

# Reading recall: A comparison of reading comprehension

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## SUMMARY

Electronic books, or e-books, have become more popular over the past several years. Researchers query whether reading comprehension is the same, worse, or better when using e-books as compared with standard paper texts. This study evaluated this question in the elementary school population. Our hypothesis was that information would be retained equally whether read from paper or from an electronic device. Each participant read four stories, alternating between electronic and paper media types. After each reading, the participants completed a five-question test covering the information read. The study participants correctly answered 167 out of 200 comprehension questions when reading from an electronic device. These same participants correctly answered 145 out of 200 comprehension questions when reading from paper. At a significance level of  $p < 0.05$ , the results showed that there was a statistically significant difference in reading comprehension between the two media, demonstrating better comprehension when using electronic media. The unexpected results of this study demonstrate a shift in children's performance and desirability of using electronic media as a reading source. Parents and teachers may need to adapt to their children's and students' needs and desires in order to maximize learning potential.

## INTRODUCTION

Many people engage in reading, whether for pleasure or academic needs. Today, reading on electronic devices instead of paper is very common. Schools are increasing the use of e-textbooks, especially during the coronavirus disease 2019 (COVID-19) pandemic (1). Since many schools closed their doors during the pandemic and shifted to online learning, several students lacked access to print books and instead relied on digital media (1). The use of digital media quadrupled during the pandemic (1). According to Melissa Jacobs, director of the New York City Department of Education School Library System, the number of digital books accessed by students increased by 228% between March 2020 and February 2021 (1). Many young students are growing up with electronic media and have been described as "digital natives" (2). The use of electronic media is second nature to these students, and often makes reading fun (2). Despite this, a large percentage of students still prefer print

books, often related to the tactile experience and to the limitation of distractions, such as text messages and other notifications (2, 3). Perhaps, however, these statistics about student preferences are changing as a result of the pandemic (1).

Although digital books may be more convenient and engaging, studies have been mixed in regard to comprehension, concentration, speed of reading, and overall recall of information from digital books in comparison to paper books (2-4). Studies using older subjects have shown that comprehension and recall appears to be lower and reading appears more physically and mentally demanding when reading from an e-book than a print book (5). Rudins conducted a similar study in 2016 with middle school students (6). This prior study showed no statistically significant difference of reading comprehension when using paper books compared with Apple iPads®. However, 16 out of 20 of the participants preferred paper, and many complained of headaches, exhaustion, and watery eyes when reading on the iPads (6). Although the accuracy of the students' performances on the comprehension tests may not have been impacted by media type, the participants perceived the effort required to maintain focus and comprehend the stories to be higher when reading on iPads as compared with reading on paper.

Schools' choices of reading media is a critical issue globally. As schools increase the use of electronic media, they may be impacting the learning experiences of the students (1). Angela Arnold, general manager of OverDrive Education, claims digital books are now seen as a "necessity" rather than an "accessory" (1). If e-books are becoming a necessary part of both young children's and adults' lives, we must be aware of both the positive and negative impacts of this transition.

In this study, we examined if elementary school students comprehend and recall information read on an electronic tablet as well as when read on paper. Our hypothesis was that the students would comprehend and recall the information equally well, whether read from paper or from an electronic device. The participants in the study read two short stories on paper and two stories on an electronic device, alternating between the two media types. After each reading, the participants completed a five-question comprehension test. The results showed that there is a statistically significant difference in reading comprehension and subsequent recall between the two media, demonstrating better performance when using electronic media. Based on these findings, if used appropriately and effectively, electronic devices in the classroom may become a necessity to enhance student learning and performance.

