



## Student Comprehension of Books in Kindle and Traditional Formats

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## Executive Summary

Because electronic reading devices, including e-readers and tablet computers, are increasing in popularity at such a rapid rate, it is critical to understand how the reader's comprehension of text read on these devices compares with traditional print books. Previous research suggests there is no difference in comprehension when reading in the two formats, but many of these studies were conducted with animated storybooks. None involved extensive reading for pleasure in a typical school setting.

The current study involved two fourth-grade classrooms in a school in the Upper-Midwest. In total, 31 students were asked to read up to six books, alternating between the AmazonKindle e-reader and traditional print formats to avoid any treatment effect. The books were selected from a list of more than a dozen popular fiction titles selected to match the students' reading proficiency as measured by the STAR Reading<sup>1</sup> assessment. The students read a total of 135 books, 69 on the Kindle and 66 in print. After reading each book, the students completed a brief, computer-based Accelerated Reader (AR)<sup>2</sup> assessment to measure their understanding of the story. At the completion of the study, the students responded to a short survey that asked about their reading preferences.

The results showed no statistically significant difference between the students' understanding of the Kindle and print versions of the books.

The results showed no statistically significant difference between the students' understanding of the Kindle and print versions of the books. On the comprehension assessment, the percent correct for books read on the Kindle averaged 88%,<sup>3</sup> while the average for books read in print was 88.5%.<sup>4</sup> Students' percent correct on the study books was almost identical to their comprehension of print books read outside the study, suggesting that within-study performance was typical for the participants.

When asked about using the Kindle, the majority of the students who responded said it was very easy (76%) or okay to use (16%). In terms of understandability, 28% found the Kindle much easier to understand than a printed book, 24% said it was a little easier, and 40% said it was about the same. If given a choice, 62% of the students said they would prefer to read using a Kindle rather than a book.

The results of the current study are consistent with the majority of the previous research on digital reading devices. The large number of books in the study and the naturalistic approach to the research—students read the books in a typical setting at school or at home—suggest that the results are dependable, and that students' comprehension of narrative texts is the same for e-readers and print books. Students enjoy reading on e-readers, and the novelty effect of these devices may encourage less proficient students to read more.

Because only narrative texts were used in the study, the results should not be extended to informational texts or to studying textbooks. Another issue is the nature of the task associated with reading, which refers to the action students are expected to perform to demonstrate their understanding. In this case, the task was taking an Accelerated Reader quiz. The notion of task is an important feature of the new 2010 Common Core State Standards and the construct of text complexity. In the current study, the task was relatively straightforward and familiar to the students. The author encourages both a replication of the current study and extensions involving informational texts and a broader variety of tasks.

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<sup>1</sup> STAR Reading is highest rated for reading screening and progress monitoring by the National Center on Response to Intervention, with perfect scores in all categories.

<sup>2</sup> Accelerated Reader meets criteria for scientifically based progress-monitoring tools set by the National Center on Student Progress Monitoring and has earned the top rating for Prevention and Intervention at all grade levels by the National Dropout Prevention Center.

<sup>3</sup> *SD* = 15.7%

<sup>4</sup> *SD* = 15.2%

## Introduction

Electronic reading devices are increasing in popularity, both for personal use and in education, and the trend is undoubtedly going to continue over the coming years. Some of these devices are dedicated e-readers, like the AmazonKindle or Barnes & Noble's NOOK, while others are multipurpose electronic devices including tablet or laptop computers, smartphones, game consoles, and even desktop computers. Of the devices, dedicated e-readers and tablet computers provide an experience that is most homologous to reading a traditional print book.

The popularity of electronic readers is nowhere more evident than in book sales reported by Amazon, where as early as 2010, more books were sold in the Kindle format than in print (Ostrow, 2010). In January 2011, *USA Today* reported that e-book versions of the top six best sellers were doing better than their print counterparts (Dilworth, 2011). The number of American homes that now have tablet computers or e-readers is more than 12%, a threefold gain from a year ago (Svensson, 2011).

