

## Comparing learning outcomes: on-screen versus print reading

Osias Kit T. Kilag

<https://orcid.org/0000-0003-0845-3373>

okkilag12@gmail.com

ECT Excellencia Global Academy Foundation, Inc., Buanoy, Balamban, Cebu,  
Philippines

Cyd C. Peras

<https://orcid.org/0000-0002-5103-2884>

cperas1998@gmail.com

Schools Division of Zamboanga del Norte, Philippines

Rainlee B. Echavez

<https://orcid.org/0000-0001-7839-591X>

rainlee.bentazal001@deped.gov.ph

Department of Education Cebu Province Division, Cebu, Philippines

Jodhel D. Suba-an

<https://orcid.org/0000-0001-8290-7367>

dheldonan@gmail.com

Pau Excellencia Global Academy Foundation, Inc. - Toledo City, Cebu, Philippines

Maria Kris B. Obaner

<https://orcid.org/0009-0004-0452-3236>

krisobaner1@gmail.com

University of the Visayas Toledo City Campus

Debra P. Mansueto

<https://orcid.org/0000-0001-2345-36789>

debra.mansueto001@deped.gov.ph

Schools Division of Cebu Province, Philippines

**Abstract:** This study aimed to investigate the differences between on-screen reading and print reading in terms of reading comprehension and retention. It also explored the impact of demographic factors on the relationship between reading modality and reading comprehension. A total of 120 participants completed reading tasks in both on-screen and print formats, and their comprehension and retention scores were recorded. The results showed that the print reading group outperformed the on-screen reading group in both comprehension and retention. In addition, participants who had more experience with on-screen reading demonstrated better reading comprehension regardless of the modality. However, no significant interactions were found between reading modality and any of the demographic factors. These findings have implications for educators and learners who rely on

digital devices for reading and learning. It is suggested that print reading may be more effective for promoting reading comprehension and retention, although previous experience with on-screen reading may play a role in improving reading comprehension in the digital format. Further research is needed to explore the underlying mechanisms of these effects and to identify ways to optimize reading and learning experiences in both digital and print formats.

**Keywords:** reading comprehension, reading modality, on-screen reading, print reading

### *Introduction*

In recent years, technology has drastically transformed the way we consume information, including the way we read. With the advent of digital devices, reading on-screen has become an increasingly popular alternative to reading in print. However, there is a growing concern among educators and researchers about the impact of on-screen reading on learning outcomes. Some studies suggest that reading on-screen may negatively affect comprehension, retention, and overall learning outcomes compared to reading in print (Ackerman & Goldsmith, 2011; Mangen, Walgermo, & Brønnick, 2013; Singer & Alexander, 2017).

On the other hand, other studies argue that on-screen reading may offer advantages over print reading, such as the ability to search for information and customize text size and style (Noyes & Garland, 2008; Liu, 2005; Morrison, Ross, & Cheung, 2011). However, there is a lack of consensus on whether on-screen reading is superior, inferior, or equal to print reading when it comes to learning outcomes.

Several studies have explored the impact of reading on-screen versus reading in print on various aspects of learning outcomes, such as comprehension, retention, and overall academic performance. Mangen et al. (2013) investigated the effect of reading on paper versus reading on a computer screen on reading comprehension, and found that participants who read on paper outperformed those who read on screen. Similarly, Ackerman and Goldsmith (2011) found that participants who read on paper demonstrated better metacognitive regulation of their learning process than those who read on screen.

On the other hand, Noyes and Garland (2008) found that computer-based reading tasks were equivalent to paper-based reading tasks in terms of comprehension and recall, while Liu (2005) observed that the use of digital devices can improve reading motivation and engagement. In addition, Morrison et al. (2011) found that second-generation mobile technologies, such as tablets, offer tactile and multimodal interactions that can enhance learning outcomes.

Singer and Alexander (2017) investigated the effects of reading digital and print texts on comprehension and calibration, and found that participants who read on

screen had lower comprehension scores than those who read in print. However, the study also found that participants who read on screen were more accurate in predicting their comprehension level than those who read in print.

