

# The Effectiveness of Media Platforms on Reading Comprehension: A Meta-analysis

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**Abstract:** The debate about whether digital devices are better than paper to support reading has been last for decades since e-book was introduced. Many researches have focused on this issue and drawn different results. The present study aims to synthesize them by meta-analysis method and gain a comprehensive conclusion. This paper analyzed data extracted from 27 published studies, concluding that PC and iPad have a positive influence on reading comprehension but other digital devices are not. In addition, text genre and the grade of participants are important moderators.

**Keywords:** media platforms; reading comprehension; meta-analysis

## 1. Introduction

The term “e-book” is used to describe a text or a book, which is digitally displayed on the screen of a computer, a personal digital assistant, or a specifically designed reader. It may comprise text, graphics, video, animation, and sound (Jeong, 2012). Reading from the computer screen and tablet devices (e.g., iPad and Kindle), whether for personal enjoyment, business, or education is becoming progressively common (Hermena et al., 2017). Compared with the paper books, electronic books have many advantages. They can provide us extra reading experience, such as audio/video playback and hyperlink, which means a better interaction with readers. Digital devices are more portable, economic, environment-friendly and benefit for fragmented reading because of their traits of portability and high-capacity. Readers can highlight the sentences with colors, take notes as well as undo such changes on e-books. What’s more, its agreeable price wins much preference.

Plenty of e-books have emerged since the first one was introduced in the late 1970s during Project Gutenberg and published on the internet (Hart, 2017). More and more people tend to purchase e-book so that its sales volume surpassed paperback in January 2011 according to the data from Amazon (Yarow, 2011). However, the rapid growth disappeared and the popularity of paper turned back from 2015 (Preston, 2017).

Jones and Brown (2011) emphasized reading skills are critical for academic and personal growth. Nevertheless, it’s still a prevalent topic to determine which one is better for reading in the forty years when the electronic book coexisted with the physical book.

## 2. Literature Review

Whether people are able to read and comprehend information effectively from digital media is a hot topic since the arrival of personal computers in the 1980s (Ball & Hourcade, 2011). There were some investigations comparing the effectiveness of media platforms on reading, and the debate of reading effectiveness among mobile devices, paper, and computer screen is still ongoing (Grimshaw, Dungworth, McKnight, & Morris, 2007; Jeong, 2012; Margolin, Driscoll, Toland, & Kegler, 2013; Sackstein, Spark, & Jenkins, 2015).

## 2.1 Reading Comprehension

Reading is a complex process and its assessment is also difficult. As for reading outcome, Church regarded comprehension as the measurement of reading process. Baker (2010) also explained that comprehension is an essential factor when accessing reading effectiveness. Though it's complicated to monitor the reading process, researchers arrived on one common proposition "the purpose of reading is comprehension" (Farr & Carey, 1987). Thus, comprehension is clearly a necessary clue that the current research should follow, which was always indicated by the scores of reading test in former investigations.

## 2.2 Effectiveness of Different Media Platforms on Reading Comprehension Performance

Mixed conclusions are found among previous studies (Ackerman & Lauterman, 2012; Korat, 2010; Masataka, 2014; Sun, Chieh, & Huang, 2013). According to Korat, e-books played a more positive role than paper books. And Alfassi (2000) also illustrated e-books could assist the learner to deduce, solve problems, and construct learning strategy. However, other researches showed people's digital reading comprehension score was significantly lower than the paper reading (Ackerman & Lauterman, 2012; Jeong, 2012). Thus, we need to use vast data and a more objective method to explore deeply.

## 2.3 Other Factors

Reader's age and familiarity toward devices are key elements mentioned before (Ball & Hourcade, 2011; Cheng, Zheng, Li, & Chen, 2014). Ball and Hourcade (2011) indicated that age was statistically significant on comprehension when comparing reading from paper and computer. Chen et al. (2014) pointed digital reading performance was relevant with reader's familiarity towards the devices. Readers' age sometimes has a correlation with familiarity. Additionally, different literature types would trigger different information process activities, inference, and integration (Mo, Wang, & Leng, 2012), so genres of literature should taken into consideration (Yoo, 2015). Overall, the impact of such elements must be considered when investigating present topic.

## 2.4 Research Questions

Based on the theory of reading comprehension and previous studies about this issue, the current research focuses on two questions:

Q1: Are the digital devices, including mobile devices (e.g., iPad and Kindle) and computer screen useful to support reading comprehension performance?