The use of e-readers in education is growing as well. Almost every day, Internet outlets, such as *eSchool News* or *TechLearning*, report on a school or district incorporating e-readers or tablet computers into the curriculum. This trend has not gone unnoticed by educational publishers; most are at least dabbling in adapting their texts to electronic formats. In a comment made to *eSchool News* (2011), Jay Diskey, executive director of the Association of American Publishers' schools division, said that the major textbook publishers are making the transition to electronic texts, but for the near future, at least, traditional textbooks will still be important. He also observed that an important question remains: What works best in print and what works best digitally for students and teachers?

The popularity of electronic readers is nowhere more evident than in book sales reported by Amazon, where as early as 2010, more books were sold in the Kindle format than in print.

(Ostrow, 2010)

Curiously, public opinion about the use of e-readers is mixed. In a study by Scholastic (2010), approximately 25% of children between the ages of 6 and 17 reported that they had read an electronic book, but 57% said they are interested in reading one. One-third of children said they would read more books for fun if they had greater access to e-books. Two-thirds of the respondents said they will always want to read traditional books even if they have access to e-books.

In a recent Gallup/Kaplan survey, only 28% of respondents believed that elementary students should have access to e-books. Their opinion changed, however, with the age of the student, with 51% supporting e-readers for middle school students and 64% for high school students (Bushaw & Lopez, 2011).

## What the Literature Says About Digital Reading

Although reading on an e-reader is very similar to reading a book, there may be some differences. The two most important, particularly in education, are reading speed and comprehension. Relatively little research has been done to explore these differences with contemporary e-readers, although a number of studies have been done with prior generations of digital devices.

Nielsen (2010) did a within-subjects study with 24 competent adult readers. The text was a Hemingway short story in several formats: print book, personal computer, iPad®, and Kindle. The sequence of exposures to each format was randomized, and subjects' understanding was tested using a brief comprehension questionnaire. The setting was an environment in which the participants read as they might at home.

The average time to read the short story was fastest for the print book, followed by the iPad (6.2% slower), the Kindle (10.7% slower), and the PC, for which speed was not reported. The differences between the book and the two devices were statistically significant at the .01 and .06 levels, respectively. There was no difference among the formats in terms of comprehension, with most subjects answering the questions correctly. In terms of user satisfaction, participants rated each medium on a 7-point scale. The iPad, Kindle, and the print book were clustered together at 5.8, 5.7, and 5.6, respectively, with the PC scoring 3.6.

A number of studies have found that enhancing the digital reading experience through multimedia improves comprehension for some young students. An example is Pearman’s (2008) work with second-grade students. Each student read traditional text and a CD-ROM storybook at their developmental reading level the way they would if they were reading on their own. Using oral retellings as a comprehension measure, Pearman found no significant difference between the scores of students who had high or medium proficiency levels. Retelling scores were significantly higher, however, for the electronic text format for students with low reading proficiency.

Anecdotal reports suggest that most young readers enjoy using e-readers. Larson (2009) reported on her observation of 10 fifth graders. All of the students expressed a preference for reading e-books over traditional print books, and they were especially engaged by the tools that allowed them to interact with the books by flagging paragraphs, taking notes, and highlighting text. In a second case study using qualitative techniques with second-grade students and a Kindle, Larson (2010) concluded that the “findings suggested that using digital reading devices with second-grade students promotes new literacies practices and extends connections between readers and text as engagement with and manipulation of text is made possible through electronic tools and features” (p. 17).

In her review of the literature dealing with technology in early education, Burnett (2010) stated, “Current educational practices are becoming increasingly anachronistic within a world in which knowledge, learning, and relationships are being re-defined in digital environments” (p. 265). She urged researchers to investigate children’s sustained engagement with digital texts in educational settings. It is this purpose that motivated the current study.

## Study of Student Comprehension of Books Read on Kindle Versus in Print

The design of the current study replicated the way e-readers will most likely be used in classrooms and explored two research questions: (1) Was there a difference in students’ comprehension of books read in Kindle versus traditional print formats?, and (2) Did students’ reading proficiency relate to their differential understanding of the books in the two formats?

