaf-like wings but eventually learns to appreciate them as their dry-leaf appearance plays a crucial role in saving its butterfly friends from an evil bird. This storybook was hosted on a website with several multimedia and interactive features, including English narration, multimedia dictionaries, bilingual support, and character statement hotspots where users could click on the items/characters and listen to some story-related statements by the characters. The only difference between the e-books for the treatment and the control groups was that the bilingual discussion prompts with feedback were embedded in the e-books for the treatment group. While the control group's e-books did not include discussion prompts, all other multimedia and interactive features matched the treatment group's.

3.2. Bilingual discussion prompts with feedback

Following the "CROWD" dialogic reading principle (Zevenbergen & Whitehurst, 2003), we designed four types of discussion prompts in our storybook asked by the avatar Little Oak, who was the main character of the story. The four types are (1) Recall prompts where children are prompted to recall the story plot (e.g., "What did Mama just say to Little Oak?"); (2) Open-ended prompts which encourage the child to interpret or respond to the story or illustrations in their own words (e.g., "What colors are the wings of the butterflies in this picture?"); (3) Wh-questions which start with why, what, where, when, how (e.g., "Why are those butterflies so



Fig. 1. Demonstration of a multiple-choice discussion prompt page with feedback.

popular?"); and (4) Distancing prompts that encourage children to relate the story to their own experiences or emotions (e.g., "Have you seen a snake before?", "Do you like them?", "Why?").

We provided multiple-choice answer options with visual cues (see Fig. 1.) to half of the discussion prompts for the following reasons: a) it would be less challenging for the children to make a response given that the children who participated in the study were at a young age and most of them have limited English proficiency; b) adding multiple-choice answers to the prompts allowed us to design individualized feedback pop-ups for each discussion prompt to model the "prompt – evaluate – feedback" sequence and thus facilitate the parents to practice the "PEER" strategy. Specifically, individualized feedback was provided in a pop-up window by Little Oak after the parent or child selected an answer by touching the screen. For example, if the user selected a correct answer, Little Oak would appear saying: "Congratulations! That is correct! Everyone likes colorful butterflies because they are as beautiful as a rainbow!" or if the wrong answer was selected, he would say "Uh-oh, that doesn't seem to be the right answer. Try again!"

For discussion prompts that related to children's own experiences or descriptive prompts that rely on children's observation and interpretation, an example answer is provided from Little Oak's perspective (see Fig. 2.) after the child makes a response. For example, the final discussion prompt asked, "Has mommy/daddy ever had tears of joy?" The answer provided by Mama Oak was "Mama Oak had tears of joy when Little Oak won the singing competition in the garden."

There was a total of 20 discussion prompt pages in both reading sessions (10 in each session). The discussion prompts in the second reading session were more challenging than those in the first reading session. All the discussion prompt pages had automatic audio narration in English and written text in English and Chinese for parents' reference. Given that most of our children were English learners and preliterate in Chinese, we hypothesized that this design would motivate parents to get engaged with translation and scaffolding. The discussion prompts were automatically played as the users were reading the story but they could stop the narration and skip the discussion page by clicking on the "next" button.

3.3. Study design and procedures

To examine the impact of the discussion prompts on children's learning outcomes, we conducted a randomized controlled trial with 107 young English learners and their parents whose first language is Chinese. Initially, we recruited 130 families, but due to the difficulties with remote data collection, internet issues, device issues, and parents' tight schedules, 107 families completed the full set of procedures. During the experiment, children and their parents were randomly assigned into either (1) the treatment group where parents read the e-book embedded with discussion prompts with their children twice or (2) the control group where parents read the e-book without discussion prompts with their children twice. We intentionally assigned more children to the treatment group (1.5 times control). The two reading sessions took place in children's homes on two scheduled consecutive days.

Children were administered three post-tests following the two reading sessions: English Story Vocabulary Test - Receptive and Expressive Vocabulary Subtests, Story Comprehension Test, and Story Retelling Test. All assessments were administered through Zoom. Parent-child interactions during the two reading sessions were also videotaped by parents using another mobile device. Following the post-tests, parents completed a questionnaire, and we conducted semi-structured interviews with the parents and children to gain information about their perceptions and experiences with the discussion prompts.



Fig. 2. Demonstration of an open-ended discussion prompt page with feedback.

