

Effects of E-Books and Printed Books on EFL Learners' Reading Comprehension and Grammatical Knowledge

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In today's digital era, tablets are gaining popularity as reading devices. However, few studies have compared reading e-books on tablets with reading printed books and regular classroom instruction for language learning. To evaluate the role of tablets in reading and analyze the possibilities, the current study examined 97 elementary school students learning English as a foreign language in South Korea. These students were taught English once or twice a week for 11 weeks based on extensive reading using tablets ($n = 42$), printed books ($n = 32$), or regular textbook-based instruction as control ($n = 23$). The results indicate that literal level reading comprehension was improved the largest in the tablet group compared with the other groups. By contrast, improvements in inferential reading comprehension and grammatical knowledge were greater in those reading printed books than in the tablet group. The findings suggest that the print medium was superior for deep reading and digital texts were better for quick and shallow learning.

Key words: extensive reading, tablets, e-books, printed books, literal reading comprehension, inferential reading comprehension, grammatical knowledge

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1. INTRODUCTION

Reading is essential to understand the world, acquire knowledge, develop higher-order thinking skills, achieve personal success, and contribute meaningfully to society (Smith, Mikulecky, Kibby, Dreher, & Dole, 2000). Advances in modern technological devices, such as computers, tablets, and smartphones, have led to an increasing shift from reading in print to digital reading, as well as more opportunities for online education (Pardede, 2019; Sage, Augustine, Shand, Bakner, & Rayne, 2019). During the coronavirus disease 2019 (COVID-19) pandemic, many schools conducted their classes online using digital materials due to school closures and social-distancing policies, which has accelerated the transition from paper-based to online learning (Sun, Loh, & Nie, 2021). Online learning is expected to continue after the pandemic. Therefore, digital reading may no longer be a choice but a necessity to learn the first language (L1) and second or foreign languages (L2) (Sun et al., 2021).

Many experts have suggested that online reading is useful for literacy education. One obvious advantage of e-books over printed books is their portability, which allows readers to easily access vast amounts of texts regardless of place and time (Dao, 2014; Sage et al., 2019; Vo, 2013). Digital reading is also economical in the long term, i.e., readers can access many e-books (using digital devices) in the most updated formats at a low cost (Sage et al., 2019). Furthermore, digital reading provides an interactive experience enriched with multimodal texts (i.e., written texts, sounds, and images) and diverse platforms for collaboration and the exchange of ideas (KazazoĜLu, 2020; Lin, Chen, & Hsu, 2021; Sage et al., 2019).

Despite the widespread use and advantages of digital reading, experts and educators are uncertain about its use in L2 classrooms (Pardede, 2019) and question its effects on deep reading comprehension, other language skills, and critical thinking skills (Singer & Alexander, 2017; Walsh, 2016). In fact, when compared to reading in print, digital reading is associated with lower levels of reading comprehension and retention (Delgado, Vargas, Ackerman, & Salmerón, 2018; KazazoĜLu, 2020; Reich et al., 2019). Also, researchers concern about the negative impact of digital reading on readers' concentration because e-books take longer to read (Richter & Courage, 2017). Moreover, e-book readers get easily distracted because tablet readers talk more about the device rather than the content of the book (O'Toole & Kannass, 2018) or they tend to turn on hotspots and connect to the Internet (Piotrowski & Kremer, 2017).

Although a growing body of research has compared on-screen versus on-paper reading, there is no consensus about whether online reading can produce similar, better, or worse learning outcomes than printed reading. Furthermore, most studies compared the learning outcomes between reading on computers and reading printed materials. These studies did

not evaluate the outcomes of reading on other digital devices. Some studies that included young children reported that multimedia e-books improved phonological awareness, word-level reading, and vocabulary knowledge (Bus, Verhallen, & de Jong, 2009; Korat, 2010). Some other studies have found that paperback reading improved the reading comprehension of students learning English as a foreign language (EFL) compared to reading on computers (Halamish & Elbaz, 2020; Mangen, Walgermo, & Brønnick, 2013; Støle, Mangen, & Schwippert, 2020). In addition, a few studies did not identify differences in reading achievement between paper reading and reading on computers (Kaban & Karadeniz, 2021).

Findings for one form of online reading (i.e., desktop or laptop computers) may not apply to other forms (e.g., tablet computers/tablets) because of the different features and functions of each device (Biancarosa & Griffiths, 2012). Tablets have recently gained popularity as individualized and effective reading devices because of their numerous benefits—they blend the features of paper, smartphones, and computers, as well as offer personalized applications, enhanced readability, portability, accessibility, ease of use, and easy connection to the Internet (Chen, Cheng, Chang, Zheng, & Huang, 2014; Hermena et al., 2017; Lin et al., 2021; Reich et al., 2019; Young, 2014). Some studies have suggested that L2 learners may gain similar reading achievements from printed books and e-books, if the tablet screen displays e-books in a manner similar to that of printed books or the navigation functions of the tablets are controlled (Chen et al., 2014; Hermena et al., 2017). However, the effects of reading on tablets, compared to reading printed books, on the reading comprehension and language skills of L2 learners are unclear (Kaman & Ertem, 2018; Salmerón, Delgado, Vargas, & Gil, 2021).

To bridge the gaps in research, we compared the effects of reading e-books (using tablets) and reading printed books on reading comprehension and grammatical knowledge. We used measures to evaluate literal (shallow) and inferential (deep) reading comprehension separately. Additionally, we measured grammatical knowledge because deep reading habits would allow concentration on the syntactic aspects of a given language and develop the ability to parse sentences into idea units. Furthermore, most previous studies measured the reading comprehension of learners immediately after reading printed or online texts (Chen et al., 2014; Halamish & Elbaz, 2020; Hermena et al., 2017; Sage et al., 2019; Salmerón et al., 2021), whereas digital reading is continued in the long-term in the daily lives of students. Therefore, it is necessary to investigate the impacts of long-term exposure to printed books and e-books (Reich et al., 2019). For this, we selected extensive reading as an experimental condition for elementary school students learning EFL in South Korea. Whereas paper-based extensive reading has been shown to be effective for reading comprehension and grammatical knowledge (Day & Bamford, 2002; Lee, Schallert, & Kim, 2015), tablet-based extensive reading has rarely been studied. Furthermore, digital natives (i.e., those who grew up surrounded by digital technology and are familiar with using digital devices, such as the

children in this study) have a stronger preference, more open attitude, and higher level of motivation for digital reading compared to adults (Halamish & Elbaz, 2020; Kaban & Karadeniz, 2021; Sage et al., 2019). To evaluate how young EFL learners adopt tablets for reading, we designed the present study using the following research questions:

1. What are the impacts of tablet-based extensive reading, print-based extensive reading, and regular instruction on literal and inferential reading comprehension of young EFL learners?
2. What are the impacts of tablet-based extensive reading, print-based extensive reading, and regular instruction on grammatical knowledge of young EFL learners?