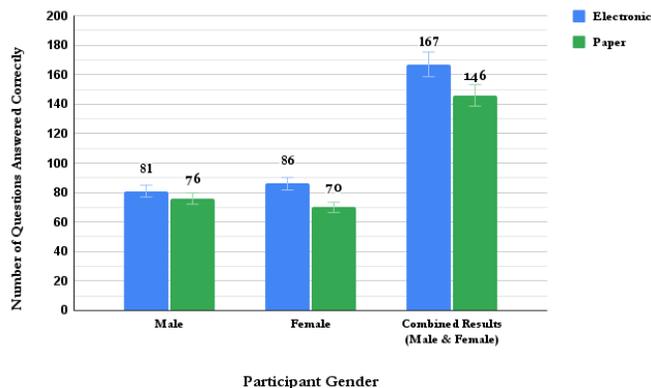
RESULTS

A group of 20 elementary school students aged 6 to 9 years (10 male and 10 female) participated in this study. Each participant read four short stories and answered a set of five comprehension questions after each story. After completing the stories and questions, each study participant was then asked whether he/she prefers reading from paper or electronic media.

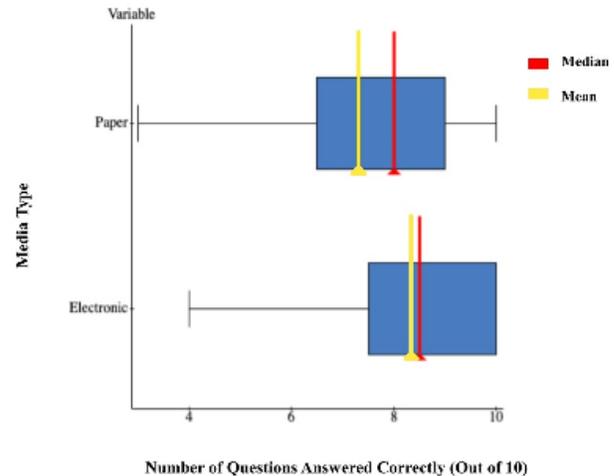
The reading test results were similar, but overall, the electronic media resulted in higher scores in both boys and girls (Figure 1). Out of a total of 200 possible points for all participants, the electronic media had a 21-point advantage over the paper media, which we found to be statistically significant (matched-pair t-test,  $p = 0.03$ ). The students scored a higher mean by 1.05 points and a higher median by 0.5 points on the reading comprehension test after reading from the electronic media, as compared with the paper media (Figure 2). These values show that there is a small, but statistically significant, difference in reading comprehension between the two media. Therefore, we rejected our hypothesis that there would be no statistically significant difference in reading comprehension when using electronics or paper.

We observed a similar pattern when examining the differences within the individual stories (Figure 3). Again, electronic media had a higher score in 2 out of 4 stories, while paper showed a higher score in 1 out of 4 stories, and the remaining story resulted in a tie between the two media.

Electronic media and paper media were similarly preferred, with electronic media having a small advantage over paper media (Table 1; Figure 4). Both males and females had identical preferences, but gender differences were not a focus of this study.



**Figure 1: Electronic and paper reading comprehension raw data by gender.** This graph represents the total number of correct answers to the comprehension questions when reading from paper compared with the total number of correct answers to the comprehension questions when reading from an electronic device. Each student answered a total of ten questions for each media type. Therefore, the male/female bars represent the number of correct answers out of 100, and the combined bars represent the number of correct answers out of 200. The use of electronic media resulted in higher reading comprehension scores, both in males and females. Analyzing the differences in comprehension levels based on gender was not within the scope of this study, but raw data was included for informational purposes. The overall difference between the two media types for the combined category was statistically significant ( $p = 0.03$ ). The error bars represent 5% error of the compiled scores.