3.4. Participants

Children who met the following criteria were considered for recruitment: (1) 3–7 years of age; (2) first language is Chinese; (3) do not have severe learning disabilities, cognitive disabilities, or developmental delay reported by the teacher; (4) do not have other physical disabilities which might hinder them from reading the e-book (e.g., hearing impairment); and (5) have web-accessible touchscreen tablets or computers at home. Inclusion criteria for parents were: (1) Chinese native speakers and (2) do not have other physical disabilities which might hinder them from reading the e-book (hearing impairment). Using a snowball sampling approach, the lead researcher and research assistants reached out to potential participants through social media platforms. We sent the Study Information Sheet in English and Chinese to the parents for careful review. The lead researcher and the research assistants addressed all the parents' and children's questions. Of the 107 parent-child pairs that completed the study, 103 lived in China and 4 lived in the United States.

3.5. Measures

English Story Vocabulary Test was administered to assess the word knowledge skills of the story-related English vocabulary after the two reading sessions. This test contained two subtests: Story Receptive Vocabulary and Story Expressive Vocabulary, and each subtest consisted of 25 items (50 in total). In the Receptive Vocabulary subtest, children heard one English word or phrase from the story and selected which four pictures displayed on the screen best illustrate that term. The test instructions were in Chinese. In the Expressive Vocabulary subtest, children were shown four big pictures consisting of 25 story-related items (5–8 items on each picture). Test administrators used their mouse to point to an image illustrating each target word and asked the children to name it in English. Children scored one point for each item correctly named in English and a score of zero for incorrect responses and no responses. This test yielded a Cronbach Alpha of .97.

Story Comprehension Test. After the two shared-reading sessions, children were given a comprehension test to evaluate their understanding of the story. The comprehension test consisted of seven sets of questions. Three of the question sets included a simple closed-ended question followed by a follow-up open-ended question (e.g., "Did Little Oak use his camouflage when saving his friends? How did he do it?") and the other four included only one open-ended question in each question set (e.g., "Why did everyone say that Little Oak is a real hero?"). Closed-ended questions asked simple questions such as yes or no questions and children received scores of 1 for correct responses and 0 for incorrect answers and nonresponses. Open-ended questions were wh-questions that required a longer response and were scored on a scale of 0–3, with 0 representing nonresponses or completely incorrect answers and 3 representing thorough and correct answers. Answers received a score of 1 if the child mentioned an on-topic word or a phrase, but the answer was generally incorrect or irrelevant. Responses received scores of 2 if they were partially correct. Story comprehension questions were read aloud in English and Chinese, and children answered in their preferred language. The maximum score for this test was 24. All the answers were doubled-scored with an inter-rater reliability of over 90%. This test had a Cronbach Alpha of .85.

Story Retelling Test. After the two shared reading sessions, children were also administered a cued Story Retelling Test. Because of their young age, children were shown key illustrations as recall prompts to retell the story. We used the following instructions: "Hi, I just missed the story of Orange Oakleaf! Can you tell me what happened to Little Oak? You can refer to the following illustrations to remind you of what happened." When children stopped in the middle of the retelling, the test administrator prompted them with, "and then?" or "and next?" Due to the limited English proficiency of most participants in the experiment, we asked the children to retell the story in Chinese. To score the retelling post-test, we transcribed children's verbal responses into text and scored the critical idea units in the story (Capotosto & Kim, 2016). The first author and a trained research assistant scored the test, and the inter-rater reliability was 95% among the group.

3.6. Parent-child interactions on the discussion pages

Parents recorded the shared reading sessions with another device and shared the videos with the research team after finishing the experiment. We randomly selected 20 video recordings from the group who read with the discussion prompts to explore the parent-child responses on discussion pages. Trained research assistants transcribed the verbal interaction scenarios on the discussion pages using the CLAN program (MacWhinney, 2021). These 20 videos yielded 200 verbal interaction scenarios and 2699 utterances. The qualitative data coding and analysis were both inductive and theory-driven. We remained open to the unplanned themes and categories of how our participants respond to the discussion prompts and were informed by the dialogic reading and second language acquisition theories on what specific behaviors or conversations impact children's learning. The first and second authors coded the parent-child behaviors and conversations on discussion pages in the following three steps (Muller & Kogan, 2010).