2. LITERATURE REVIEW

2.1. Effects of Digital Reading and Print Reading on Reading Comprehension

Reading is a prerequisite to develop the mind, perform well in schools, pursue a career, and function adequately in society. Moreover, reading is important to develop other language skills (e.g., grammar, writing) and learn foreign languages (Kaban & Karadeniz, 2021; Pardede, 2019). Because language input is necessary to learn languages, reading serves as an important resource for EFL learners, who typically receive minimal language input inside and outside the classroom (Ellis, 2005; Gilakjani & Sabouri, 2016). Many researchers and educators have recommended that extensive reading should be implemented in EFL classrooms to provide comprehensible language input (Day & Bamford, 2002; Lee, Schallert, & Kim, 2015; Renandya & Jacobs, 2016). Extensive reading has been well known for developing vocabulary (Nation, 2015; Suk, 2017; Webb & Chang, 2015), reading comprehension (Nakanishi, 2015; Suk, 2017), and reading rate (McLean & Rouault, 2017; Suk, 2017). It also improves writing skills (Lee & Schallert, 2016; Linuwih, 2021), grammatical knowledge (Alqadi & Alqadi, 2013; Khansir & Dehghani, 2015; Lee et al., 2015), and reading attitudes (Yamashita, 2013).

In the digital era, electronic media have attracted the attention of experts and educators for meeting the needs and improving the motivation and engagement of readers by offering individualized, multimodal and tailored language input (Grimshaw, Dungworth, McKnight, & Morris, 2007; Hermena et al., 2017). However, some experts have suggested that the influence on reading comprehension may differ between electronic media and paper reading because readers use different strategies and cognitive processes to comprehend texts based

on the characteristics of the medium (e.g., paper, tablets, computers, or smartphones) (Chen et al., 2014; Pardede, 2019). Studies of the impact of reading medium on reading comprehension have produced mixed results (see Appendix).

Some studies have reported that print media are more effective than computer screens for improving reading comprehension among students at different levels, such as those in elementary schools (Halamish & Elbaz, 2020; Kerr & Symons, 2006; Støle et al., 2020), secondary schools (Mangen et al., 2013), and universities (KazazoĖLu, 2020; Singer & Alexander, 2017). In particular, several studies have demonstrated that printed texts are strongly correlated with the in-depth reading comprehension of readers (Kerr & Symons, 2006; Singer & Alexander, 2017). In a study of 90 United States college students learning their L1, Singer and Alexander (2017) found few differences between text media (computers or print) if the participants were able to identify the main ideas of the texts. However, the print group performed better at recalling the key points of the text and other relevant information. In another study, despite the display on the computer screen being similar to a printed text, elementary school students read the printed book faster and recalled information more efficiently compared to those who read the text on computers (Kerr & Symons, 2006).

Reading comprehension is affected by several differences between paper and the computer screen. The printed text presents information in a pre-fixed, predictable, and linear manner (page by page or left to right). These features contribute to the readers' spatial representation and provide specific spatial clues that support the memorization and recall of necessary details (Mangen et al., 2013). These features are associated with less cognitive burden and higher stability for understanding the content compared to digital texts (KazazoĖLu, 2020; Kerr & Symons, 2006; Pardede, 2019). By contrast, digital texts are typically displayed on a computer screen as hypertext with a scrolling function that allows readers to navigate the information in a non-linear, multi-layered manner. Despite their usefulness, these features hamper the ability of readers to construct and maintain mental representations of the text, add to the cognitive burden and visual fatigue, and prevent deep understanding of the text (KazazoĖLu, 2020; Mangen et al., 2013; Støle et al., 2020; Walsh, 2016).

However, printed texts may not always guarantee higher reading comprehension compared to digital texts. Some studies demonstrated similar reading comprehension between students reading printed or computer texts. For example, Sage et al. (2019) found no significant differences in reading times and L1 reading comprehension (measured using multiple-choice items) among undergraduate students across papers, computers, and tablets. Similar results were also seen in EFL learners. Lin et al. (2021) investigated the effects of a 14-week reading program using a printed textbook or mobile-based e-textbook in Thai EFL university students. Similar achievements in reading comprehension and vocabulary knowledge were observed in both groups, suggesting that the medium type may not be

important for determining reading growth. Although participants in both studies used digital resources more frequently outside the classroom and recognized the benefits of digital reading (e.g., portability), they preferred print reading over digital reading. Furthermore, Kaban and Karadeniz (2021) did not observe significant differences in reading comprehension between reading on computers and reading on paper after 5 weeks among Turkish EFL primary school learners. However, the students exhibited greater motivation toward computer-based reading.

The previously mentioned studies identified the shortcomings of reading from desktop or laptop computers compared to reading on paper. Tablets have recently emerged as useful, affordable, and reliable reading tools. Tablets overcome many of the drawbacks of other technological devices. Several studies have demonstrated that tablets offer a reading experience similar to that with printed books, including page flipping (instead of scrolling), controlled navigation, an ink screen, and a page-sized screen (Chen et al., 2014; Salmerón et al., 2021; Young, 2014). Young (2014) found that Canadian university students retained the main ideas of the story and demonstrated similar deep understanding after reading from paper or tablets, despite the greater likelihood and higher expectation of participants having better reading comprehension when using printed texts. Hermena et al. (2017) did not find significant differences in the reading time and reading performance between using printed text or tablet text (displayed similar to the printed text) in undergraduate L1 students from the United Arab Emirates, regardless of their familiarity with tablets. The researchers emphasized that tablets are a potentially effective reading tool for learners, given that the font size, margins, brightness, and letter spacing can be adjusted to mimic those of paper. Moreover, Keman and Ertem (2018) found a higher reading comprehension level in Turkish EFL primary school students after they had read from tablets compared to reading on paper for 14 weeks, although the difference was not statistically significant.