The students were given an opportunity to read six books appropriate to their individual STAR Reading grade equivalent (GE) scores. Half of the students read the Kindle version first, and half read the print version first. To determine if level of reading achievement and text difficulty affected understanding of the text, the students were grouped as shown in Table 1.

**Table 1: Student Grouping by Level of Reading Achievement**

Student Group	STAR Reading GE Score	ATOS Book Level Range of Study Books
A (n = 1)	1.4 – 2.3	2.0 – 2.5
B (n = 13)	3.2 – 4.8	3.5 – 4.0
C (n = 17)	5.1 – 9.0	5.0 – 5.5

Our study has several features not present in other studies: (1) Most students read several books in both formats; (2) the study took a naturalistic approach to student participation, allowing students to read the types of books they would normally read, when and where they would typically read them; and (3) data were gathered on students' performance of research tasks outside the study to add an element of reliability.

The study participants were the majority of students from two fourth-grade classrooms in an elementary school located in a small Upper-Midwestern town. Meaningful data were collected for 31 students. Estimates of general reading achievement were obtained through STAR Reading, a standardized, computer-adaptive assessment (Renaissance Learning, 2011). A few students were excluded because their reading proficiency was below the specification for the study.

Within each group, students read the same titles, which were chosen to match students' reading proficiency, based on the books' ATOS book levels (Milone, 2009).<sup>5</sup> In addition to readability level, the titles within each group were selected for length, popularity among boys and girls, and availability in Kindle and print formats. The titles and authors chosen are included in Table 2 (bottom of facing page).

Participants read the books beginning in early April after spring break, and the study concluded during the final week in May. The lists of books, in the order they were to be read, were provided to students, teachers, and librarians. After students finished reading each book, they completed a standardized, computer-based assessment to check their understanding by taking an Accelerated Reader Reading Practice Quiz.

Near the end of the school year, students completed a survey about the experience, which included questions about their book and medium preferences. Survey questions can be found in the Appendix, p. 8.

In general terms, the study was conducted in a way that was as nonintrusive as possible. Researchers reviewed the details of the study with the principal and an administrative assistant. Participating teachers familiarized students with the Kindle, monitored student use of Accelerated Reader, and answered questions from students as needed.

## Results

As expected, not all students read all books they were assigned. Twelve of the 31 participants read six titles, 4 students read five books, and the remaining students read four or fewer titles. The varied participation level reflects the naturalistic approach to the study in that students read the books as they normally would have.

With respect to the central research question, it appears there is no statistical or practical difference in comprehension between the two book formats (see Figure 1). On the comprehension assessment, the percent correct for books read on the Kindle averaged 88%,<sup>6</sup> while the average for books read in print was 88.5%.<sup>7</sup> The mean difference between the two formats was only 0.5%.<sup>8</sup>

When the performance of each student group was compared, similar results were found. The measured comprehension of books read on the Kindle and in print was very close, and the difference was not statistically significant.<sup>9</sup>

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<sup>5</sup> ATOS book levels are determined using Renaissance Learning's scientifically-based ATOS for Books Readability Formula.

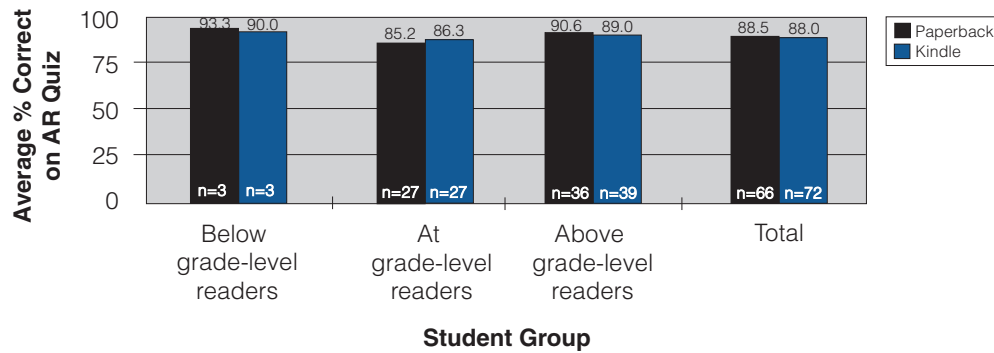
<sup>6</sup>  $SD = 15.7\%$

<sup>7</sup>  $SD = 15.2\%$

<sup>8</sup>  $F(1, 132) = .336, p = .563$

<sup>9</sup>  $F(2, 132) = .111, p = .332$

**Figure 1: Overall and Group Performance on Both Book Formats**



Note: n = Number of books read.