First, we conducted open coding and memoing to explore, reflect and identify the content and topics of parent-child verbal and nonverbal interactions from all discussion scenarios. To ensure all possible topics can be identified, this step was solely driven by data where the two researchers read the transcripts repetitively, coded the data individually, and discussed together without having any presumptions from the theories. Some initial topics were identified for each scenario, for example, the parent is correcting the children's misunderstanding of the previous story plot, or the parent is encouraging the child to repeat the word in English.

Second, axial coding was conducted to look for patterns across various participants and discussion prompts. While identifying the themes that represent the most defensible interpretations of the data, we referred to studies on dialogic reading (e.g., the C-R-O-W-D & P-E-E-R strategies) and English language acquisition (e.g., social constructivism from Vygotsky's (1978) and Krashen's (1981) Theory of Second Language Acquisition) as theoretical guidance.

The final step was selective coding where we centralize and superordinate the codes into core categories. In this step, several main themes of parent-child interactions and the learning opportunities emerged, including parents naturally practicing dialogic reading strategies and providing scaffolding, children receiving comprehensible input, and children becoming active learners. Aside from the themes aligned with literacy and language learning theories, we also noticed that some discussion prompts did not yield any discussion (e.g., the question was skipped or the child was distracted from a discussion).

3.7. User experiences of the discussion prompts

The perceptions and user experience of the discussion prompts for both parents and children were examined using the parent questionnaire and the semi-structured interview data. The interview was conducted after the post-test. Trained research assistants asked all children, "How do you like this e-book?" and children in the treatment group, "How do you like the questions asked by Little Oak?" Similarly, all parents were asked, "How do you like this e-book?" and parents in the treatment group were asked, "How do you like the discussion prompts in the e-book?" After parents' and children's initial responses, follow-up questions were asked to gain more detailed information. After the interview, trained research assistants transcribed parents' and children's responses into printed text. We quantitatively analyzed answers for the yes or no question, and we qualitatively coded the rest of the data to identify topics of interest and gain insights into parents' and children's experiences and perceptions of the discussion prompts feature.

4. Results

4.1. RQ1: What is the impact of discussion prompts with immediate feedback embedded in the story on children's story comprehension, prompted story retelling, and English vocabulary learning?

Table 1 summarizes children's outcomes in treatment and control groups. To avoid experiment-wise Type I Error, we conducted a multivariate analysis of variance (MANOVA) before proceeding to t-tests, and our findings imply a significant impact on the three variables in the treatment condition ($F(4, 102) = 7.74, p < .001$). A series of Bonferroni-adjusted t-tests showed that children who read the e-book with discussion prompts demonstrated significantly better comprehension ($t(105) = 5.42, p < .001$) and retelling ($t(83) = 3.36, p = .001$) than children in the control group. The effect sizes (measured with Cohen's d) for story comprehension and story retelling were 1.07 and 0.66 respectively. However, there was no significant difference between the two groups' performance on English story vocabulary ($t(105) = 0.62, p = .54$). Similarly, there were no significant differences on the receptive vocabulary subtest ($t(105) = 0.03, p = .98$) or expressive vocabulary subtest ($t(105) = 1.14, p = .87$).

4.2. RQ2: To what extent are the number of closed-ended discussion questions answered and the number of questions answered correctly on the first trial correlated with children's story comprehension, prompted story retelling, and English vocabulary post-test scores for the children in the treatment group?

The correlations of the user log data for the 11 closed-ended discussion questions with learning outcomes for children in the treatment group are summarized in Table 2 in the Appendix. We found that the number of closed-ended questions attempted was positively correlated with children's story comprehension post-test scores ($r = .28, p = .02$). That is, children who attempted to answer more of the closed-ended discussion prompts tended to show better story comprehension at post-test. Moreover, the number of questions that were answered correctly at the first trial was positively correlated with children's story retelling ($r = 0.26, p = .04$) and story receptive vocabulary scores ($r = 0.34, p = .01$). In contrast, the time spent on discussion pages was not significantly correlated with children's learning outcomes ($r = 0.14$ for story comprehension, $r = -0.07$ for retelling, $r = -0.23$ for expressive vocabulary, and $r = -0.17$ for receptive vocabulary). Note that these results should be interpreted with caution because they are correlational and cannot yield causal inferences.

4.3. RQ3: What are the main ways that parents respond to discussion prompts, and how do they appear to affect children's learning?