Despite the strengths associated with tablets, some experts question the effectiveness (especially in terms of reading comprehension) of reading from tablets compared to reading on paper. Reich et al. (2019) observed that pre-school L1 students from the United States had better recall and arranged the story sequences better when reading on paper compared to reading from tablets. Similarly, Salmerón et al. (2021) found that Spanish EFL elementary school students, especially those with lower learning abilities, who read from tablets had difficulty in understanding expository texts. The participants in that study might have been confused between using tablets for pleasure (such as playing games) and using them for academic reading. Low reading comprehension after reading on tablets may be a result of shallow reading habits during digital reading. Støle et al. (2020) suggested that learners develop superficial and fast reading habits while using digital devices for entertainment, such as surfing the web, chatting with friends in real time, and exchanging messages on social network services. The shallow, quick, and immediate reading habits accumulated from the

daily use of digital devices lead to a similar reading pattern for educational materials on digital devices, which impedes deep learning (Delgado et al., 2018). Therefore, encouraging learners to read digital media in depth and recognize tablets as a learning tool may alter the attitudes of learners towards digital media (Salmerón et al., 2021).

To determine whether reading comprehension differs between tablet- and print-based reading, reading comprehension was classified into literal and inferential reading comprehension. Literal reading comprehension involves understanding the surface meaning explicitly presented in the text; inferential reading comprehension involves more profound understanding, such as finding implied message, drawing inferences, making generalizations, analyzing contextual elements, and using the reader's prior knowledge (Alptekin & Ercetin, 2010; Chen et al., 2014; McNamara, 2007; Salmerón et al., 2021; Walsh, 2016). Few studies have compared the impacts of digital and print media on the different levels of reading comprehension. To the best of our knowledge, Chen et al. (2014) was the only study to compare the effects of three media (paper, computers, and tablets) on literal (measured using multiple-choice items) and inferential (measured using summarization items) reading comprehension. In 90 Chinese college L1 students, the print group exhibited a significantly higher level of literal reading comprehension than did the computer group, but there was no difference between the print and tablet groups. Chen et al. (2014) reported that reading on tablets with controlled scrolling may improve surface-level reading comprehension, similar to print reading. However, there was no difference in inferential reading comprehension among the groups, probably because of the difficult task (i.e., summarization). In the further study, the effects of tablet and print reading should be compared using valid and reliable measures for inferential reading comprehension.

2.2. Effects of Digital Reading and Print Reading on Grammatical Knowledge

Extensive reading improves the grammatical knowledge of L2 learners by having them being exposed to extensive written texts comprising various sentence structures (Alqadi & Alqadi, 2013; Khansir & Dehghani, 2015; Lee et al., 2015). Renandya and Jacobs (2016) suggested that extensive reading forces the readers to repeatedly receive language input and understand its context, thereby increasing the familiarity with sentence structures in real situations. Learning through natural exposure to the target language is very different from traditional grammar teaching that involves presentation, practice, and production of the target rules. Several studies have provided empirical evidence showing the impact of the extensive reading on grammatical knowledge. For instance, among EFL university students in Jordan, the group that carried out extensive reading performed better than the control group that received regular instruction regarding accuracy in paragraph writing (Alqadi &

Alqadi, 2013). The repeated exposure to reading materials eliminated confusion and familiarized the learners with correct grammar. Khansir and Dehghani (2015) found that extensive reading combined with regular instruction improved the grammatical knowledge of Iranian secondary school EFL learners compared to the traditional grammar-translation method. Furthermore, Korean secondary EFL students in the extensive reading group obtained significantly greater knowledge in specific aspects of grammar (e.g., articles) compared to the translation group (Lee et al., 2015). However, both groups showed similar improvements in general grammatical knowledge.

Despite the values of the prior work, most previous studies were conducted using printed books and focused on students at the secondary or tertiary school level. Considering the frequent use and importance of online reading among elementary school EFL learners, there is a pressing need to investigate whether online extensive reading produces similar learning outcomes as reading printed books.

3. METHODS

3.1. Participants and Settings

This study included 101 participants. However, four students were excluded because of their absence or transfer from school. The remaining 97 students (51 boys, 46 girls; aged 10-12 years old), enrolled in grade 5 or 6 of an elementary school in South Korea, were included in the analysis. The participants had begun learning EFL since grade 3 of an elementary school. We conducted a background survey before the treatment. Table 1 shows that most participants were not regularly exposed to English reading materials, either in print or online, outside the classroom. More than half of the students reported that they had never read printed books (62.9%) or digital materials (59.8%) in English outside of the classroom. Although many students were receiving private English lessons after school, most (94.8%) had never lived or lived for less than 3 months in English-speaking countries.

We chose this elementary school for the study because this school provides students with individual digital devices and many English books (both online and printed). Because of the COVID-19 pandemic, the Ministry of Education of South Korea is providing public schools with digital device rental services to mitigate the impact of school closure and increase access to online learning, particularly for vulnerable and disadvantaged students. Therefore, all students in this study had individual digital devices for online learning at school and home. Moreover, the school had purchased, for 1 year, the *Reading Gate* program that provides approximately 2,000 online and printed English books for different proficiency levels. The contract with *Reading Gate* offered every student and teacher individual access to the

website (<http://www.readinggate.com/>), which has printed books and e-books with identical contents, illustrations, and text layouts. There are additional e-books available, which are updated in real-time. Even though the students had little experience in reading English books online or in print, the school created a supportive and conducive environment for this study.

TABLE 1
Responses to the Background Questionnaire (N = 97)

Item	Response Category					
	Never:	<3 mths:	3–6 mths:	6mths-1yr:	1–1.5 yrs:	1.5–2 yrs:
Duration of living abroad	56 (57.7%)	36 (37.1%)	5 (5.15%)	0 (0%)	0 (0%)	0 (0%)
Duration of private English lessons	Never: 3 (3.1%)	<1 yr: 17 (17.5%)	1–2 yrs: 14 (14.4%)	2–3 yrs: 14 (14.4%)	3–4 yrs: 19 (19.6%)	4+ yrs: 30 (30.9%)
Time spent on online English reading per day	Never: 58 (59.8%)	<30 min: 17 (17.5%)	30min-1 hr: 12 (12.4%)	1–1.5 hrs: 7 (7.2%)	1.5–2 hrs: 3 (3%)	>2 hrs: 0 (0%)
Time spent on print English reading per day	Never: 61 (62.9%)	<30 min: 16 (16.5%)	30min-1 hr: 12 (12.4%)	1–1.5 hrs: 4 (4.1%)	1.5–2 hrs: 2 (2%)	>2 hrs: 2 (2%)

