



# The effects on children's literacy skills of reading e-books with different features: Are 'bells and whistles' over-rated?



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## ABSTRACT

Children's literacy skills in schools and at home are widely supported by technologies designed to advance their development. Surprisingly, the unique effects of specific interface features are widely disputed and inconsistent research findings make it challenging to generalise across different technologies. It is difficult to make an informed choice about which types of e-books, and which specific features, are most effective. This small-scale, experimental study examines the effects of specific interface features and compares them to a Flat e-book. In a pre- and post-test comparison design, we investigated the effects of three different e-book conditions (1) 'Flat' e-book, (2) 'E-friend', and (3) 'Dictionary'. Ninety typically developing Year-1 readers were selected from nine primary schools in England and then randomly assigned to one of the experimental groups. Results showed that children in the 'Dictionary' group increased more in Word Recognition of target words compared to the children in the 'E-friend' group. However, children in the 'E-friend' group made significantly greater gains in Reading Comprehension than children in the 'Dictionary' group. Children in the 'Flat e-book' performed as well on all measures as children in the enhanced features groups. We suggest new directions for research on features that might be superior to Flat e-books.

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## 1. Introduction

Children's literacy and language skills in schools and at home are widely supported by technological devices such as electronic books (e-books). Indeed, a number of research studies have reported that well-designed e-books can support children above and beyond traditional books and are able to enhance children's phonological decoding skills, vocabulary and comprehension [1–7]. The enhancements in e-books make the reading experience qualitatively different from that of traditional paper books [8].

When children read or listen to e-books, they can choose to read a story themselves, listen to the story, and/or engage with interactive features [9]. E-books include features like animated pictures, hotspots, sounds and activities. They often incorporate oral reading and print that changes colour as it is being narrated, which helps the child follow the text [4]. Previous literature demonstrates that the 'highlighting' of written words when read out by a narrator exposes children to grammatical forms of written language and draws attention to individual words [4,10–13]. In

addition, activities might expand children's knowledge of the story's events beyond the original text.

E-books can provide children with 'personalised' reading support, enabling them to read independently and assume greater control over their own learning [14]. They have the potential to support, encourage and motivate children [15], possibly because of the digital enrichments that traditional books do not have [8]. They can make books fun through lively animations and expose children to print and pictures in an enjoyable manner. In contrast, when children read traditional books, they can set their own pace but might struggle with decoding unfamiliar words or understanding passages without the help of an accomplished reader [16].

The literature on adult support during traditional book reading shows clear benefits for children. A meta-analysis on the added value of parent-child interactions during shared book reading demonstrated that it is not just exposure to storybooks that fosters children's literacy development but that parent-child dialogue is equally important [17]. Parents' participation strengthens the effects of book reading and boosts story comprehension and language development by, for example, asking specific questions and expanding on the text [17].

E-books and the like contain increasingly more enhanced features that resemble adult support. Hotspots, which are intended to provide additional information to the reader [18] are inserted to

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activate questions about the story and highlight the pronunciation of words, mimicking a parent–child interactive reading session. However, too many embedded features may distract children from the narration. Only when narration and non-verbal information are congruent with one another, are e-books able to promote story and text comprehension [8]. Embedded dictionaries, which provide synonyms or definitions of difficult words, may be similar to parents' explanations when children do not know a word. Similarly, highlighting and narrating of text may be similar to adults pointing to words when a child reads traditional print books. Interestingly, however, a recent study has shown that the attention of young (pre-school aged) children was not always on the word being pointed at by the adult [19].

One major drawback in a rapidly changing technological world is that many e-books are untested and potentially not of educational benefit [20–22]. Bus et al. [8] warn about cognitive overload and the fact that young children find it difficult to divide their attention between story comprehension and on-demand features like dictionaries and pronunciations. The authors suggest that multitasking requires complex executive functions, and that many young children are not yet able to control their attention skills effectively and switch between story text and embedded features.