Based on the qualitative analysis of the 200 verbal interaction scenarios of the discussion prompts, we identified four main themes which yielded 12 types of parent-child responses. For a table listing examples of all the themes, please see Table 3 in the Appendix.

First, we found that the discussion prompts provide unique opportunities for the children to receive more comprehensible input

Table 1

T-test results on children's learning outcomes.

	Treatment Group (n = 64)		Control Group (n = 43)		t-test
	Mean	SD	Mean	SD	
Story Comprehension	19.39	3.18	14.59	5.93	5.42***
Story Retelling	15.09	4.97	11.67	5.44	3.36**
Story Receptive Vocabulary	13.83	7.33	13.79	7.41	0.03(ns)
Story Expressive Vocabulary	15.11	7.56	13.4	7.68	1.14(ns)

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

(Krashen, 1981), which is key to second language acquisition. By translating the English story into Chinese and reviewing the story and vocabulary, parents, facilitated by the e-book app, ensured that their children receive natural communicative input that is appropriate for the current stage of their linguistic competence while still being able to enjoy the story. This theme is reflected by the following types of responses: (1) *Translation* (frequency: 75%) with the L1 support, parents were able to translate the discussion questions, English vocabulary, new phrases, and story plot into Chinese, which facilitated children's story comprehension. (2) *Vocabulary review* (13.5%) The discussion questions enabled parents to detect unfamiliar English vocabulary and review the key English vocabulary words with the child. (3) *Story plot review* (6%) Parents review or retell the story when the child forgot or misunderstood the previous story plot. An example of a mother translating the English discussion prompt into Chinese for their child is provided below:

Narrator: "Can you name a few other animals who use camouflage to protect themselves?"

Mother: "你还记不记得用自己颜色保护自己的动物?" ("Do you remember any animals that use their own color to protect themselves?")

Second, we found that with the discussion prompts, followed by the customized feedback on discussion pages, parents naturally practice dialogic reading strategies to facilitate and scaffold their children's learning (Towson et al., 2017). Just as social constructivism emphasizes, learning happens in the Zone of Proximal Development and can be fostered through interactive and dialogical pedagogical practices (Vygotsky, 1978). We found that this kind of scaffolding is achieved by the following types of parent-child responses on discussion pages: (1) *Follow-up questions* (57.5%) asked by the parent to encourage the child to elaborate or provide more information to the original prompt; (2) *Scaffold/correction* (26.5%), when the parent scaffolds the child towards the right answer for the discussion questions or corrects any of their story-related misunderstandings; (3) *Elaboration* (13.5%), when parents expanded the discussion of the story plot or vocabulary by explaining, describing, and connecting; (4) *Distancing discussion* (10%) in which the parent or child makes a personal connection with the story content. For example, when the e-book provides a discussion prompt for the child to answer, the mother translates the question without the child seeking assistance and asks a follow-up question that the child is capable of answering:

Mother: 你之前见过蛇吗? (Have you seen a snake before?)

Child: 我没见过没见过。 (I have never seen it before.)

Mother: 在动物园也没见过吗? (Haven't seen it in the zoo?)

Child: 对, 没见过 一条蛇也没见过。 (Yes, never seen a snake before.)

Mother: 哦, 你喜欢他们吗? (Do you like them?)

Child: 不喜欢不喜欢。 (No, Don't like them.)

Mother: 为什么? (Why?)

Child: 他们会咬人。 (Because they bite.)

Third, we found that with the facilitation of the discussion prompts, parents create a positive learning climate that encourages children to become active storytellers instead of passive listeners. By responding positively to children's participation (20.5%), such as a thumbs-up or verbal praise when they respond during the discussion, parents lowered the Affective Filter, particularly boosting children's self-confidence and reducing anxiety (Krashen, 1981). Meanwhile, encouraging the child to repeat and talk in English (18%) increases the quantity and quality of the language output, which is crucial to second language acquisition (Swain, 2005). An example of a mother encouraging their child to answer the discussion prompt using an English phrase can be found below:

Mother: 用英语说谢谢你怎么说? (How do you say "thank you" in English?)

Child: "Thank you".

Narrator: "If I were one of the butterflies, I would say to Little Oak thank you very much for coming here and saving us".

Mother: "Thank you very much for coming".

