



Children's Reading With Digital Books: Past Moving Quickly to the Future

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ABSTRACT—*Digital books, such as e-books, story apps, picture book apps, and interactive stories, are narratives presented on touchscreens with multimedia and interactive features. Evidence suggests that early reading of print versus digital books is associated with different patterns of parent-child engagement and children's outcomes. Parents' verbal scaffolding, children's age, and the congruence between a book's narrative and its interactive and multimedia features are three documented process variables that explain the difference between reading print and digital books. To maximize the added value of digital books for children, we need to study the interaction among the characteristics of parents, children, and books; we also need to target these interactions through interventions and through collaborations between designers and researchers.*

KEYWORDS—*e-books; digital books; story apps*

From a very young age, children are increasingly using digital media. This phenomenon, coupled with the undisputable benefits of children reading print books, makes it imperative to

identify the benefits and limits of children's digital books. The findings of studies on the topic have been mixed, with researchers following different theoretical and methodological approaches and reaching different conclusions, as highlighted in two recent literature reviews (Kucirkova, 2019; Reich, Yau, & Warschauer, 2016). If we assume that digital books unidirectionally alter the nature of parent-child interaction, then shared reading of digital books is inferior to shared reading of print books. But if we view the context of parent-child reading as something that is created together socially and materially, then different digital books are suitable for different children and parents.

Research on the use of children's digital books has grown over the past two decades into a multidisciplinary and methodologically diverse area, with a focus on qualitative or quantitative research techniques and books produced commercially or by researchers. In this article, I focus on children's digital books in relation to the interaction among parents' reading strategies, children's characteristics, and books' features, and explain the mixed findings in the literature on reading print versus digital books. Some have argued that comparisons of children's outcomes in relation to digital versus print books isolate elements of context and design. Such an approach neglects several important process variables, such as parents' and children's behaviors with different features of books, which jointly affect children's learning. The field needs more practice-focused scholarship that considers nuanced sociocultural influences, which dovetail with the design features of individual e-books.

The focus in this article is on children from birth to age 5 years, when most children are not yet readers, which is the popular under-5 category targeted by commercial e-book providers (e.g., Apple). The term *digital books* refers to e-books, story apps, picture book apps, and iBooks, which offer fictional narratives in texts, illustrations, sounds, and interactive features, and which are available via touchscreen technologies. In this review, I include studies of children reading digital books with adults, with other children, and by themselves.

First, I consider key findings from studies that compared digital and print books in relation to children's early literacy

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outcomes. Then, I discuss research on three components that might mediate these outcomes: parents' reading strategies, children's characteristics, and books' characteristics. The interaction among these variables, together with inconclusive evidence based on small negative correlations between digital books and children's outcomes, raises questions about the conclusion reached by some pediatricians—that the promise of digital books improving children's learning has not been fulfilled and their use should be discouraged in favor of print books (Tomopoulos, Klass, & Mendelsohn, 2019). I conclude with recommendations for a joint research and design agenda.

Children's Learning Outcomes With Digital Versus Paper Books

A substantial body of research has focused on comparing digital books to print books, with evidence of both positive and negative effects for children's emergent literacy skills. For example, in a Canadian study of 17- to 26-month olds that compared electronic books and print books, children learned more new words and displayed more engaged and socially desirable behavior when reading the digital books (Strouse & Ganea, 2017a). In another experiment, in which researchers compared the interactions of 3- to 4-year old Dutch children with digital and print books, children's receptive vocabulary scores were higher when they read the digital book (Gremmen, Molenaar, & Teepe, 2016). However, in a study of 4-year-old US children who read digital and paper books, children's reading comprehension scores were almost equal for both formats (Lauricella, Barr, & Calvert, 2014). Similarly, another study of 3- to 5-year-old Canadian children's recall of stories presented in digital and print formats found no differences between the two formats (Richter & Courage, 2017).

Research evaluating the benefits of digital books for children's early literacy has also yielded mixed results. One review of the utility of digital books for supplementing literacy teaching outlined the positive benefits of digital books for children's emergent literacy skills (Biancarosa & Griffiths, 2012), whereas another concluded that print books led to greater learning than digital books (Miller & Warschauer, 2014). Although these reviews did not follow systematic procedures like those used in biomedical reviews and did not evaluate the methodological quality of the studies, their contrasting conclusions highlight the conceptual differences in the field.