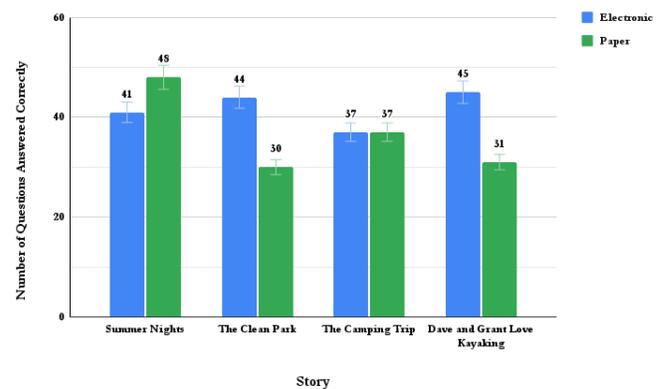


**Figure 2: Comparison of the distributions of student scores.** This diagram represents the mean and median scores on the comprehension tests for each reading media. The students scored a higher mean by 1.05 points when reading from the electronic media, compared with the paper media. The students also scored a higher median by 0.5 points when reading from the electronic media.

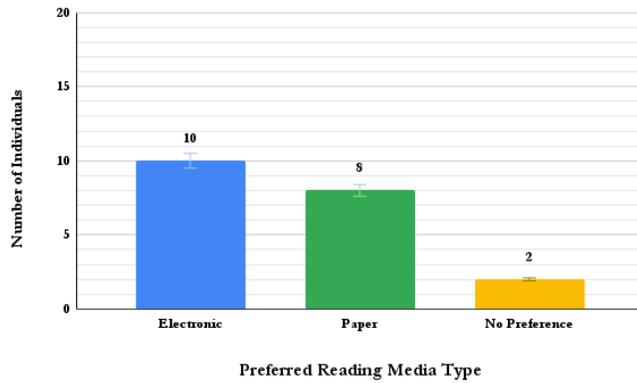
In the 2016 study, the use of paper media resulted in higher reading comprehension scores, both in males and females, but these differences were not statistically significant at  $p < 0.05$ . (matched-pair t-test,  $p = 0.28$ ) (Figure 5) (6). Additionally, the participants strongly preferred paper media to electronic media for reading purposes (Figure 6; Table 2).

DISCUSSION

Our results showed there is a statistically significant difference in reading comprehension between electronic media and paper media in the elementary school population, favoring the use of electronic media. The preferences shown by the students in the study also leaned toward electronic media. Half of the children preferred reading from the electronics rather than the paper for a variety of reasons, most of which reflected their comfort with and interest in electronics. Four



**Figure 3: Electronic and paper reading comprehension raw data by individual story.** This graph compares the number of correct answers to the comprehension questions when using each media type, grouped by story. Each story had a maximum of 50 correct answers for each media type. The error bars represent 5% error of the compiled scores.



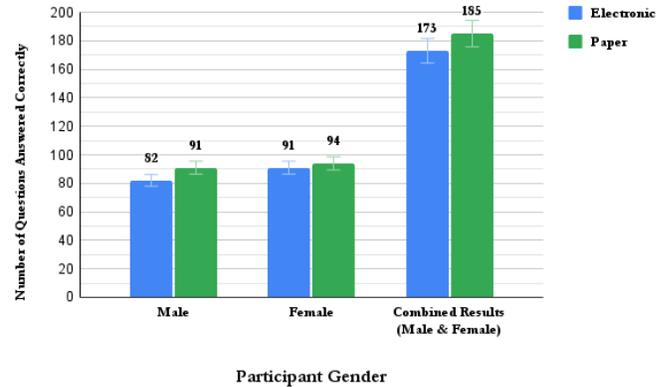
**Figure 4: Preferred reading media type of children age 6-9 years.** This graph represents the preferred reading media type of children tested in the study. Out of the 20 study participants, 10 students preferred reading from an electronic device, 8 preferred reading from paper, and 2 had no preference. The error bars represent 5% error of the compiled results.

children who preferred paper commented on the negative aspects of electronics, rather than focusing on the positive aspects of paper books. One of these children responded with, “because books don’t get glitches,” and another child mentioned the inconvenience of having to regularly charge the device. Additionally, one child who preferred reading from the tablet responded with, “idk” (shorthand for “I don’t know”; often used in text messages). Answers such as these show that children have been surrounded with electronics for most, if not all, of their lives. This may be one reason for their strong ability to read and comprehend stories when using an electronic device. In the population studied, one complicating factor that was not addressed was access to electronic media and the degree to which this impacts the student’s comfort level with using electronic devices for reading. Perhaps, if students are not regularly exposed to electronic media, they would tend to retain a preference for paper media.