Q2: How age and text genre moderate the impact of digital devices on reading comprehension ?

## 3. Method

The present meta-analysis follows the steps of formulating the research problem, searching and collecting of studies, coding, data analysis, constructing results and interpretation (H. Cooper & Hedges, 1994).

### 3.1 Study Source

For relevant published studies from January 2007 to March 2017, a search on Web of Science, MEDLINE, SciELO Citation Index, and ERIC was conducted. The search included terms (key words) for the digital readers (including *e-book*, *e-reader*, *computer screen*, *computer-based reading*, *tablet*, *electronic devices and media platform*) and reading comprehension (including *reading*, *reading comprehension*, *comprehension*, *the effectiveness of comprehension*).

The inclusion and exclusion criteria used in this study are as follows:

- Studies were published in English and from January 1<sup>st</sup> 2007 to March 1<sup>st</sup> 2017.

- As many other meta-analysis papers, the studies must be journal papers (Brydges et al., 2015; Hatala et al., 2014; Shin, Park, & Kim, 2015). Conference paper and academic dissertation were excluded.
- Studies must include the experimental and control group, compare the effectiveness of paper and one of these two kinds of digital methods, and demonstrate the score of a reading comprehension test.

Finally, after selected by two researchers, a literature pool of 16 journal papers including 27 studies was constructed.

### 3.2 Data Extraction

According to the literatures of Lipsey and Wilson (2001), Copper (2009), and Pearson (2005), a coding framework containing 33 variables was developed. Two coders coded all 27 studies, and interrater reliability was generally high, with  $\kappa = .747$  (Landis & Koch, 1977). Uncertainty and disagreement were resolved through discussions among coders. Eventually, the data were inputted into the software Stata 14<sup>®</sup> to calculate effect sizes.

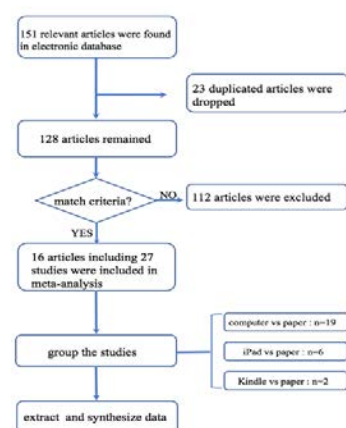


Figure 1. Meta-analysis procedure

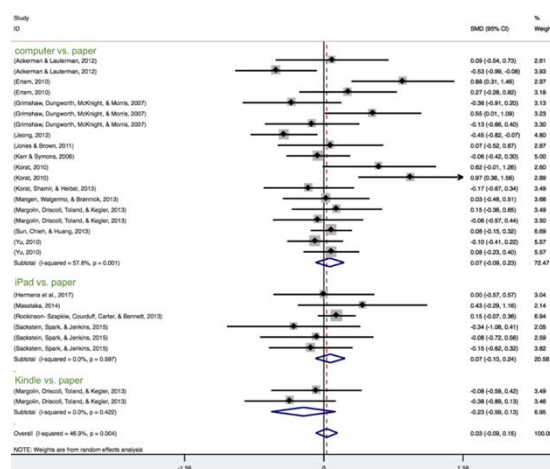


Figure 2. Meta-analysis of computer, iPad, Kindle compared with paper books.

### 3.3 Data Synthesis

For each study, we calculated the standardized mean difference (SMD, Cohen's d effect size) with mean and standard deviation (SD) (Cook et al., 2011). The presented study chose random effects model because the effect sizes were diversified (Borenstein et al., 2009).

## 4. Results

The search result included 151 relevant papers. After screened (Figure1) by researchers, 16 journal papers including 27 quasi-experimental or experimental studies matched criteria. These researches covered 2113 participants aged 4-69 years old, from K-12 school, university and community schools.

### 4.1 Overall Effect Size

As the forest plot (Figure.2) shows, the overall effect size illustrated electronic media platforms had a slight positive effect than paper (SMD=0.032;  $p=0.605$ ) (Cohen, 1988). And these studies showed moderately consistent results ( $I^2=46.9\%$ ) (Higgins, Thompson, Deeks, & Altman, 2003).