Another major criticism of research on e-book features is that studies are heterogeneous [9] and research findings inconsistent [11]. Findings depend on the nature of the specific e-books used and do not readily generalise to other products, making it difficult to draw firm conclusions about what advantages children gain from e-books and other devices [23,24]. Unique effects of specific interface features are disputed and unclear [21,22]. The effectiveness of a particular e-book depends on several factors, including the quality and purpose of the e-book, the specific reading skills promoted, accompanying activities, the child's age, their initial knowledge, and how they use the e-book [11,24]. For example, highlighting of text in e-books has been found to have limited effects on the print-specific skills of children under 5 [25], whereas it has been found to be effective for older children [11, 26,27]. Furthermore, the impact on children's recall skills is still in question [9]. A study by de Jong & Bus [4] demonstrated that children who read e-books with numerous hotspots were able to recall as much from the story as from stories read to them by adults. Another study by Ricci and Beal [28] found that children who read enhanced e-books with hotspots (unrelated to the story) had improved recall. However, another study showed that children who read 'enhanced' e-books recalled significantly fewer narrative details than children who read the print version of the same story [29].

A recent meta-analysis (43 studies) on the effects of technology-enhanced stories on young children's literacy development by Takacs et al. [9], found a small but significant additional benefit of technology for story comprehension ( $g+ = 0.17$ ) and expressive vocabulary ( $g+ = 0.20$ ). The authors conclude that technology could enhance the effects of storybooks on young children's literacy development. However, it was suggested that a wide variety of technology-enhanced stories and measures were used in the studies and effects were heterogeneous. The authors underscore the "importance of investigating the effects of different technological features on literacy development" (p. 30) [9]. Bus et al. [8] also call for well-controlled studies that examine the effects of new e-book and app formats on emerging literacy skills. They emphasise that researchers are obliged to examine key components of effective digitised books, so that technology might reduce the disparity in academic performance between groups of students.

In sum, inconsistent findings limit generalising across different software products, making it difficult to make an informed choice about which incorporated features are most effective. What

features support children's literacy and language skills? Does the combination of certain features result in additional support for reading?

The current study attempts to tease apart some of the common interface features found in e-books and investigates which features are effective in supporting specific literacy skills. Three e-book conditions were compared. The first was a 'Flat' e-book, to act as a 'control' condition. This was simply a book in PDF format which included flat illustrations and text. The other two separated certain features in order to study their effects independently. The 'E-friend' e-book was designed to support general reading of the text as well as understanding of the story. It involved a character who would ask questions and offer highlighting and audio cues. The 'Dictionary' e-book was also designed to offer enhanced reading support, although its main feature, inbuilt dictionary definitions and pronunciations of individual words, focused on certain key words.

Based on the literature, the following hypotheses were tested:

1. Children in the E-friend and Dictionary groups will have higher scores on *target word reading* when compared with the Flat e-book group.
2. Children in the E-friend condition will demonstrate higher scores on *story comprehension* compared with the other groups.
3. Children in the E-friend and Dictionary groups will show higher scores on *recalling* the story than the Flat e-book condition.
4. Children in the Dictionary group will demonstrate higher scores than children in the other conditions to describe the *meaning of target words*.

## 2. Method

### 2.1. Design

The effects of three e-book conditions were examined in a randomised control trial with three experimental conditions:

- 'Flat e-book' ( $N = 30$ ): Children independently read an e-book with flat illustrations and text on a computer. This e-book included no additional features, audio, highlighting or animations. It was identical to a paper book, but presented on a computer screen, with pages being advanced by the child clicking the mouse, and thus can be seen as the 'control' group.
- 'E-friend' ( $N = 32$ ): Children independently read the E-friend e-book. Pressing the "E-friend" button opened a separate window in which the E-friend asked a question about the story. The E-friend did not have audio; children had to read the question themselves. Children also had access to visual highlighting and an audio cue via the "Speaker" button. It should be noted that children were only able to hear the full sentence read aloud to them in a 'story-telling' voice but could not click on separate words for pronunciations (as in the Dictionary e-book).
- 'Dictionary' ( $N = 28$ ): Children independently read the Dictionary e-book and could access pronunciations of each individual word but not the full sentence (as in the E-friend version). When children clicked on a word they received the pronunciation in a computer voice. The e-book also included 21 inbuilt dictionary definitions taken from a well-known children's dictionary. When children clicked on the "Dictionary" button challenging words were highlighted. If the child clicked on a highlighted word, the pronunciation and definition was given by a human voice in a separate window.

### 2.2. Participants

A total of 90 typically developing Year-1 readers (34 boys) from diverse socioeconomic status (SES) families were selected from 9

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