Studies that compare formats operate from the premise that the "medium is the message" (McLuhan, 1964, p. 84), which can, in and of itself, explain variation in distal variables, such as children's literacy outcomes. Such an approach does not accord with the sociomaterial research tradition (Barad, 2003), which posits a continuing back and forth between social actors (e.g., parents and children) and material, nonliving objects (e.g., digital books) in complex networks of multiple subjectivities. Moreover, in line with typical reading practice with print books, most comparisons between digital and print books investigate children's outcomes with books read by an adult. Thus,

children's engagement and outcomes need to be studied in relation to the interaction techniques (i.e., reading strategies) used by parents and other caregivers.

PARENTS' READING STRATEGIES

In most studies that compare the reading strategies of parents of 2- to 5-year olds, strategies used by parents with digital books (as compared to print books) have been more focused on behavioral and technical aspects than on story content (Kremer & Cingel, 2014). Comments on how to hold the iPad or how the pages are swiped dominate parents' talk during shared reading of digital books, with fewer language-stimulating dialogic reading strategies than when they share print books (Munzer, Miller, Weeks, Kaciroti, & Radesky, 2019). In studies that compare different types of digital books, researchers have identified similar patterns, with more interactive features correlating with less language-stimulating talk by the parent. For example, in a study of US parent-child dyads, parents' use of dialogic reading techniques (e.g., prompts, questions, pointing) and children's story comprehension skills were lower with digital books than with electronic console books and CD-ROM books that had fewer special effects (Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff, & Collins, 2013).

Parents' different reading strategies with print and digital books may be related to their strong preference for children's print books. In interviews, Australian mothers of 2-year olds preferred using printed storybooks, particularly at bedtime (Nicholas & Paatsch, 2018). In a national survey in the United Kingdom, parents of children from birth to age 2 years had major concerns about digital books and minimized their children's exposure to them (Kucirkova & Littleton, 2016).

Parents' attitudes toward digital books might influence their perceptions of children's engagement and enjoyment of the reading sessions. For example, when asked about their children's engagement with digital and print books, parents of 1- to 4-year-old Canadian children said their children engaged in and enjoyed print books more than digital books (Strouse & Ganea, 2017b). However, these parents' perceptions do not accord with researchers' observations, which show that children prefer digital books (Strouse & Ganea, 2017b) or enjoy print and digital books equally (Grimshaw, Dungworth, McKnight, & Morris, 2007). Parents' negative and incorrect beliefs about children's preferences for reading likely contribute to their lower-quality reading strategies, which, in turn, influence children's lower-quality learning with digital books (Strouse & Ganea, 2016). Therefore, researchers must identify the factors that shape parents' negative attitudes toward children's digital books.

A meta-analysis of 29 studies of preschool, kindergarten, and elementary school children compared children's comprehension and word learning from digital and print books read with and without the support of an adult (Takacs, Swart, & Bus, 2014). Digital books, which included books that synchronized

illustrations with the narrative, were more beneficial than print books used without the help of an adult. When an adult was present, there was no difference in children's story comprehension between digital or print books (Takacs et al., 2014). Differences between paper and digital books (in favor of digital books) appeared only when no adult was involved; this led to the conclusion that adults' interactions while reading paper books with children might have the same impact as children interacting with the multimedia additions in the digital books on their own. In addition, several children's characteristics, including age, language, and temperament, influence parents' perceptions and reading strategies.