3.2. Treatment Conditions

The students participated in two 40-minute English classes per week. However, because of the COVID-19 pandemic, the elementary school limited the number of individuals in each classroom to ensure safety, resulting in partial school closure. Consequently, the English classes were conducted once or twice per week for 11 weeks, for a total of 18 in-person classes (40 minutes each). Five intact homeroom classes (on average, 22-24 students per class) were randomly assigned to three types of instruction: two classes (grades 5 and 6) to the tablet extensive reading group ($n = 42$), two classes (grades 5 and 6) to the printed extensive reading group ($n = 32$), and one class (grade 6) to the control group ($n = 23$) receiving regular English lessons with a textbook. Whereas the English treatments were offered to all five classes, only the participants who agreed to use their data for the research were included in the current study. The results of a one-way analysis of variance (ANOVA) showed that the English proficiency level did not differ significantly among the three groups, as measured using three English tests administered at the beginning of the treatment on literal reading comprehension (measured using multiple-choice items; $F [2, 94] = .88, p = .42$), inferential reading comprehension (measured using recall tests; $F [2, 94] = .16, p = .86$), and grammar knowledge (measured using sentence structure items; $F [2, 94] = 1.54, p = .22$).

For the tablet group, each student was provided with an individual tablet with Wi-Fi access—the Galaxy S5e model with a 10.5-in screen ($24.5 \times 16.0 \times 5.5$ cm). Each student was free to choose English books from *Reading Gate* and read e-books silently in the classroom. Although e-books offer audio files, built-in dictionary functions, and comprehension check questions at the end of each chapter, we limited these functions in this study to compare the effects between digital and printed books. After reading a book, the students recorded its title, main characters, brief story, and newly learned vocabulary in a reading log in Korean. These reading logs were collected at the end of the class and collated into a portfolio at the end of the program. While the students read e-books from individual tablets, the English teacher (the first author of this paper) played the role of a facilitator by monitoring the number of books read by the students, checking their reading logs in the portfolios, and encouraging them to read more. For the print reading group, each student chose a printed English book from the school library and read it in a designated classroom inside the library. Similar to the tablet reading group, students in this group wrote reading logs after the reading activity, compiled the logs into portfolios, and submitted them to the teacher at the end of the program. Although some students from both reading groups voluntarily engaged in extensive reading at home, they did not record the information from those reading sessions in the reading logs. Therefore, we only calculated the number of books read during the in-person classes. Finally, the control group learned English using an English textbook provided by the school in accordance with the national English curriculum. This textbook includes short dialogues, vocabulary, short reading passages, and sentence-level grammar or writing activities (e.g., filling in the blanks). English lessons in elementary schools mainly focus on listening, speaking, or reading of short passages, rather than grammar and writing. The English teacher asked the control group to pronounce words, listen to short dialogues, role play with their partners, read aloud short passages, solve comprehension questions, and fill in the blanks in a teacher-fronted manner.

3.3. Measures

3.3.1. Background questionnaire

At the beginning of this study, a questionnaire was administered to record the demographic information of the participants, including their age, sex, study-abroad experience, private tutoring experience, and frequency of reading English materials in print or online.

3.3.2. Reading comprehension tests

We used two types of tests to measure the effects of the treatments on reading comprehension: a multiple-choice test for surface-level reading comprehension and recall tests for deep reading comprehension. For the multiple-choice reading test, 44 items were selected from the national English proficiency tests developed and implemented from 2003 to 2019 by the Korean Institute of Curriculum and Evaluation to evaluate the English proficiency of primary and secondary school students. We modified the questions, constructed two sets of 22 multiple-choice items (four options for each) for pre- and post-tests, and had the items reviewed by an English teacher for suitability. The difficulty level of the reading texts in the pre- and post-tests was examined based on the Flesch-Kincaid Grade Level (Kincaid, Fishburne, Rogers, & Chissom, 1975). The readability index was 2.6 for both the pre- and post-tests, implying that the two tests had equivalent difficulty levels. Furthermore, the pre-test items were pilot tested in 18 students from a different elementary school. The Cronbach's alpha was .796, confirming the reliability of the test items.

Another reading comprehension measure was the recall test. Recall has been used as a valid measure for reading comprehension because it evaluates the understanding of details and the sense of flow of the whole text (Riley & Lee, 1996; Wilson, Gambrell, & Pfeiffer, 1985). Recall requires students to write everything they can remember after reading a passage, and it is considered "the most straightforward assessment of the result of the text-reader interaction" (Johnston, 1983, p.50) and a purer measure of in-depth understanding of a text (Bernhardt, 1991). Furthermore, we included both narrative and expository texts to control for the effects of text genre on recall tests. The texts, extracted from several English textbooks that the participants were not exposed to, were modified by two English teachers to match the proficiency level of the participants. The narrative text contained 97 and 113 words in the pre- and post-tests, respectively; the expository text contained 119 and 116 words in the pre- and post-tests, respectively. Flesch-Kincaid readability scores of pre- and post-recall tests (combined for the narrative and expository texts) were at the grade 3 level (Kincaid et al., 1975).

Because students were less familiar with recall testing than with the multiple-choice method, the English teacher explained how to take a recall test and provided students with a sample question for practice before the actual test. Furthermore, we followed the recommendations by Chang (2016) for overcoming the weaknesses inherent in recall tasks. Recall tasks are criticized because they require significant abilities in working memory, L2 writing, and idea organization skills in addition to reading comprehension skills. Therefore, we asked the participants to read an English passage at their own pace and immediately write everything they could remember in their L1 without reviewing the passage. Following the recall test for the narrative text, the students received an expository text and followed the

same procedure for the practice and actual recall tests.

Using the guidelines provided by Lee (1986), two raters developed a scoring scheme based on selected idea units from each narrative and expository passage. Most of the idea units included content words and one point was given to each unit. If the English text had a similar meaning to the Korean translation, the answers were considered correct. For example, the English sentence “*Meerkats live in a dangerous wild desert,*” was divided into five idea units (i.e., “*Meerkats/ live/ in a dangerous/ wild/ desert.*”). When a student wrote all five idea units in Korean, they scored five points. The pre-test (for both narrative and expository texts) was pilot tested with 15 grade 6 students who attended a different primary school. For the pilot test, both raters graded the responses of students to develop scoring criteria. The first rater graded all the responses in the actual pre- and post-recall tests, whereas the second rater rechecked 30% of the test papers that were scored by the first rater. High inter-rater reliability was obtained for both pre- and post-tests, with intraclass correlation coefficient of 1.000 (95% confidence interval = .999–1.000) and .998 (95% confidence interval = .998–1.000), respectively.