Child: "Thank you! Thank you! Thank you!"

Besides the above-mentioned parent-child responses that benefit learning, we also found that in a small number of scenarios, no parent-child verbal interactions were stimulated by the discussion prompts. Given the significance of social and dialogical interactions in bilingual literacy practices, we cannot conclude that learning is facilitated in these circumstances. These included (1) *no child response* (9.5%), in which the child did not respond despite the parent's attempt to engage verbally with their child; (2) *distraction* (2.5%) reflected instances when the child was disengaged, such as clicking the cursor randomly or making off-topic comments; and (2) *skipped questions* (7.5%) reflected instances when the discussion questions were cut-off due to technical problems or the reader's clicks/mis-clicks to skip the problem.

4.4. RQ4: What are parents' and children's self-reported experiences and perceptions of the embedded discussion prompts in the bilingual e-book?

We examined the self-reported experiences and perceptions of the e-book, and the discussion prompts feature. The interview data revealed that for the whole sample, 93% of the children and 92% of parents enjoyed reading the e-book story and whether the e-book has discussion prompts did not impact how users liked the e-book. The discussion prompt feature was well received, as 82% of the children and 98% of the parents liked it. Several children reported the discussion prompt was their favorite feature: "I love it the most. It helps my brain run really fast!"; "I love this the most because I feel so excited when I get the questions right." Another frequently mentioned reason for liking the discussion prompt was the appearance of our questioning avatar as the main character, Little Oak: "I love it when the little oak raises a question because I could learn more about him"; "I like the questions because the little oak is there." However, a few children showed less interest in or disliked this feature because the questions interrupted the reading flow or were too hard to answer. As one child commented, "I always had to pause the story reading for those questions."

The discussion prompts were parents' favorite feature among all the design features because they felt that the questions enabled their children to understand the story better and engage with the e-book. Typical comments were "It triggers him to think logically," and "The feedback is like a reward that makes her happy."

5. Discussion

Previous research showed that as a commonly used family literacy practice in monolingual contexts, parent-child shared reading, may be less effective in English as second or foreign language contexts (Chow et al., 2010). Indeed, reading an English story to a child could be very challenging for non-English speaking parents, especially those who are less educated and from low socioeconomic backgrounds. Multimedia features in digital storybook apps may provide new opportunities to this conundrum by facilitating parent engagement in the second language reading process. This study examined one e-book design feature: discussion prompts with bilingual support and their impact on children's learning in EFL settings.

The results from our randomized controlled trial showed that the discussion prompts with bilingual support in the e-book promoted greater story comprehension and retelling among EFL children. These results not only complement the findings from Troseth et al. (2020)—interactive e-book with a questioning avatar successfully enriched parent-child talk for low socioeconomic families—but also provide a critical piece of evidence that well-designed discussion prompts can effectively promote literacy outcomes even when parents have limited English proficiency. The comprehensive analysis of the user activities on e-book discussion pages, parent-child interactions, and user experiences reveals the following ways that bilingual discussion prompts may facilitate children's learning.

First, discussion prompts allow parents to effectively practice C-R-O-W-D and P-E-E-R dialogic reading strategies with their children. Our results indicated that bilingual discussion prompts, coupled with the immediate feedback, helped parents use dialogic reading strategies, such as evaluating children's responses, correcting their misunderstanding, elaborating story content, reviewing vocabulary, and connecting the story with previous experiences (Arnold & Whitehurst, 1994; Hargrave & Sénéchal, 2000; Troseth et al., 2020), without explicit training in these strategies. These dialogic reading scenarios provided unique scaffolding opportunities through the Zone of Proximal Development that is crucial to children's learning (Vygotsky, 1978). Moreover, parents who responded to their children with encouragement and praise may have enhanced the reading experience to be more engaging and enjoyable and thus boosted children's learning motivation.

Second, discussion prompts allow parents to provide comprehensible input (Krashen, 1981) to the children via translation and vocabulary review. When exploring parent-child verbal interactions on discussion pages, we noticed that parents engage in translanguaging practices: parents repeated the discussion questions in English and translated, elaborated, and scaffolded them in Chinese because they assumed their children needed extra assistance to overcome the language barrier. This bilingual scaffolding may have provided additional learning opportunities and bolstered children's comprehension and memorization. This kind of parental support at the discussion sessions, specifically translating the story and vocabulary, may be particular to second language or bilingual settings and may not be observed in monolingual settings. Given that this observation was from the qualitative analysis of the verbal transcript, further investigation of parent-child verbal interactions and how these interactions are associated with children's learning outcomes is required.