In addition to the books involved in the study, Accelerated Reader data were available for print books students read during the school year. The average percent correct for these additional 447 books was 89%, which is approximately the same as the study books. Thus, the students' performance in the study seems typical to their comprehension of books they routinely read.

Given the variety of titles read, it was possible there might be an effect associated with the books themselves. In Table 2, an examination of the average percent correct by book for the Kindle and print formats shows comparable understanding. Although the number of students who read each title in the two formats is small (see N columns), the data suggest there is no effect associated with title. The larger mean differences were associated with the smallest number of participants, suggesting that these scores were simply outliers.

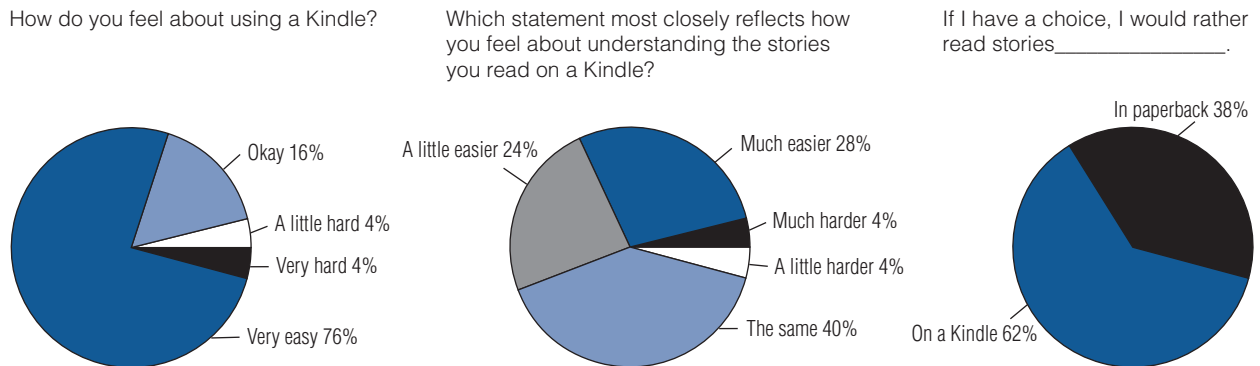
**Table 2: Comprehension by Book Title**

Title (Author)	ATOS Book Level	N	Kindle	Print	N
<i>Ginger Pye</i> (Eleanor Estes)	6.0	7	91%	91%	7
<i>The Trouble with Tuck</i> (Theodore Taylor)	5.5	5	88%	88%	6
<i>Muggie Maggie</i> (Beverly Cleary)	4.5	3	63%	77%	6
<i>My Father's Dragon</i> (Ruth Stiles Gannett)	5.6	8	94%	91%	7
<i>Chocolate Fever</i> (Robert Kimmel Smith)	4.2	5	86%	98%	6
<i>The Secret of Red Gate Farm</i> (Carolyn Keene)	5.7	5	88%	87%	6
<i>Regular Guy</i> (Sarah Weeks)	5.5	5	90%	91%	7
<i>The Tiger Rising</i> (Kate DiCamillo)	4.0	4	95%	90%	5
<i>A Week in the Woods</i> (Andrew Clements)	5.5	6	90%	83%	6
<i>The Lemonade War</i> (Jacqueline Davies)	4.1	6	85%	93%	6
<i>How to Steal a Dog</i> (Barbara O'Connor)	4.0	5	90%	75%	2
<i>Lawn Boy</i> (Gary Paulson)	4.3	4	85%	60%	2

Note: Students in Groups B or C read the books listed above. The student in Group A was assigned the following books: *Sunset of the Sabertooth* (Mary Pope Osborne); *Stink: The Incredible Shrinking Kid* (Megan McDonald); *Help Me, Mr. Mutt! Expert Answers for Dogs with People Problems* (Janet Stevens); *The Lost Lake* (Allen Say); *Horrible Harry and the Drop of Doom* (Suzy Kline); and *Dinosaurs Before Dark* (Mary Pope Osborne).