3.3.3. Sentence structure tests

The test items were constructed and reviewed by two researchers. The sentence structure tests included 40 items each in the pre- and post-tests that measured various aspects of grammatical knowledge, such as knowledge on articles, verbs, prepositions, nouns, adjectives, modals, tag questions, infinitives, gerunds, relative pronouns, and conditionals. The test items were designed in a multiple-choice format with four options. The items were reviewed by two English teachers for their difficulty level and appropriateness. The test required the students to select the correct grammar from the given options. These sentences were chosen from English textbooks that the participants had not learned. The pre-test was pilot tested on 20 students who attended a different elementary school. The Cronbach’s alpha was .77, indicating good reliability of the tests. Sample questions are presented as follows:

Jane has a dog _____ has a long tail.

- ① what ② which ③ where ④ who

My parents want _____ live with them.

- ① to me ② me to ③ for me ④ me for

3.4. Procedure

The experiment was conducted in three stages: preparation, operation, and wrap-up. During the preparation stage, the first researcher explained the purpose of this study to the

students and distributed informed consent forms (including parental permission). After obtaining informed consent, the researcher administered a background questionnaire and three pre-tests (i.e., a multiple-choice reading comprehension test, a recall test, and a grammar test) during four 40-minute classes over 2 weeks. The five intact classes were randomly divided into three groups: tablet extensive reading, print extensive reading, and control groups. We guided the two reading groups to explore either the *Reading Gate* website or the library during their 1-week orientation. The students explored English books appropriate for their levels of English proficiency. During the operation stage, the two reading groups read English books on tablets or in print, kept reading logs, and compiled the logs in their portfolios. The control group received textbook-based English instruction. All three groups engaged in the programs during 18 sessions of 40-minute classes over 11 weeks. At the end of the treatment, three post-tests were conducted during three regular 40-minute classes over 2 weeks. All tests were administered in a pencil-and-paper format.

3.5. Data Analysis

Descriptive and inferential statistics were used to analyze the data with SPSS statistical software (version 21). The number of books read by the two reading groups were counted based on their portfolios. The reading comprehension and grammatical test scores were calculated. Means and standard deviations were calculated for the test scores. For each language test, a repeated-measures ANOVA was performed using time as the within-subjects variable and intervention group as the between-subjects variable. We performed post-hoc Tukey's honestly significant difference (HSD) tests to evaluate differences between groups when significant interaction effects were found.

4. RESULTS

4.1. Reading Comprehension

Table 2 shows the number of books read by students in the tablet and print extensive reading groups over 11 weeks. The tablet and print extensive reading groups read an average of 27 and 34 books, respectively, and this difference was statistically significant ($t [1, 72] = 2.45; p = .017$). Notably, the number of book pages and words on each page varied among the books, depending on their difficulty levels. These numbers reflect the reading behaviors of the tablet and print groups, rather than their reading growth.

TABLE 2
Number of Books Read by the Two Reading Groups

Group	<i>n</i>	Range	Mean (<i>SD</i>)	Median	Significance
Tablet reading	42	9–63	27.07 (12.88)	24.50	.017*
Print reading	32	6–55	34.16 (11.58)	33.05	

Note. *SD*: standard deviation.

Table 3 displays the descriptive statistics for the multiple-choice reading tests. The repeated-measures ANOVA revealed a significant time effect ($F [1, 94] = 77.51; p = .00$; partial $\eta^2 = .45$) and a significant time-by-group interaction effect ($F [2, 94] = 3.54; p = .03$; partial $\eta^2 = .07$), suggesting that the three groups exhibited significant improvement in literal reading comprehension over time, with notable differences present among the groups. Post-hoc analyses were conducted to further evaluate the differences among groups. The results of paired t-tests for each group demonstrated significant improvement in literal reading comprehension over time. In addition, according to one-way ANOVA at each time point, similar means for the pre-test score were found for all groups ($F [2, 94] = .88; p = .42$). However, the mean post-test score differed significantly among the groups ($F [2, 94] = 5.55; p = .01$). Tukey's HSD post-hoc analyses showed that the tablet group achieved the largest gain (Mean difference, $[MD] = 14.74$), significantly larger than that of the print or control group. Although the print group obtained a higher mean achievement score ($MD = 10.59$) compared to the control group ($MD = 6.87$), this difference was not significant.

TABLE 3
Descriptive Statistics for Multiple-Choice Reading Test Results ($N = 97$)

Group	Time	Items	Min	Max	Mean (<i>SD</i>)	Skewness (<i>SE</i>)	Kurtosis (<i>SE</i>)	Mean Difference
Tablet reading ($n = 42$)	Pre-test	22	16	81	58.38 (17.93)	-.61 (.37)	-.44 (.72)	14.74*
	Post-test	22	29	81	73.12 (12.96)	-1.99 (.37)	3.56 (.72)	
Print reading ($n = 32$)	Pre-test	22	18	81	53.22 (16.87)	-.12 (.44)	-.73 (.81)	10.59*
	Post-test	22	16	81	63.81 (18.24)	-.96 (.41)	.08 (.81)	
Control ($n = 23$)	Pre-test	22	16	81	53.35 (22.60)	-.56 (.48)	-1.25 (.94)	6.87*
	Post-test	22	23	81	60.22 (18.89)	-.68 (.48)	-.91 (.94)	

Note. *SD*: standard deviation; *SE*: standard error. The maximum attainable score was 81. * $p < .05$.

Table 4 depicts the descriptive statistics for the recall tests. The repeated-measures ANOVA revealed a significant time effect ($F [1, 94] = 37.09; p = .00$; partial $\eta^2 = .28$) and a significant time-by-group interaction effect ($F [2, 94] = 6.99; p = .00$; partial $\eta^2 = .13$). These results suggest that the interventions significantly increased deep reading comprehension over time, but the level of increase differed among the groups. Paired t-tests for each group revealed that the recall scores increased significantly over time in the print reading and control groups, but remained constant in the tablet reading group. Moreover, one-way ANOVA at each time point revealed that the three groups did not differ significantly from one another in terms of the pre-test ($F [2, 94] = .16; p = .86$) or post-test ($F [2, 94] = .89; p = .42$). Therefore, we performed repeated-measures ANOVA to compare the tablet group with print group, the tablet group with the control group, and the print group with the control group to identify the source of the significant interaction effect. The results showed that the growth was significantly greater in the print reading group than in the tablet reading group ($F [1, 72] = 17.35; p = .00$; partial $\eta^2 = .19$), whereas growth in the print reading group did not differ significantly from that in the control group ($F [1, 53] = 2.55; p = .12$). Moreover, the gain scores did not differ significantly between the tablet and control groups ($F [1, 63] = 2.22; p = .14$).