CHILDREN'S CHARACTERISTICS

Cumulative evidence shows that children's engagement, as measured by visual attention or observer ratings, is greater with digital than with print books (Richter & Courage, 2017; Strouse & Ganea, 2017b). We do not know whether this engagement is greater because of children's restricted access to digital books, or because of their parents' mediating strategies or the books' interactive and multimedia features. Research on children's characteristics is beginning to explore age and executive functioning as factors that influence how children learn with digital books. In a study of 3-, 4-, and 5-year-old Canadian children reading digital and print books, children's greater engagement with digital books was significant only for the 3-year olds (Richter & Courage, 2017). In another study, 2- and 3-year-old US children verbalized and collaborated more while reading print books than while reading digital books (Munzer et al., 2019). These findings suggest that 2- and 3-year olds are more engaged with digital books than older toddlers. However, when researchers compared outcomes of digital versus print books, the children's executive functioning, not their age, explained variation in attention and story recall (Lauricella et al., 2014). It is difficult to draw strong conclusions about developmental trends because we lack longitudinal and cross-sectional studies involving the use of digital books with children under age 2 years. Richter and Courage (2017) recommend using maturity of children's executive functioning to gauge the suitability of digital books for young children's use.

For minority-language children or children from households with little history of reading, the distributed authorship and free-to-the-reader pricing of digital libraries (e.g., International Children's Digital Library, Storyweaver) suggest the significant potential of digital books to increase reading choice and volume through access to low-cost and diverse materials. Systems of scalable reading apps designed to teach children to read (e.g., Curious Learning, BookNook) and promote parent-child story sharing (e.g., the Worldreader Kids App) provide a way to individualize reading instruction for children from low-income areas. Researchers need to identify who and under what circumstances children benefit from such digital books.

CHARACTERISTICS OF BOOKS

Adults' negative perceptions of children's digital books are typically countered by highlighting the added value of these books for bilingual education, motivating reluctant readers, supplementing learning for children with special educational needs, and reaching families that have low literacy and own few print materials but have smartphones or tablets. Most evidence for these benefits comes from individual case studies, which use digital books designed by researchers with scaffolding features constructed to foster emergent literacy skills. Such books have been helpful for children at risk of a learning disability (Shamir, Korat, & Fellah, 2012), children from low socioeconomic backgrounds (Korat & Shneor, 2019), and children with language impairments (Korat, Graister, & Altman, 2019) or poor letter knowledge (Rvachew, Rees, Carolan, & Nadig, 2017). Moreover, digital books designed to encourage parent-child conversations increased conversational turns between caregivers and 2- to 5-year olds from low-income backgrounds (Troseth, Strouse, Flores, Stuckelman, & Johnson, 2019).

However, as we interpret these results, we must be aware that many commercially produced digital books are of very low quality. For example, in a descriptive analysis of English and Hebrew digital books, researchers identified distracting multimedia features and few features that supported story comprehension or language learning (Korat & Falk, 2017). Similarly, the most popular (best-selling) digital books in Greece, Hungary, the Netherlands, and Turkey are of low educational value (Sari, Takacs, & Bus, 2017). Despite well-formulated research suggestions for improving the design of these books (Hirsh-Pasek et al., 2015; Richards & Calvert, 2017), the quality of digital books has improved very little over the past 10 years (Korat & Falk, 2017).

Poor quality relates to the books' content as well as to features such as weight, brightness and quality of images and illustrations, opportunities to engage the senses, and the presence or absence of augmented reality (visual overlays activated by the camera or imaging device that enhance the content with virtual texts and images). Most research on digital books has focused on interactivity (touch-activated movements of characters, changes to plot, or playing games embedded in the story) and multimedia features (a combination of media such as sounds, music, voice-overs, illustrations, photos, drawings, text, and videos). Unlike external properties of digital books, such as the devices they are accessed on, multimedia and interactivity are embedded in digital books and realized when a reader interacts with the book.

In studies comparing US children's learning from interactive versus noninteractive digital books, interactivity had a positive effect (Kelley & Kinney, 2017; Zipke, 2017). Interactivity in these studies consisted of features beyond what print books offer, such as spoken narration, text highlighting, sound effects, music, and moving characters. However, two major research

summaries—a meta-analysis (Takacs, Swart, & Bus, 2015) and a literature search that included studies of 2- to 12-year olds and compared outcomes with effect sizes (Zucker, Moody, & McKenna, 2009)—concluded that interactive features, broadly defined, have a negative impact on children’s learning when they are incongruent with stories’ plot and main narrative. Incongruent interactivity includes features not aligned with the main story line and that draw attention from the story to games or other activities embedded in the digital books. Incongruent interactivity was also negatively related to vocabulary scores, retelling, and inference in an analysis of 5- to 6-year-old US children reading digital books over 1 school year (Christ, Wang, Chiu, & Cho, 2019).

