The Four Pillars of Learning: e-Books Past, Present, and Future

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Abstract In this chapter, we will explore explanations for this conflicting evidence, and importantly, demonstrate the power of evidence-based recommendations for e-book use. In an effort to compare traditional books and e-books, this chapter will apply four pillars of learning generated from the Science of Learning (Hirsh-Pasek K, Zosh JM, Golinkoff RM, Gray JH, Robb MB, Kaufman J. Psychol Sci Public Interest 16(1):3–34. https://doi.org/10.1177/1529100615569721, 2015)—active, engaged, meaningful, and socially interactive. By harnessing the science of learning and relying upon the lesson generated by decades of research in psychology, education, and cognitive science, this chapter will explore how we can harness the potential—and mitigate the drawbacks—of e-books. Technology can be a marvelous tool—but only if we know how to use it.

Keywords Science of learning · e-Books · Early childhood · Literacy

In 2016, the American Academy of Pediatrics (AAP) released new guidelines on media use, and again, parents and educators were challenged to consider a readjustment of how they facilitate children's access to smartphones and tablets. How much—and likely more importantly—what kind of digital media consumption is acceptable for young children?

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In these new AAP recommendations (2016), "no screens under two" became "no screens for 18 months and younger" with the proviso that video chatting is acceptable for all ages. Recommendations for older children include less than 1 hour per day of screen time, using only "high-quality programming," and co-viewing with an adult. However, the notion of "high-quality" remains abstract. The revisions by the AAP along with the current state of research seem to be converging on the following idea: digital media itself is not necessarily a problem—the problem lies with how that technology is used.

One specific type of digital media that has the potential to be high quality is the e-book. The benefits of traditional storybook reading for young children's language and literacy development is well-established in the literature (e.g., Hargrave and Sénéchal 2000; Whitehurst et al. 1988; Zevenbergen and Whitehurst 2003), and one primary advantage of e-books is that families now have easy access to a variety of different e-books on devices that are constantly within reach. By 2014, 62% of 2- to 10-year-olds had access to either a tablet or a dedicated e-reader for electronic reading at home, and parents reported that about half of those children regularly engaged in electronic reading (Rideout 2014). Even children with emergent literacy skills are using this new technology for reading. Younger children (2- to 4-year-olds) use e-reading devices at similar rates as older children (Rideout 2014), with children beginning to use e-books at an average of 5 years of age (Gilmore 2015). When we use the term "e-book" in this chapter, we include several different formats of digital books, including those formatted for computers, consoles like LeapFrog, as well as their more modern equivalents on tablets. Although these formats may have some differences, the research literature has investigated all of these formats under the broad umbrella of "e-books" as technology has developed over the years. Also, it is worth noting that not all e-books have multimedia features, such as animation, narration, or interactive, touch-screen components, so here we include both interactive and non-interactive formats.

To date, there have been conflicting findings with some studies finding that e-books hinder learning while others demonstrate that they help. Some researchers have argued that e-books can support literacy development while some argue that they do not. Meanwhile, some studies have demonstrated that e-books can hurt parent-child interaction and some show similar interactions in the two mediums. Here, we explore these seemingly contradictory results through the lens of a particular set of book reading behaviors that have consistently demonstrated success in children's literacy development across book platforms: dialogic reading. Whitehurst et al. (1988) coined the term *dialogic reading* for a now widely recognized shared book-reading technique featuring adult scaffolding and child participation. Dialogic reading consists of adults: (1) using strategies to encourage a child to actively participate reading a story; (2) offering praise, explanations, and corrections for children's comments about the story; and (3) scaffolding children's independent level of understanding by incrementally increasing the complexity of adult – child reading interaction (Whitehurst et al. 1988).

We examine evidence about how children learn generated from the Science of Learning (Hirsh-Pasek et al. 2015) to make sense of how traditional and electronic books compare and explore how we can harness the potential—and mitigate the drawbacks—of e-books.

1 The Four Pillars and Book Reading

In their paper about "putting the education back in educational apps", Hirsh-Pasek, Zosh, and colleagues (2015) suggest that children learn best when they are active (minds-on) and engaged (not distracted) in meaningful learning via high-quality social interaction. Here, we suggest that dialogic reading is a perfect example of an activity that leverages all 4 pillars simultaneously. Further, we argue that lessons learned from traditional books should inform how electronic books are designed and used and that these insights could potentially provide explanations for seemingly contradictory research results about the benefits and costs of electronic books.