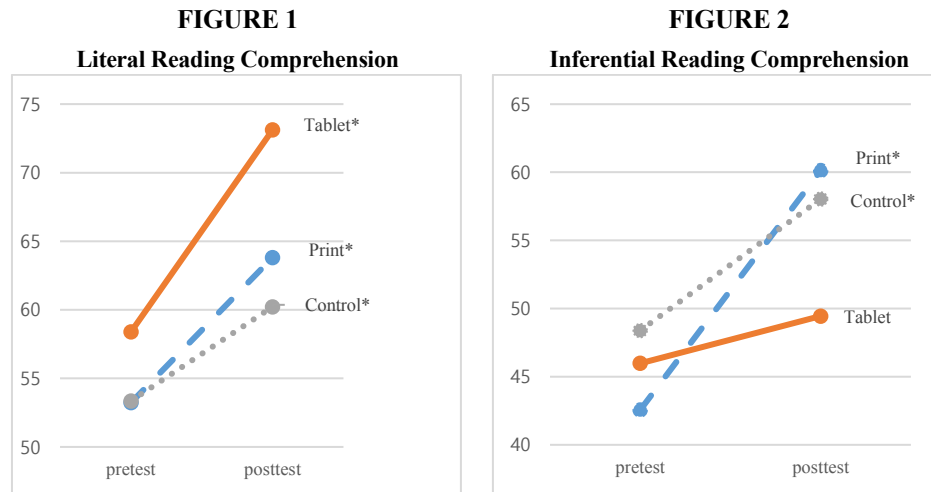
TABLE 4
Descriptive Statistics for Recall Test Results ($N = 97$)

Group	Time	Items	Min	Max	Mean (<i>SD</i>)	Skewness (<i>SE</i>)	Kurtosis (<i>SE</i>)	Mean Difference
Tablet reading ($n = 42$)	Pre- test	2	0	122	45.98 (36.58)	.54 (.37)	-1.02 (.72)	3.48
	Post- test	2	0	126	49.45 (34.87)	.39 (.37)	-.89 (.72)	
Print reading ($n = 32$)	Pre- test	2	0	120	42.56 (38.58)	.50 (.41)	-1.23 (.81)	17.56*
	Post- test	2	0	136	60.13 (34.83)	.46 (.41)	-.65 (.81)	
Control ($n = 23$)	Pre- test	2	0	123	48.39 (43.57)	.48 (.48)	-1.33 (.94)	9.65*
	Post- test	2	2	128	58.04 (40.88)	.37 (.48)	-1.37 (.94)	

Note. *SD*: standard deviation; *SE*: standard error. The maximum attainable score was 157. * $p < .05$.

Our results indicate that extensive reading using a tablet was most effective among the three methods for improving literal reading comprehension. Reading printed books extensively and receiving regular English instruction significantly enhanced surface-level reading comprehension, with insignificant group differences. For inferential reading comprehension, the opposite result was found. Extensive reading using printed books developed the deep reading comprehension of students significantly more than did extensive

reading using tablets, but the level of improvement was similar to that in the control group. The control group used printed textbooks and obtained significant gains from the pre- to post-recall test. Figures 1 and 2 display the results of these analyses.



* $p < .05$

4.2. Grammatical Knowledge

Table 5 displays the means and standard deviations of the grammar test scores for the three groups. The results of repeated-measures ANOVA showed an insignificant time effect but a significant time-by-group interaction effect ($F [2, 94] = 10.23; p = .00$, partial $\eta^2 = .18$). The results indicate that the treatment effect was more pronounced for some groups. Paired t-tests for the three groups revealed that only the print group improved significantly over time ($t [1, 32] = 4.98; p = .00$). By contrast, scores in the tablet reading and control groups declined (but non-significantly) over time. Moreover, one-way ANOVA at each time point revealed that neither the pre-test ($F [2, 94] = 1.54; p = .22$) nor post-test ($F [2, 94] = .32; p = .73$) score differed significantly among the three groups.

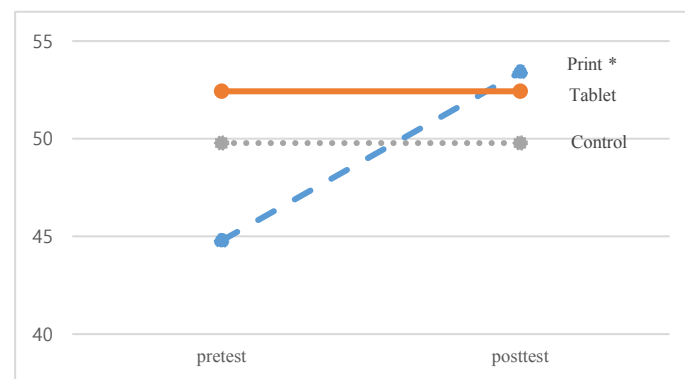
TABLE 5
Descriptive Statistics for Grammatical Test Results (N = 97)

Group	Time	Items	Min	Max	Mean (SD)	Skewness (SE)	Kurtosis (SE)	Mean Difference
Tablet reading (n = 42)	Pre-test	40	21	94	52.43 (21.44)	.53 (.37)	-.71 (.72)	-1.98
	Post-test	40	15	86	50.45 (18.41)	.22 (.37)	.79 (.72)	
Print reading (n = 32)	Pre-test	40	14	98	44.78 (17.84)	.94 (.41)	1.44 (.81)	8.63*
	Post-test	40	22	84	53.41 (18.23)	-.11 (.41)	-.98 (.81)	
Control (n = 23)	Pre-test	40	26	98	53.00 (23.11)	.61 (.48)	-.95 (.94)	-3.22
	Post-test	40	16	91	49.78 (20.17)	.39 (.48)	-.74 (.94)	

Note. SD: standard deviation; SE: standard error. The maximum attainable score was 100. * $p < .05$.

To determine the source of the significant interaction effect, we performed repeated-measures ANOVA to compare the tablet group with the print group, the tablet group with the control group, and the print group with the control group. The results showed that the level of grammatical knowledge increased significantly in the print reading group ($MD = 8.63$) compared to the other two groups. Moreover, the changes in the tablet ($MD = -1.98$) and control ($MD = -3.22$) groups did not significantly differ from each other. These results suggest that the extensive reading of printed books may be the most effective method for improving the ability of learners to identify correct sentence structures compared to other methods. Figure 3 displays the development patterns of grammatical knowledge in the three groups.