The importance of congruence also applies to multimedia features which, if not in agreement with the story, impede children’s comprehension and word learning (Bus, Takacs, & Kegel, 2015). These findings can be explained by the capacity theory of attention (Kahneman, 1973), according to which performance on a task is limited by the cognitive resources available to an individual: Incongruent interactivity consumes the cognitive resources that would otherwise be available for children to infer or comprehend the meaning of the story. Thus, it is not interactivity or multimedia per se but their incongruent versions that are not helpful for children’s early literacy outcomes.

Children’s digital books lack a conventional design, which limits their usability as well as researchers’ ability to analyze

them consistently across studies. Several qualitative studies have focused on the development of typologies and the characterization of various types of features in digital books (e.g., Turrión, 2014). In observations of Spanish children’s engagement with digital books at home, interactive and multimedia features that actively involved the child in the story increased autonomy, enjoyment, and agency (Aliagas & Margallo, 2017). Such personalized reading experiences are created through embedded algorithms (automatic personalization) or a reader’s active contribution of content (agentic personalization). Personalized interactivity and multimedia features position the child as collaborator, storyteller, or author of the story, and support a positive reading atmosphere at home (Kucirkova, Messer, Sheehy, & Flewitt, 2013) and children’s sense of volition (Kucirkova, 2018). In summary, in terms of book characteristics, digital books that offer high-quality content and other carefully defined features can add value for children at risk of academic success.

ISSUES RELATED TO RESEARCH AND PRACTICE

Given the interrelationships among parents, children, and the characteristics of books, researchers should draw on a dynamic model of book reading in which design and research work together to strengthen the research base and enhance children’s contemporary reading experiences. This dynamic model