Because the user experience is so important to comprehension and motivation, students were asked to respond to several questions reflecting their attitudes toward the format of the books. Their responses are in Figure 2. A *novelty effect*, associated with using technology rather than traditional media, can be seen in students' reactions to the second question regarding their perception of understanding the books read.

**Figure 2: Student Survey Responses**



*Note: Due to miscommunication between the teacher and students in one class, responses are missing for 7 students.*

## Discussion

The results of the current study are consistent with much of the previous research. There was no statistical or practical difference in students' comprehension of books read on a Kindle or in print. Given the rapidly increasing number of e-readers in schools, this finding is encouraging. In the coming years, more and more students will be doing their independent and assigned reading on these devices.

Equally encouraging is the evidence suggesting that students with differing levels of reading achievement are able to comprehend text presented digitally and in print at a comparable level. In the case of the assessment instrument used in this study, Accelerated Reader, which measures student understanding of what has been read, the average performance was above 85%. AR Best Practices, which guide use of Accelerated Reader in the classroom to ensure fidelity, recommend that students score 85% or above to foster growth in reading achievement (Renaissance Learning, 2007). Given the rate at which e-readers are increasing in education, this finding means teachers can be relatively confident that a broad range of students will be able to comprehend text on devices that are homologous to print if the text is within their current achievement range.

The finding that students had comparable understanding of a variety of texts is also important to educators and parents. Previous research has been conducted with relatively few texts, but in the current study, meaningful data were gathered on more than a dozen popular trade books. The implication is that students can comprehend books read for pleasure on e-readers to the same degree as traditional print books. This is no small matter because recreational reading contributes significantly to students' silent reading fluency, vocabulary development, background knowledge, and other aspects of literacy (Cullinan, 2000).

Although not one of the research questions, the finding that students' comprehension of texts outside the study is similar to their within-study comprehension is of more than passing importance. The question of typicality of behavior is often difficult to answer because research is usually intrusive in one way or another. In the current study, additional data had been collected during the school year using Accelerated Reader to test students' understanding of print books they routinely read. The consistency of comprehension within and outside the study strengthens the assertion that students' understanding of e-reader texts is equivalent to their understanding of print books.



Survey results showed that more of students' favorite books and fewer of their least favorite books were in the print format. Given the overall enthusiasm for reading on the Kindle, this came as something of a surprise. One possible explanation is students could take the print books home and read them, while Kindle use was limited to the classroom. This difference in utility is slight, but it may have contributed to the favorability of the print books.

The Kindle versus print study participants were as enthusiastic about using an e-reader as students in other studies. They also found the Kindle to be relatively easy to read and understand. As e-readers become more common in education settings, this novelty effect may prove to be a crucial element in motivating students to read more and to explore a broader variety of topics than they might otherwise consider.

## Limitations and Cautions

The results of the study should not be generalized to all forms of reading on digital devices. The Kindle and comparable e-readers are very similar in format to traditional print books. Reading on a very small screen device, however, like a smartphone or online reading, with its links, multiple pages, and sometimes distracting graphics, pose very different comprehension challenges (Leu et al., 2011).

The relatively small number of students in the study is a limitation associated with most of the research on reading using digital and print texts. To maintain fidelity in these studies, a small sample size is more or less required. The consistency of the finding of comprehension equivalence in several studies over the past few decades suggests the study results are dependable, but replication and extension are clearly necessary.