1.1 Dialogic Reading

Many studies with children from a variety of ages and diverse backgrounds using traditional paper books have found that dialogic reading is effective for supporting children's language and literacy development (e.g., Fielding-Barnsley and Purdie 2003; Mol et al. 2008; Wasik and Bond 2001; Zevenbergen and Whitehurst 2003) and those lagging behind in vocabulary (Hargrave and Sénéchal 2000). For instance, Wasik and Bond (2001) tested the efficacy of dialogic reading in a school setting. The authors assigned two classrooms to the intervention condition and two classrooms to a control condition. In the intervention, teachers were trained in the CROWD-style of dialogic reading (Whitehurst et al. 1994). The CROWD acronym represents: sentence **C**ompletion prompts, information **R**ecall prompts, **O**pen-ended (recalling information in students' own words) prompts, **W**h-word prompts (who, what, when, where), and **D**istancing (applying book content to other contexts) prompts (Whitehurst et al. 1994). Control group teachers received no specific training. The study examined the effect of interactive shared book reading plus extension activities reinforcing the use of target vocabulary in the book on children's language development (Wasik and Bond 2001). Teachers read two storybooks to their students every week for 15 weeks, either using dialogic reading strategies or using their typical reading styles. Afterwards, children who received the intervention performed significantly better on a measure of receptive vocabulary than their control group peers.

Below, we suggest that dialogic reading may be so beneficial because it harnesses the four pillars of learning. We briefly review how dialogic reading relates to each pillar and then explore what is known about how traditional and electronic books support (or detract from) each pillar.

Active Contexts Research from the Science of Learning suggests that children learn best when they are active, meaning that they remain "minds on" instead of passive (Hirsh-Pasek et al. 2015). Learning requires the active mental manipulation of ideas. It requires that children think about possibilities, comprehend not just the

words but also the story, hypothesize about what comes next based on the story and their own experiences and knowledge, and hold information in mind as the story unfolds. This is precisely the work of dialogic reading. The CROWD model (Whitehurst et al. 1994) described above is a perfect example of engaging children in minds-on thinking.

Even when children use e-books independently, outside of a dialogic reading context with an adult, features that encourage children to use minds on thinking can promote learning, as long as the features help focus children's attention on the educational content. In fact, Courage (this volume) argues that active e-book features can be highly effective if they steer the child to focus on key story information, define and use new words, and increase children's attention to the story. Indeed, Smeets and Bus (2014) found that children learned more vocabulary from an e-book featuring hotspots that defined target words when children touched them compared to an e-book without a touch feature. Similarly, research has found that some multimedia features like animated pictures, music, and sound effects seem to be beneficial for word learning, likely because these features can point to a word's meaning or support definitional information in the text (Bus et al. 2015; Takacs et al. 2015). For example, an animation of someone fanning a fire would likely lead to a more complete understanding of the meaning of the word "fanning" than a still image would because the back-and-forth motion would be visible in the animation, whereas motion is more difficult to depict in a still image. Although e-book features may still lag behind the type of active learning that can occur during one-on-one interaction with an adult, they might promote more comprehension and learning than completely non-interactive versions.

Engaged Contexts Hirsh-Pasek et al. (2015) proposed that a second pillar of learning is that the context must be engaging and this is accomplished through keeping children's minds "on task" and not distracted. Anyone who has sat through a fire alarm while in school, gotten a text message mid-conversation, or even struggled to focus due to an emotional experience can identify how distraction takes away from the matter at hand. Indeed, research suggests that the ability to focus on the right information and exclude extraneous information (Mayer 2014) is critical for learning. This is a challenge, not just for children (e.g., Kannass and Colombo 2007), but also adults, with a miniscule 2% of adults classified as effective multitaskers (Watson and Strayer 2010).

Research with traditional books suggests that this is a particularly important pillar for children. Even something like pop-up features in paper books have been shown to incur a cost to comprehension (Tare et al. 2010) with simplified books leading to increased learning (Chiong and DeLoache 2012). Even limiting children's viewing to one illustrated page at a time rather than two has been linked to increased story comprehension (Flack and Horst 2017). But notably, a gesture that helped children to find the referent when presented within two illustrations eliminated this deficit, suggesting that contextual factors are critically important to helping children stay on task.