Third, the individualized feedback followed by the discussion questions provided extra learning opportunities for the children. Correlation analysis revealed that, generally, the more multiple-choice questions parents and children attempted to answer, the better children comprehended the story. Indeed, by making selections on the multiple-choice questions, children received customized audio feedback from the e-book to either further elaborate the story or correct misunderstandings. The findings from the current study added one more piece of evidence to support the benefits of individualized interactions during digital storybook reading to children's learning (Xu et al., 2021; Yang et al., 2020).

Fourth, the questioning avatar of the discussion prompts promoted children's parasocial relationships with the story character and boosted motivation. Studies show that children learn more effectively from media characters with whom they develop strong parasocial relationships (Brunick et al., 2016; Calvert & Richards, 2014). The most popular e-book element, according to the study participants, was the questioning avatar, Little Oak—the story's main character. The discussion prompts with immediate feedback provided a unique space for the children to learn more about the character and develop a closer relationship by connecting their real-life experiences through joint interactions. This real-world relevance may foster children's sense of social realism, hence establishing an emotional bond with the media character (Bond and Calvert, 2014a; Troseth et al., 2006). These findings provided critical implications for storybook app designers and researchers that some interactive features, such as discussion prompts with feedback, are effective and should be incorporated into the story-based learning system to develop parasocial relationships between children and the story characters and promote engagement. Another direction for future research is to empower the avatar with a bilingual conversational agent, providing more learning opportunities for children.

As for the vocabulary learning outcomes, we noticed that discussion prompts provided additional learning opportunities for children to review English vocabulary with their parents. Like Troseth et al. (2020), no significant effect of discussion prompts on learning English vocabulary was found. However, the non-significant finding of the discussion prompts in enhancing English word learning may reflect the nature of the prompts we used, which focused on overall story comprehension rather than story-related vocabulary. Therefore, future research should examine if discussion prompts focusing on story vocabulary promote children's second language vocabulary development.

We also observed that a few number of readers did not utilize the discussion prompts adequately. For example, instead of encouraging the child to answer the questions posed by Little Oak, several parents answered the questions for their children, or they skipped the discussion pages and continued with the story. These behaviors could be attributed to a variety of factors, e.g., not being

unaware of the potential benefits discussion prompts may provide for the children, or as indicated by the interview, children finding the questions too challenging to answer or thinking that the questions interrupted their reading flow. Future studies might explore how to improve and customize this design feature to meet the needs of different user populations.

6. Limitations

Several limitations need to be considered when interpreting the findings. First, the findings on parent-child responses were based on qualitative analysis; thus, we cannot draw causal inferences about the extent to which the discussion prompts impact parent-child interaction and the use of dialogic reading strategies. Second, though user-experience interviews were conducted right after the reading sessions, cases of inefficient use of discussion prompts were not identified until later, after we had the opportunity to transcribe the parent-child interactions. For that reason, we may have missed some details in these interviews. Future user experience studies should examine the reasons behind such user behaviors to improve the e-book discussion prompt feature.

7. Conclusion

This study examined the role of e-book discussion prompts with bilingual support in parent-child shared reading in an English as a foreign language setting. The randomized controlled trial showed that embedding bilingual discussion prompts in the storybook app significantly promoted children's story comprehension and retelling. Our qualitative analysis revealed that the discussion prompts with feedback allow parents to practice dialogic reading strategies and provide scaffolding to their children naturally and effectively, even without explicit training. With parents translating and elaborating the story, children received more comprehensible input, thus enhancing their comprehension. The questioning avatar further established children's parasocial relationship with the story character and boosted their motivation.

Training parents and education practitioners on effective bilingual literacy practices may be costly and time-consuming. This study shed light on the exciting potential of well-designed English storybook apps powered by interactive discussion prompts as an effective learning aid in EFL and bilingual education. This simple and low-cost instructional technology has the potential to minimize the achievement gap and educational inequity, particularly for children from low-income households with diverse linguistic backgrounds.