In the 2016 study conducted by Rudins, the use of paper tended to show better reading comprehension, as compared to the use of electronics, though was not statistically significant. This study resulted in paper having a higher score by twelve points (6 percentage points) (Figure 5). The results were consistent in showing the trend of a slight benefit of paper over electronic media in all groups tested. Furthermore, at the conclusion of the testing, each participant was asked to state a preference for paper or electronic media. Sixteen out of 20 study participants preferred paper (Figure 6). Interestingly, in 2016, only one female and three male participants preferred electronic media over paper media, whereas, in 2021, the preferences among males and females were identical to each

	Electronic	Paper	No Preference
Male	5	4	1
Female	5	4	1
Combined	10	8	2

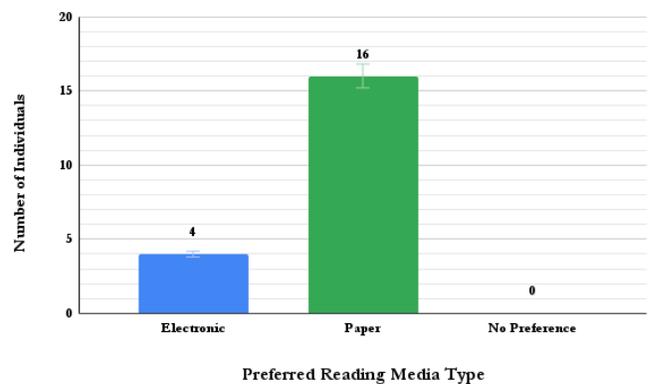
**Table 1: Preferred reading medium of children ages 6-9.** After completing the four stories and associated questions, the participants answered a question about their reading media preference. The compiled results are shown in the table.



**Figure 5: Electronic and paper reading comprehension raw data of children age 11-14 years (2016).** This graph represents data from a similar study conducted in 2016 with 20 middle school students. The total number of correct answers to the comprehension questions when reading from paper compared with the total number of correct answers to the comprehension questions when reading from an electronic device are shown. Each student answered a total of 20 questions for each media type. Therefore, the male/female bars represent the number of correct answers out of 200, and the combined bars represent the number of correct answers out of 400. The error bars represent 5% error of the compiled scores.

other. During the 2016 study, participants made claims to the author that reading on electronics resulted in watery eyes, headaches, and distractions. Only one participant in the most recent study complained of eye discomfort (6).

The time lapse between studies and age differences between participants in these two studies show that there has been a shift in preference from paper books to electronics in elementary-aged children. The younger generation has been exposed to electronics much more than any other generation. Additionally, the majority of students tested in the most recent study previously completed more than a year of virtual schooling, which only increased the amount of time spent reading on electronics. The students tested in the 2016 study had used print textbooks for several years prior, and



**Figure 6: Preferred reading media type of children age 11-14 years (2016).** This graph represents the preferred reading media type of the middle school children tested in the 2016 study. Out of the 20 study participants, 16 preferred reading from paper, and 4 preferred reading from an electronic device. The error bars represent 5% error of the compiled results.

	Electronic	Paper	No Preference
Male	3	7	0
Female	1	9	0
Combined	4	16	0

**Table 2: Preferred reading medium of children ages 11-14, 2016.** In 2016, after completing the four stories and associated questions, the participants selected their reading media preference. The compiled results are shown in the table.

had never experienced virtual schooling. As students spend more time using electronics and less time reading paper books, they may adapt to the new reading medium, which leads to slightly improved reading comprehension levels when using electronics rather than paper books. These younger students may engage more with the electronics because they are curious as to how the device works and enjoy the ease of referencing additional material, whereas a book is something they view as less engaging.