Although e-books have many potential advantages for learning, one danger is that the format itself can distract children from engaging with the educational content. For example, in one study, Parish-Morris et al. (2013) found that when reading an electronic console book with embedded activities, parents and children each made more behavioral comments, such as "Can I turn the page?" or "Touch the puppy and it will play a song," during e-book reading than when reading a paper book. When reading a paper book, parents and children made a greater number of dialogic, story-related comments, such as, "What's Caillou doing?" than during e-book reading. When book reading time is taken up by procedural comments about how to work the tablet or by reminders to touch the screen to activate an activity, less time and mental capacity is available for meaningful engagement with the story. For example, when reading *Little Snowflake* (Metzger 2003) in a version of Scholastic's Storia app, the story is interrupted so that children can complete the following hotspot activity: "Match the words with the pictures below. (Word "fly" (match with picture of a bird), carry (match with dog carrying a stick), hop (match with rabbit)" (Hassinger-Das et al. 2016). When many of these flashy and exciting activities are presented in e-books, it can alter the shared book reading experience and result in children comprehending less about the story (Parish-Morris et al. 2013). Indeed, Krcmar and Cingel (2014) suggested that the reason why children in their study comprehended significantly more when reading a traditional book compared to an e-book was related to the increase in distraction-related talk by parents in the e-book condition.

Conversely, some research suggests that e-books elicit greater engagement on the part of children than traditional books, perhaps because children are drawn to digital and mobile technology in general. Studies have demonstrated that children may pay more visual attention to an e-book than a traditional book (Lauricella et al. 2014) and also shown that children were more engaged with an e-book than a traditional book overall (Richter and Courage 2017; Strouse and Ganea 2017). Van Daal and colleagues (this volume) argue that a particular focus of future research needs to be on determining when and what factors influence children's readiness to use e-books, apps, and games. At what age and attention level are children prepared to look past the distractors present in various forms of digital media and engage with the content beyond?

Meaningful Contexts In order to increase the likelihood of learning new material, it is important to make that information personally relevant or connected to prior knowledge (Chi 2009; Hirsh-Pasek et al. 2015). Research has shown that people who make connections between new information and their own lives or previous knowledge are more likely to retain that information (Brown et al. 2014). Indeed, a cornerstone of dialogic reading is drawing attention to the meaning of what is happening in the current story and making connections between these topics and the child's life, experiences, and expectations.

In the realm of e-books, findings from a pilot study testing the features of e-books and traditional books (Hassinger-Das et al. 2016) suggested that although there were not significant differences in children's story comprehension based on book

format, the children of parents who used more distancing prompts—or talk that related the story to the children's own lives—while reading had better story comprehension. This type of parent comment may be especially valuable because distancing prompts have been shown to help children relate the story to their own lives and make inferences (Van 2008). When parents connect something in the story to their children's lives – for example, noting that the train in the book is like the one they saw on vacation last week – they encourage children to link the book's content to experiences they have had.

Other types of parent behavior may also help make e-book content meaningful for children. Because parents know a great deal about their children's development and prior knowledge and experiences, they are in a better position than a standard e-book to adjust in many ways to their child's reading level. They can adjust their reading speed, connect the story to their child's interests and experiences, and adapt to their child's background knowledge or lack thereof. Past research has shown that personalizing a storybook can promote children's learning (Kucirkova et al. 2014). Similarly, first to third grade children seem to profit from individualized literacy instruction (Connor et al. 2013). Despite much excitement about the potential of computers and tablets to offer individualized education (e.g., de Jong and Bus 2003; Moody 2010), for activities such as storybook reading, a caring and observant adult who is knowledgeable about the child's abilities and interests, may be best positioned to offer a child a beneficial individualized reading experience—regardless of book type.

In this publication, Revelle et al. (this volume), Strouse, Troseth, Rvachew, and Forrester review studies examining the *Read with Me, Talk with Me* program. These studies provide a great example of how dialogic reading practices can make meaningful connections for children between storybooks and their own lives. The studies featured versions of a Peg + Cat book with the Ramone character providing dialogic reading assistance. During feedback sessions after the book reading, parents mentioned that Ramone helped them see new ways that they could connect the story to their children's own lives--and make it more meaningful.

Socially-Interactive Contexts The importance of social interaction for learning begins at birth. Children's first teachers are the adults around them (Csibra and Gergely 2009), and learning from and with others continues to remain important throughout the lifespan. Research has investigated parent-child interactions around traditional book reading, and research suggests that the socially interactive nature of shared book reading may be the ingredient that promotes the best kind of learning environment for children (Hirsh-Pasek et al. 2015).