FIGURE 3
Grammatical Knowledge



* $p < .05$

5. DISCUSSION

The goal of the present study was to compare the impacts of extensive reading using tablets, extensive reading using printed books, and regular instruction using a textbook on the reading comprehension and grammatical knowledge of young elementary school EFL students. We found that the literal reading comprehension level increased significantly in the tablet reading group compared to the print reading and textbook-based groups. However, reading printed books was more effective in enhancing inferential reading comprehension compared to reading e-books on tablets. Furthermore, only the group reading printed books had a significant increase in grammatical knowledge over the 11 weeks. Neither online readers nor textbook learners exhibited any significant changes in their grammatical knowledge during this period.

These results have several important implications. First, the present study revealed the potential of tablets as a new reading resource for developing literal reading comprehension. This finding is inconsistent with previous studies that reported higher levels of reading comprehension with printed texts than with digital texts (Halamish & Elbaz, 2020; KazazoĖLu, 2020; Kerr & Symons, 2006; Mangen et al., 2013; Reich et al., 2019; Salmerón et al., 2021; Støle et al., 2020; Singer & Alexander, 2017). However, it is notable that, unlike the current study, the previous studies did not evaluate literal and inferential reading comprehension separately but rather, measured general reading comprehension only. One previous study (Chen et al., 2014) investigated both types of reading comprehension after controlling the device navigation and scrolling functions while reading e-books, which might have impeded reading comprehension. This study identified similar levels of literal reading comprehension (measured using multiple-choice items) between paper and tablet reading groups of Chinese EFL university students (Chen et al., 2014). However, the paper reading group performed at a higher level than did the computer reading group. Despite similar multiple-choice reading comprehension measures and controlled navigation conditions, Chen et al. (2014) and the current study produced conflicting results.

One reason for this discrepancy may be because we measured the literal reading comprehension of young EFL learners after the 11 weeks of extensive reading using printed books or tablets. Conversely, Chen et al. (2014) evaluated the immediate effects of reading short passages on paper, computers, and tablets. It is possible that the improvement in literal reading comprehension in L2 students reading e-books using tablets depended on their extent of reading. In other words, the positive effects of using tablets may be more pronounced after long-term reading. Furthermore, the *Reading Gate* application more closely simulates print reading than does *Epub*, the electronic publication viewer used by Chen et al. (2014). The *Reading Gate* application offers page-by-page turning using a touch screen and a paper book-like layout with colorful illustrations. These features reduce cognitive burden by

removing disruptive functions, such as hypertext or surfing, and provide a stable reading experience similar to reading printed books (Kazazoğlu, 2020; Mangen et al., 2013; Støle et al., 2020; Walsh, 2016). Moreover, the participants in the present study were young EFL readers who had greater familiarity with mobile devices such as smartphones or tablets than the older EFL university students in Chen et al. (2014). Several studies have suggested that young learners who grow up using digital devices prefer and are more motivated to engage in digital reading (Halamish & Elbaz, 2020; Kerr & Symons, 2006). Because motivation plays an essential role in developing reading skills among young learners (Kaban & Karadeniz, 2021), we speculate that the positive attitudes of young EFL students toward digital reading motivate them to read e-books and promote reading comprehension skills.

Despite the contribution of tablet reading to literal reading comprehension, students reading printed books recalled significantly more information than did those reading e-books on tablets. No significant differences were found between the print reading and control groups and between the tablet reading and control groups. Nevertheless, students in the control group, who learned English with a textbook, but not those in the tablet groups, improved significantly in the recall tests over time. These results indicate that printed materials, regardless of whether printed books or a textbook was used, improved inferential reading comprehension. Similar to the results of the current study, previous studies showed that undergraduates (Singer & Alexander, 2017) and elementary school students (Kerr & Symons, 2006) recalled more detailed information and more idea units from reading in print than from reading on computers for the same reading times.

One possible explanation is that the fixedness of the print medium supports the readers in linearly constructing meaning, finding the locations of the necessary information in the text, and remembering and recalling the main ideas or details in the text (Mangen et al., 2013; Pardede, 2019). We applied a tablet reading condition similar to that for printed books by controlling the navigation and scrolling functions. This was effective in improving literal reading comprehension but not inferential reading comprehension. Furthermore, this unique feature of the paper might have contributed to increased attention in the readers. Lin et al. (2021) and Sage et al. (2019) found that learners expected that they concentrated more and better understood after reading printed texts compared to reading e-books, regardless of their actual reading performance results. Yildiz and Cetinkaya (2017) also suggested that a higher level of concentration while performing reading tasks is associated with faster reading speed. Considering that the English proficiency of the present study (measured using multiple-choice reading comprehension, recall, and grammatical tests) was similar between the groups before the intervention, the higher average number of books read by the print extensive reading group compared to the tablet extensive reading group suggests that the print reading group might have concentrated more on reading and possibly, read faster than the tablet reading group. Therefore, reading on paper reduces the cognitive burden on readers

by forcing them to focus on fixed text and enabling them to engage in the deep reading process, leading to sustained attention and high retention (Kazazoğlu, 2020; Kerr & Symons, 2006; Pardede, 2019; Young, 2014).

Another explanation may be that the participants in the current study developed different reading habits toward reading using digital devices and printed books. The *Shallowing Hypothesis* suggests that frequent use of digital and social media (e.g., short messages, tweets, and social networking service posts) allows quick interactions, immediate feedback, easy portability, and consistent connection to the Internet, leading to shallow cognitive processing and decreased reflective thought (Annisette & Lafreniere, 2017). If readers continue to use digital devices for a long time, they may find it challenging to maintain attention in complex tasks, such as reading comprehension (Delgado et al., 2018). Indeed, several studies have demonstrated the shallowness of digital media compared to print media. Mangen et al. (2013) claimed that students develop superficial reading habits and a simple reading process when engaging with digital texts, such as daily news, celebrity gossip, emails, and social networking service posts on mobile devices. Støle et al. (2020) suggested that despite the high level of familiarity of primary school EFL students with digital devices in Norway, these students achieved higher reading comprehension while reading on paper compared to reading on computers. They argued that the participants might have developed shallow reading habits by reading text on screen and processing the information quickly. It is possible that the tablet and print reading groups in the present study might have fostered distinctive reading habits when reading on tablets and printed books. Moreover, only the control group who had used a printed textbook significantly enhanced recall scores from pre- to post-test, whereas the tablet group revealed insignificant improvement. This difference might have contributed to the difference in reading habits between digital versus paper texts.