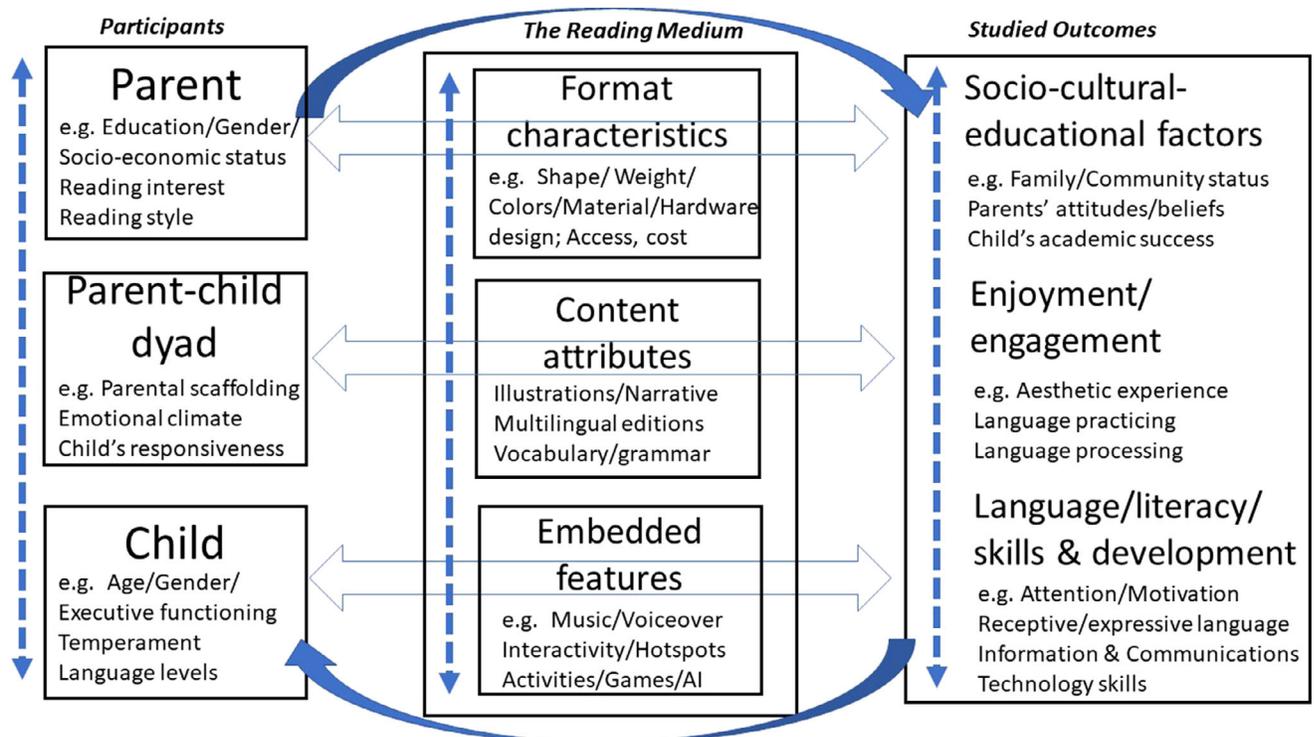


Figure 1. Dynamic model of children’s e-reading.

hypothesizes an interplay among parents, children, and the characteristics of the book in a complex model of interactions (see Figure 1). In light of the dynamic model, I propose three avenues for research-design collaboration:

User-Led Participatory Approaches

To break the negative cycle of low-quality content and low-quality mediation of parent-child shared reading of digital books (Strouse & Ganea, 2017a), researchers need to address the mediators of parents' negative attitudes toward digital books, including the aforementioned poor quality of commercially available children's digital books. Researchers should develop guidelines and best-practice examples for parents to select and interact with children's digital books. Such a research-practice approach, also known as user-led participatory design or human-centered design, dominates best-practice models in children's technology (Druin, 1999) and could add valuable tools to the field of children's digital books.

Qualitative Markers of Digital Book Features

Understanding the properties of specific book features would better explain the patterns in current research. For example, incongruent interactive features (e.g., illustration that distracts from the text) can be detrimental to children's learning while personalized incongruent interactive features (e.g., a child's own illustration that distracts from the text) might reinforce or mitigate these effects. Building on the large body of evidence concerning interactive and multimedia features of children's digital books, it is time to move toward features specific to reading digitally. In particular, researchers should capitalize on the possibility of using digital books to provide a reading experience for children while also providing data about the experience. Personal data can prompt parents to personalize the reading experience for their children, and data on children's reading progress can identify individual children's reading strategies and adapt content (Huang & Liang, 2015). A fine-grained focus on qualitative markers of the features of digital books expands the current research-design focus on verbal interaction to include embodied reading (i.e., reading that is understood as a whole-body experience), in which all modes of communication are valued equally. Embodied reading is a vibrant field of research on adult reading (e.g., Mangan, 2008) but is underrepresented in research on children's reading. Studies of adults' and children's literature have been unhelpfully segregated for several decades, and the study of digital books could pioneer research that integrates these data with a shared analytical focus.

Combining Different Types of Content With Different Types of Formats

With few exceptions (studies that looked at parent-child reading of nonfictional digital books; Strouse & Ganea, 2016), most research knowledge about digital books comes from studies focused on fictional, narrative content. The interaction between

diverse types of content with diverse types of books' features is not well understood and needs to be addressed given the increased policy interest of some countries (e.g., China) to replace all print-based textbooks with digital textbooks in elementary schools. The potential of digital books to bridge home-school reading (Roskos, Brueck, & Lenhart, 2017) and provide multimedia, multilingual education (Wang, Christ, & Mifsud, 2019) will be realized more readily if researchers prioritize the study of diverse contents that cover reading for pleasure as well as reading for information. In addition, the development of high-quality content and formats of children's digital books necessitates strategic government investment on national and international levels, as well as removing the unfair advantage for distributing print books (e.g., the reading tax in the United Kingdom on digital publications).

CONCLUSION

In conclusion, digital books diversify and, in many cases, correspond to children's reading choices. Unless researchers and practitioners are open to understanding the value and place of children's digital books in the contemporary reading landscape, important issues around the books' use will not be addressed. Given the evidence that high-quality digital books can help children learn and enjoy reading, research-practice efforts need to optimize the design and use of children's digital books to retain the status of reading as the most important activity for children's learning.

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