In the context of e-books, recent research has demonstrated that there is likely something unique about parents and children reading together—above and beyond the benefits of reading an e-book without a contingent partner (Dore et al. 2018). In a study of 4- and 5-year-olds, parent-child dyads participated in one of three condi-

tions: parent reading to child; child engaging independently with audio narration; or child engaging independently without audio narration. When parents read with children, children remembered more story details compared to children in both independent book conditions. Children in the parent reading condition remembered an average of 20% more story elements than children who heard the e-book audio narration independently. They also answered 13% more comprehension questions correctly than children who independently listened to the audio narration. These results suggest that e-book audio narration is not the same as a parent-child shared reading, perhaps due to the important back-and-forth contingent interactions that can occur when book reading is a social activity (see also Korat and Or 2010).

For the most part, current e-books do not offer built-in opportunities for dialogic reading, meaning that children who listen to the audio narration do not partake in this critical social component of shared book reading. It is these kinds of sensitive and responsive interactions that are seemingly the most difficult for e-books to recreate. Further, during dialogic reading, these contingent responses are individualized. We know that children benefit when adults apply their knowledge about the children's cognitive and emotional development to their question asking and commenting practices during book reading (Blewitt et al. 2009). Researchers are currently exploring how to employ technology—such as artificial intelligence—to more support the parent-child dialogic reading experience. But for now, contingent social interaction with an adult appears to be the best way to support children's learning from e-books. Yet, Bus, Sari, and Takacs in (this volume) highlight the idea that adults are not necessarily taking the opportunity to use dialogic reading practices, regardless of book type, when reading with their children. They suggest that adding engaging elements, such as camera movements, to e-books may complement the ways that adults are naturally inclined to interact with their children while reading and perhaps encourage greater adult-child interaction.

It is important to note that shared reading experiences also seem to serve multiple purposes for parents and children. For instance, parents report that they view time for shared book reading to also be important for the purposes of bonding with their child (Audet et al. 2008). Some research has begun investigating the impact of print versus electronic versions of books on parental warmth and child engagement (with children aged 7–9 years) and finds that despite no differences in story recall, reading the digital version appeared to serve as a detriment to warmth (Yuill and Martin 2016).

In fact, Etta (this volume) conducted a parent survey, in which parents stated that traditional print books were more commonly used for *social* purposes, including during the bedtime routine and for parent-child bonding, while e-books were used more frequently for *babysitting* purposes, including occupying children when a parent was unavailable. Not only do researchers and parents have to ask themselves about the format of the book they are reading (electronic or traditional), but also what they are hoping to accomplish during their shared reading experience.

1.2 Research with e-Books: A Moving Target?

It is important to note that the evidence on e-books is mixed, with some research finding costs to comprehension and the quality of the parent-child book reading interactions (e.g., Krcmar and Cingel 2014; Parish-Morris et al. 2013), but other research suggesting that there are not necessarily large differences in children's story comprehension after shared reading of paper books versus e-books (e.g., de Jong and Bus 2003; Lauricella et al. 2014). There are likely a variety of explanations that factor into these differences. For instance, (1) the **design** of electronic books vary (e.g., some features are more distracting during reading than others), (2) it is likely that **individual differences** (e.g., some children are more susceptible to distraction than others) play a role, (3) **age** (e.g., younger children may be more likely to be distracted than older children, older children are able to read books independently while younger children cannot) and, (4) **experience** (e.g., the first few times one reads an e-book, the focus might be about novelty of the technology but over time, this novelty may wear off).

Thus, it is crucial to note that not only are the devices (e.g., design) and children moving targets (e.g., age, individual differences), but also is the context in which children and parents are using these devices. For example, e-books may detract from children's learning when families have little to no experience with them at home, but not when families are comfortable with the e-book format. This kind of effect could explain why some early studies found differences between e-books and traditional books in parent-child interaction and learning (Krcmar and Cingel 2014; Parish-Morris et al. 2013), whereas more recent studies have not—and some have even shown advantages for e-books in language and literacy (Courage et al. 2017; Etta et al. 2017; Strouse and Ganea 2017). As the technology becomes more familiar, parents may be better able to effectively scaffold the interaction in order to effectively capitalize on the four pillars and support children's learning.

2 Conclusion

Evidence from the science of learning demonstrates that one reason dialogic reading may be so beneficial is because children are *active* in their own learning, *engaged* in and not distracted by extraneous information (from pop-up paper flaps to interactive electronic hotspots), participate when adults connect the story to the child's own *meaningful* life experiences, and experience reading in a *socially interactive* context that supports these kinds of interactions. By infusing reading with experiences based in the four pillars of learning, adults can ensure that children are deriving the greatest benefit from e-books. Technology can be a marvelous tool—but only if we know how to use it.

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