Reading on print media was also superior for grammatical knowledge. Whereas the tablet extensive reading and control groups showed no significant changes over time, the sentence structure test scores increased significantly in the print extensive reading groups. The increase in grammatical knowledge in the print extensive reading group has also been found in previous studies. Several studies demonstrated that extensive reading using printed books notably increased the grammatical knowledge of L2 learners (Alqadi & Alqadi, 2013; Khansir & Dehghani, 2015; Lee et al., 2015). Such an improvement, however, was not observed in the tablet reading group or control (regular instruction) group. Reading quickly and superficially using tablets may reduce the level of attention learners pay to sentence structures. Moreover, the sentence structures included in the textbook may not be sufficient in quantity to develop students' grammatical knowledge. Thus, we speculate that repeated exposure to comprehensible input is vital to develop grammatical knowledge, and this input should be offered on paper to increase the level of attention toward sentence structure.

6. CONCLUSION

There were some limitations to this study. First, the number of participants in each group was not sufficiently large. Caution is needed when applying the findings of this study to other contexts. Also, we administered 18 reading sessions over 11 weeks because of COVID-19 pandemic. As Renandya and Jacobs (2016) suggested, longitudinal extensive reading may be more appropriate to determine the effects of reading. Finally, although we counted the average number of books read by the two reading groups, we did not track the length of the books or reading times to determine their reading speed. Further information on the reading speed may improve our understanding of the reading processes involved in reading e-books and printed books.

Despite these limitations, the results of the current study have several important implications. The present study revealed that the tablet extensive reading group read significantly more books on average than did the print extensive reading group and exhibited the highest gains in literal reading comprehension. Despite the widespread use of tablets in classrooms, some school teachers still depend on printed reading materials, without considering the benefits of digital devices (Lin et al., 2021). To prepare young learners for the future, teaching the use of digital devices is important. Based on the findings from this study, elementary school EFL teachers should encourage young learners to read extensively using tablets to develop basic reading comprehension. Moreover, teachers need to inform learners of the potential problems associated with using tablets and advise students to concentrate more and reflect longer while reading on tablets. If teachers encourage learners to think deeply while reading on tablets and provide appropriate training, tablets can serve as a powerful reading device inside and outside of the classroom (Chen et al., 2014; Støle et al., 2020). Teachers should also encourage young EFL students to keep reading printed books to improve their in-depth reading comprehension and grammatical knowledge. Advances in science and technology have provided learners, educators, and policy makers with various options for learning and teaching. However, technological tools should be used with caution because they may not always lead to good results. Therefore, further studies are needed to determine the effects of these tools on learning, and this study will serve as a foundation for future research.

Applicable levels: Early childhood, elementary

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APPENDIX
Summary of the Impacts of Different Media on Reading Comprehension

Study	N	Participants & Settings	Duration	Test Types	Comparison Groups	Findings
Kaban & Karadeniz (2021)	96	Grade 6 students in Turkey (EFL)	5 weeks	Not specified	Print vs. computer	Despite the potential of computer reading for increasing motivation, no significant difference in reading comprehension was found between the two media.
Salmerón et al. (2021)	182	Grade 5 and 6 students in Spain (EFL)	Immediate effects	Open-ended questions	Print vs. tablet	Students with low reading comprehension understood better when reading in print when there was a time limit. By contrast, higher-level learners exhibited no difference between the two medium types.
Lin et al. (2021)	81	University freshmen in Taiwan (EFL)	14 weeks	Cloze test	Print vs. mobile devices (mobile phones, tablets, or laptops)	The mobile group obtained similar scores as the print group for a reading comprehension test.
Halamish & Elbaz (2020)	38	Grade 5 students in Israel (EFL)	Immediate effects	Multiple-choice items	Print vs. computer	Although the print and computer groups had the same initial reading time, learners understood better when reading on paper than when reading on a computer.
Kazazoğlu (2020)	30	University students in the USA (L1)	6 weeks	Open-ended questions, short answer questions	Print vs. computer	The print reading group performed substantially better than the digital reading group.
Støle et al. (2020)	1139	Grade 5 students in Norway (EFL)	Immediate effects	Not specified	Print vs. computer	Learners' average improvement on the reading comprehension test was lower when reading digital texts than when reading printed texts.
Reich et al. (2019)	194	Pre-school students in USA (L1)	Not mentioned	Open-ended question, multiple-choice items.	Print vs. tablet	Young learners remembered the arrangement of story sequences slightly better when reading paper books. However, there was no difference in emotional and behavioral engagement between both medium types.

Sage et al. (2019)	120	Undergraduate students in the USA (L1)	Immediate effects	Multiple-choice questions	Print vs. computer vs. tablet	Across the three medium types, participants spent the same amount of time and had equal scores in the reading comprehension test. However, participants expressed a solid preference for print media.
Kerman & Ertim (2018)	75	Grade 4 students in Turkey (EFL)	14 weeks	Not specified	Print vs. tablet	Some positive effects from tablets on reading comprehension were observed, but the positive effects decreased as the application time increased. As a result, there was no difference between the tablet and print groups.
Hermena et al. (2017)	24	Undergraduate students in UAE (L1)	Immediate effects 2 sessions *20 mins	Not specified	Print vs. tablet	When the display conditions of print and tablet texts were similar, there was no difference in reading comprehension between the two medium types.
Singer & Alexander (2017)	90	Undergraduate students in USA (L1)	Immediate effects	Short construction questions	Print vs. computer	Although there were no media differences in finding the main idea in the text, the print medium was more effective in recalling key points associated with the main idea and other related information.
Chen et al. (2014)	90	College students in China (L1)	Immediate effects	Multiple-choice item, summarization questions	Print vs. computer vs. tablet	For literal reading comprehension, the print group performed better than computer groups. For inferential reading comprehension, there was no difference among the three medium types.
Young (2014)	11	University students in Canada (ESL)	2 sessions * 3 hours	Open-ended questions	Print vs. tablet	Both paper and tablet reading groups performed similarly in retaining key points of the text and reading in-depth.
Mangen et al. (2013)	72	Grade 10 students in Norway (EFL)	Immediate effects	Multiple-choice items, short-answer constructed response questions	Print vs. computer	Participants who read on paper scored better on the reading comprehension test than reading computer texts.
Kerr & Symons (2006)	60	Grade 5 students in Canada (L1)	Immediate effects	Cued recall questions, open-ended items	Print vs. computer	Students took more time to read and recalled more in the computer reading group, but the print group did better in terms of comprehension efficiency (i.e., recalling more information within a short time).