Credit author statement

Dandan Yang: Conceptualization, Methodology, Formal analysis, Investigation, Visualization, Resources, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition, Christina Xia: Writing – review & editing, Data curation, Resources, Investigation, Formal analysis, Visualization, Penelope Collins: Supervision, Conceptualization, Writing – review & editing, Project administration, Mark Warschauer: Supervision, Conceptualization, writing – review, Funding acquisition.

Funding

This work was supported by The International Research Foundation (TIRF) for English Language Education Doctoral Dissertation Grant; Duolingo Research Grant; and University of California Office of President Catalyst Award.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

Acknowledgements

We would like to express our appreciation to the children and families who participated in the study. Assistance in website development and data collection provided by the research assistants in the Digital Learning Lab and Collin's Literacy Lab at the University of California, Irvine is also greatly appreciated.

Appendix

Table 2

Correlation table for the clickstream variables and children's learning outcomes for the treatment group.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) NDA	1.00						
(2) NDC	0.64***	1.00					
(3) TDP	0.02	-0.16	1.00				
(4) Story Comprehension	0.28*	0.17	0.14	1.00			
(5) Story Retelling	0.15	0.26*	-0.07	0.49***	1.00		
(6) Expressive Vocabulary	0.17	0.24	-0.23	0.18	0.27*	1.00	
(7) Receptive Vocabulary	0.21	0.34**	-0.17	0.07	0.24	0.88***	1.00

Note: 1. * $p < .05$, ** $p < .01$, *** $p < .001$. 2. Variables: (1): Number of closed-ended discussion questions attempted to answer, (2) Number of closed-ended discussion questions answered correctly at the first trial, (3) Time spent on the discussion pages, (4) Story comprehension scores, (5) Story retelling scores, (6) Story Expressive Vocabulary, (7) Story Receptive Vocabulary.

Table 3

Parent-child interactions on discussion pages.

Theme	Type	Frequency	Description	Example
Maximize Comprehensible Input	Translation	150	Translates English story content into Chinese	Narrator: Can you name a few other animals who use camouflage to protect themselves? Mother: 你还记不记得用自己颜色保护自己的动物? (Do you remember any animal that uses their own color to protect themselves?)
	Vocabulary review	27	Reviews vocabulary words from the story	Mother: "He looks like a flower", flower 是什么知道吗? (Do you know what "flower" means?) Child: Flower 就是一个彩虹. ("Flower" means a rainbow.) Mother: 不是, 是一朵花. (No, it is a flower.) Child: 是花. (It is a flower)
	Story plot review	12	Goes over the story plot by story retelling or question asking	Mother: 小枯叶蝶在水里看起来像什么? (What does Little Oak look like in the water?) Narrator: "good job, Little Oak realizes that he looks like a dry leaf and gets very disappointed". Mother: 小枯叶蝶意识到自己是一片, 长得像枯叶的时候非常的开心还是难过? (Little Oak realizes that he looks like a dry leaf, was he happy or sad looking like a dry leaf?) Child: 开心. (Happy.) Mother: 开心, 开心? (Happy, happy?) Child: 不. (No.) Mother: 刚刚它在水里面看到自己的样子的时候是怎么样的? (When he saw himself in the water just now, how did he feel?) Child: 它, 非常难过. (He was sad.)
Practice Dialogic Reading Strategies	Follow-up questions	115	Uses follow-up questions to encourage child response	Narrator: What did mama say to Little Oak? Mother: 枯叶蝶对妈妈, 枯叶蝶妈妈对小枯叶蝶说了什么? (What did mama say to Little Oak?) Child: 我们的翅膀后来会变成最好的礼物. (Our wings will become the best gift.) Mother: 是谁给他的礼物? (From whom?) Child: 大自然 (From the nature.)
	Scaffold/correction	53	Facilitates the child towards the right answer for the discussion question or correct a misunderstanding	Mother: "What does Little Oak look like in the water"? Mother: 他看起来, 在水里看起来像什么呀? (What does it look like in the water?) Child: 像朵花. (Like a flower) Mother: 啊, 像朵花? (like a flower?) Mother: 你要看翅膀. (You need to look at the wings.) Mother: 就是他刚刚在前面我们那一页, 他在那个水里面看到自己的倒影对吧? (On the page before, Little Oak saw its own reflection in the water, right?) Mother: 然后他觉得自己像什么? (And what did he think he looked like?) Child: 枯叶蝶. (Oakleaf butterfly.) Mother: 啊枯叶蝶, 他看起来像什么? (Oakleaf butterfly, but what does he look like?)