Determining the efficiency and effectiveness of using electronics as compared with paper will help teachers determine the best way to integrate electronic devices in a school setting. To advance the study, a larger number of participants would help improve the reliability and significance of the data. Ideally, in future studies, participants would read more stories of greater length, both on electronics and paper, and answer more questions. This would enhance the relevance and statistical strength of the project. Due to the time constraints, and to optimize the participants' focus, the children in this study only read a one-to-two page story, which may have been too short to accurately measure the difference in reading comprehension when using electronics versus paper. Further research is also needed to determine if the results of this experiment are applicable to other populations. This would include more advanced academic applications, such as high school and college, as well as various work environments. With the more recent emphasis on working from home, these results would have particular bearing on such situations. Furthermore, additional research is needed to determine if recreational reading is affected in a similar fashion. Future studies could also include assessing comprehension levels using the two media types with various age groups, genders, and generations. The difference in results of the 2016 study and this current study conducted in 2021 are intriguing. It would be very interesting to conduct a third study in another five to ten years to gain a better understanding of human adaptation to the digital world.

## MATERIALS AND METHODS

Twenty participants, ten male and ten female, age six to nine years, participated in this study. The researcher received written consent from all participants and their guardians prior to participation. Participants were randomly selected from a local summer enrichment program and a local church in Asheville, North Carolina. The materials used included Lenovo 10e Chromebook Tablets, Georgia Pacific 92 brightness paper, and reading comprehension worksheets from K5 Learning, an online source for free reading and math worksheets (7). The four stories from K5 Learning were *Summer Nights*, *The Clean Park*, *The Camping Trip*, and *Dave and Grant Love Kayaking*. The stories were read by

each student in the order listed.

The manipulated variable in this experiment was the reading media, either electronic or paper. The controlled variables were the information read and the questions asked. Other controlled variables included the font and size of type and the environmental conditions during the testing periods. The dependent variable was the participants' accuracy in answering the comprehension questions. Using K5 Learning as a reference, the author then wrote five open-ended questions about each story, asking about simple details in each of the stories. All questions required a specific, one-to-three word answer. When analyzing the reading comprehension data, one point was awarded for each correct answer. Adult mentors reviewed these questions prior to use. Participants read and answered all questions on paper, regardless of which medium was used to read the stories. In order to analyze the data, we implemented a matched-pair t-test using a TI-84 Plus Calculator and StatCrunch, at a significance level of  $p < 0.05$  and 19 degrees of freedom. This method was the best statistical test to evaluate for differences in the two data sets.

The 20 participants were asked to read the stories and answer the questions. Each participant was instructed to take as much time as needed to read each story and answer the questions. Half of the male and half of the female participants read the first story on a tablet, and the remaining individuals read the first story on paper. Each participant alternated between the two media for the subsequent stories. The participants were randomly assigned to the initial paper or electronic group. Each participant read a story, and then immediately completed a written test of five comprehension questions pertaining to that story. The participants did not have access to the stories while answering the questions. Following this, participants read a second story and completed another five-question test. In order to replicate the trial, each participant then immediately repeated the process using another pair of stories and associated questions. After completing the stories and questions, each study participant was then asked whether he/she preferred reading from paper or electronic media.

The procedure of the 2016 study was very similar to that of the 2021 study. In the 2016 study, the manipulated variable was the reading media, either electronic or paper. The controlled variables were the information read and the questions asked. Other controlled variables included the font and size of type, and the environmental conditions during the reading and the follow-up testing. The responding variable was the test score. Twenty participants, 10 male and 10 female, age 11 to 14 years, were asked to read 4 short stories and answer 10 comprehension questions after each story. Half of the participants read the electronic stories first, and half read the paper stories first; the students alternated between media types for the remaining stories. Rudins randomly assigned the order of the stories and initial media type to the participants. After completing the stories and comprehension questions, Rudins asked each participant his/her reading media preference.

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