We found 19 comparisons between computer and paper (SMD=0.07;  $p=0.411$ ). The pooled effect size was small and nonsignificant. The inconsistency was high ( $I^2=57.6\%$ ). There were 6 studies about iPad VS paper, of which the pooled effect size was also slight (SMD=0.071;  $p=0.401$ ). These

results indicated that iPad and computer have a positive but nonsignificant influence on reading than paper books. On the contrary, the comparison of Kindle VS paper revealed the negative and nonsignificant influence of Kindle (SMD=-0.228;  $p=0.213$ ).

## 4.2 Subgroup Meta-analysis

### 4.2.1 Text Type

Yoo (2015) and Mo (2012) have illustrated the genre and difficulty of content could influence reading performance. This paper divided 27 studies into different groups according to text genres. As it's shown in Table 1, people would comprehend better when using digital devices if they read narrative (SMD=0.136,  $p=0.171$ ) and practical essay (SMD=0.117,  $p=0.142$ ), however, the results turned to the opposite when it came to expository essays (SMD=-0.163,  $p=0.055$ ). All the  $p$ -values were more than 0.05 which meant the differences were not significant.

Table 1: Subgroup meta-analysis according to text type

text type	effect size	weight (%)	95% CI	p
narrative essay	0.136	55.75	(-0.059, 0.331)	0.171
expository essay	-0.163	30.62	(-0.330, 0.004)	0.055
practical essay	0.117	13.63	(-0.039, 0.274)	0.142

### 4.2.2 Grade

The age and grade of participants were also discussed before (Ball & Hourcade, 2011; Cheng et al., 2014; Zsofia K. et al., 2014). A pooled effect size was calculated to explore this factor. There was a positive impact of electronic devices than paper if the participants were younger than senior high school students or elder than undergraduates. All the  $p$ -values were more than 0.05.

Table 2: Subgroup meta-analysis according to participants' school phase

Grade	K-3	grade 4-6	junior high school	senior high school	undergraduate	more senior
effect size	0.194	0.185	0.026	-0.123	-0.094	0.084

## 5. Discussion and Conclusion

The current research revealed the effectiveness of different media platforms on the reading comprehension. The overall effect size illustrated only a small and non-significant strengthening of electronic devices than paper (SMD=0.03,  $p=0.606$ ), which was consistent with former researches (Jones & Brown, 2011; Mangen, Walgermo, & Brønnick, 2013; Sun et al., 2013; Yu, 2010). The absence of significance meant no essential gap between digital method and traditional way. Computer-based reading showed the more advantages of all platforms. This result could be explained by the relationship between reading behaviors and devices' function. Margolin (2013) pointed following along with a finger or mouse and moving lips were obviously positive for comprehension. What's more, surfing and hyperlink functions in e-books are also benefit for searching information and forming a clue or map of knowledge. These beneficial factors all existed in computer- and iPad-based books, which were more effective for reading than paper and Kindle.

As for text genre, according to the data, people performed better but not significant when reading narrative essays and practical writings like advertisements, letters and etc. Compared to expository essays, those two genres are easier to comprehend and memory. The working memory taken

up by cooperating digital hardware tended to be more important when people read obscure expository texts (Ackerman & Lauterman, 2012; Jeong, 2012).

As for the grade, there was a decrease of effect size along with the increase of age. This tendency showed reading comprehension ability may be related to the reading habit rather than time. That is to say, though the K-3 children may spend less time on reading by digital devices than the elders, they are digital natives who almost use devices to form reading style. Grimshaw (2007) also found children's comprehension was positively affected by the computer screen. People older than university students showed better reading performance than expected. It may be due to research bias caused by the lack of studies focusing on participants in this category.

Overall, people will gain better reading comprehension when using digital devices if they read narrative and practical writings, or if they are young digital natives. Reading habit and genre can moderate the effectiveness of media platforms on reading performance.

Additionally, there are maybe other factors influencing the result, such as the difficulty of reading comprehension test. A theory named "the levels of comprehension" involves three reading comprehension levels, namely, literal, inferential and evaluative level (Alonzo, Basaraba, Tindal, & Cariveau, 2009). The former researches barely introduced which level they focused on, however, different questions' level may cause different result. What's more, as we mentioned before, study-bias may cause the research question of "how age regulates the effectiveness of digital devices on reading" unaccountable, and hindered the present issue to be illustrated more comprehensively and authoritatively. In this context, we expect our team and other researchers in this area to explain the relevant information more specifically, and expand the age range of participants.

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