(continued on next page)

Table 3 (continued)

Theme	Type	Frequency	Description	Example
	Elaboration	27	The parent or child expands on a story plot or vocabulary	<p>Child: 枯叶. (A dry leaf.) Mother: 枯叶, 对了. (A dry leaf, yes.) Mother: 你找一下这图里你找得出来其他动物吗? (Can you find any other animals in this picture?) Mother: 这个是一个什么呀? (What is this one?) Child: Squirrel. Mother: Squirrel啊, 这个是 owl, 猫头鹰你看哪里是 squirrel 啊. (Squirrel! This is an owl; how did you see a squirrel?) Mother: 你看他是不是融为一体了这棵树, 他作成树的那个样子让敌人以为他是树, 他是不是就是 "camouflage to protect" himself. (See how it was disguised as the tree, the way he became the tree made its enemies think he was a tree, he just used camouflage to protect himself.) Mother: 你之前见过蛇吗? (Have you seen a snake before?) Mother: 你喜欢他们吗, 为什么? (Do you like them? Why?) Mother: 昨天提问的不一样啊, 你见过蛇吗? (This question is different from yesterday, have you seen a snake before?) Child: 我没见过没见过. (I have never seen it before.) Mother: 在动物园也没见过吗? (Haven't seen it in the zoo?) Child: 对, 没见过 一条蛇也没见过. (Yes, never seen a snake before.) Mother: 哦, 你喜欢他们吗? (Do you like them?) Child: 不喜欢不喜欢. (No, Don't like them.) Mother: 为什么? (Why?) Child: 他们会咬人. (Because they bite.) Mother: 非常什么? (What?) Child: 会咬人. (They bite.) Mother: 会咬人. (They bite.) Child: 比如说毒蜥蜴或什么的. (Like a poisonous lizard or something.) Mother: 嗯. (Ok.) Child: 毒蜥蜴会咬人. (Poisonous lizards can bite.) Mother: 为什么蝴蝶那么受欢迎呢? (Why are the butterflies so popular?) Child: 因为他们漂亮. (Because they are beautiful.) Mother: Colorful, right? Mother: 又漂亮 beautiful. (And beautiful.) Mother: 对, you are right! (Yes, you are right!) Mother: 用英语说谢谢你怎么说? (How do you say "thank you" in English?) Child: "Thank you". Narrator: "If I were one of the butterflies, I would say to little oak thank you very much for coming here and saving us". Mother: "Thank you very much for coming". Child: "Thank you! Thank you! Thank you!" Mother: "Why are the butterflies so popular?" Mother: 为什么他们这么受欢迎呢? (Why are they so popular?) *child point to the e-book* Mother: Because ... Mother: 你不用点你就说就可以了. (You don't have to click, just say it.) Narrator: because they are very colorful and beautiful. Mother: "because they are very colorful and beautiful". Mother: 他们非常的五彩斑斓非常美丽. (Because they are colorful and beautiful.) Mother: "Because they are colorful and beautiful". Mother: "Why does the blackbird". Mother: No. Child: 这个. (This.) Mother: 啧. (Tsk.) Child: 这个. (This.) Mother: 你能不能听我解释完啊. (Can't you listen to me</p>
	Distancing discussion	20	The parent or child makes a personal connection with the story content	
Promote Positive and Collaborative Learning	Positive reaction	41	Praises the child for their responses or positive behaviors	
	English talk	36	Encourages the child to repeat English phrases, answer questions or talk in English	
No parent-child verbal interactions	No child response	19	The parent tries to have verbal interaction with the child but receives no verbal response	
	Distraction	5	The child is not paying attention (clicks randomly, makes off-topic comments, does not participate/answer)	

(continued on next page)

Table 3 (continued)

Theme	Type	Frequency	Description	Example
				explain.) Child: 这个是不是? (Is it this one?) Mother: 嗯. (Hm.) Child: 是不是啊? (Is it?) Child: 嗯? (Hm?)
	Skip discussion pages	15	The question gets cut-off due to technical problems or the readers clicks/misclicks to skip the problem	Mother: Do you have the "tears of joy"? *The participants did not answer this question due to technical problem*

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