Perhaps the greatest limitation of the current study and related research is that students read narrative rather than informational texts. Research has found that most e-readers are used for reading for pleasure (Scholnik, 2001), and most users are satisfied with their devices for this purpose (NPD Group, 2010). When it comes to studying, however, traditional print books are preferred to e-books (Springer e-Book Pilot Project, 2011), at least among college students. The dissatisfaction with e-books stems from the functionality of e-readers for typical studying techniques such as annotating, highlighting, and quick referencing to various parts of a book. All of these features are present on these devices in one way or another, but they are not analogous to traditional study methods.

Students may comprehend informational text on an e-reader in the same way they would in print, but this conclusion should not be drawn based on the results of the current study. Given the emphasis placed on informational text in the Common Core State Standards (2010), a study of students' comprehension of informational text on these devices would certainly be a worthy undertaking.

## Conclusion

The results of the current study should be comforting to both educators and parents. As more and more students use e-readers, it is critical we have confidence they are understanding what they read. Given the enthusiasm with which students are using these devices, there is a good chance they may rediscover the pleasures of reading the rest of us have known with traditional print books. In the coming years, we may even see a migration away from the trivial reading of tweets, posts, and such, to more substantial texts, including the classics, many of which are available for free via e-readers.

## Appendix: Student Reading Survey

Which was your favorite story on your list that you read? Why?

Which was your least favorite story on your list that you read? Why?

What do you like best about reading stories on a Kindle?

What do you like best about reading stories as paperbacks?

Circle the answer that best fits how you feel for the following questions.

How do you feel about using a Kindle?

It is very easy to use.

It is okay to use.

It is a little hard to use.

It is very hard to use.

Which statement most closely reflects how you feel about understanding the stories that you read on a Kindle?

Stories I read on a Kindle are much easier to understand than stories I read in paperback.

Stories I read on a Kindle are a little easier to understand than stories I read in paperback.

It doesn't matter whether I read stories on a Kindle or in paperback, I understand them about the same.

Stories I read on a Kindle are a little harder to understand than stories I read in paperback.

Stories I read on a Kindle are much harder to understand than stories I read in paperback.

If I have a choice, I would rather read stories \_\_\_\_\_

in paperback

on a Kindle

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## About the Author



**Michael Milone, Ph.D.**, is a research psychologist and award-winning educational writer and consultant to publishers and school districts. He earned a Ph.D. in 1978 from The Ohio State University and has served in an adjunct capacity at Ohio State, the University of Arizona, Gallaudet University, and New Mexico State University. He has taught in regular and special education programs at all levels, holds a Master of Arts degree from Gallaudet University, and is fluent in American Sign Language. Milone served on the board of directors of the Association of Educational Publishers and was a member of the Literacy Assessment Committee and a past chair of the Technology and Literacy Committee of the International Reading Association. He has contributed to both [readingonline.org](http://readingonline.org) and *Technology & Learning* magazine on a regular basis. Over the past 30 years, he has been involved in a broad range of publishing projects, including the SRA reading series, assessments developed for Academic Therapy Publications, and software published by The Learning Company and LeapFrog. He has completed 34 marathons and 2 Ironman races.



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The effect of electronic books on the reading comprehension of middle and high school students was examined using an experimental posttest-only control-group design. A convenience sample of 140 randomly assigned middle and high school English students at an independent school in eastern North Carolina participated. E-ink devices, such as Amazon's Kindle, feature resolutions of 600 x 800 and are composed of microcapsules containing charged ink granules (Torres, 2012). If the eBook format has positive or no effect on comprehension and motivation, the many benefits regarding portability and cost encourage continued use. Fifty six percent of the survey participants reported using a combination of traditional and e-texts (Shelburne, 2009). By knowing more about reading format choices and comprehension, self-reports of reading habits will increase validity and the questions can be tailored to reflect new developments in reading generations. Background. The first part of the follow-up survey will be a ranking of the three formats: print, e-book, or audiobook. Participants will be asked to rank the formats in terms of their preferred choices for leisure reading and about their experience with each modality. The Kindle emulates the print reading experience in several ways; it is the same general size and shape of a trade paperback book (although it is significantly lighter) and the e-ink text is not backlit and thus does not cause eye strain in the way that a computer-based reader does.