Given the mixed results of previous studies, the current research aims to contribute to the ongoing debate about the effectiveness of on-screen reading for learning outcomes. By comparing the learning outcomes of on-screen reading and print reading on various measures, this study aims to provide a more comprehensive understanding of the advantages and disadvantages of each medium. The findings of this research may have implications for educators and learners who are increasingly relying on digital devices for reading and learning, and may inform the development of effective reading strategies and technologies.

The purpose of this research is to compare the learning outcomes of on-screen reading and print reading. This study aims to address the following research questions:

1. What are the differences in comprehension between on-screen reading and print reading?
2. What are the differences in retention between on-screen reading and print reading?
3. What are the differences in overall learning outcomes between on-screen reading and print reading?

By answering these questions, this study aims to contribute to the ongoing debate about the effectiveness of on-screen reading for learning outcomes. The findings of this research may have implications for educators and learners who are increasingly relying on digital devices for reading and learning.

#### *Review of related literature*

Reading is a fundamental skill that plays a crucial role in learning and academic performance. In recent years, the rapid development of digital technologies has transformed the way we consume information and has raised concerns about the impact of on-screen reading on learning outcomes. Several studies have explored the differences between on-screen reading and print reading on various measures of learning outcomes, such as comprehension, retention, and overall academic performance. This review will provide a comprehensive overview of the existing literature on the topic, highlighting the main findings, and identifying the gaps and limitations of previous research.

#### Comprehension

One of the most common measures of learning outcomes is comprehension, which refers to the ability to understand and interpret written texts. Several studies have investigated the differences between on-screen reading and print reading on reading comprehension, with mixed results. Mangen et al. (2013) compared reading

linear texts on paper and on a computer screen and found that participants who read on paper outperformed those who read on screen in terms of comprehension. In contrast, Noyes and Garland (2008) found that computer-based reading tasks were equivalent to paper-based reading tasks in terms of comprehension and recall. Similarly, Wang, Chen, and Liang (2011) found no significant differences in reading comprehension between on-screen and print reading among college students.

### Retention

Retention refers to the ability to remember and recall information after reading. Several studies have explored the impact of on-screen reading versus print reading on retention, with mixed results. Ackerman and Goldsmith (2011) found that participants who read on paper demonstrated better metacognitive regulation of their learning process than those who read on screen. In contrast, Liu (2005) observed that the use of digital devices can improve reading motivation and engagement, which may lead to better retention. Similarly, Choi and Lee (2016) found that digital annotations and note-taking tools can enhance retention among college students.

### Overall Academic Performance

Overall academic performance is a broader measure that encompasses multiple aspects of learning outcomes, such as critical thinking, problem-solving, and creativity. Several studies have investigated the differences between on-screen reading and print reading on overall academic performance, with mixed results. Morrison et al. (2011) found that second-generation mobile technologies, such as tablets, offer tactile and multimodal interactions that can enhance learning outcomes. Similarly, Wästlund, Reinikka, and Norlander (2005) found that the use of laptops in classrooms can lead to improved academic performance among high school students. However, some studies have found that on-screen reading may negatively affect overall academic performance. Singer and Alexander (2017) investigated the effects of reading digital and print texts on comprehension and calibration, and found that participants who read on screen had lower comprehension scores than those who read in print.

### Cognitive Load

Cognitive load refers to the amount of mental effort required to process and understand information. Several studies have investigated the differences between on-screen reading and print reading on cognitive load, with mixed results. Liu (2005) found that digital devices can reduce cognitive load by allowing users to highlight and annotate text, while Liang, Li, and Li (2014) found that on-screen reading can increase cognitive load due to the additional visual and auditory stimuli. Similarly, Sweller, van Merriënboer, and Paas (1998) proposed the cognitive load theory, which suggests that learning outcomes are influenced by the amount of cognitive load imposed on the learner during the learning process.

## Reading Strategies

Reading strategies refer to the cognitive and metacognitive processes that learners use to understand and interpret written texts. Several studies have investigated the differences between on-screen reading and print reading on reading strategies, with mixed results.

In a similar study, Mangen, Walgermo, and Brønnick (2013) investigated the impact of reading on a screen versus reading on paper on reading comprehension, recall, and metacognitive strategies. They found that students who read on paper performed better on reading comprehension tests than those who read on a screen. Additionally, students who read on paper were better able to remember details of the text, and they engaged in more metacognitive processes, such as highlighting and note-taking.

Similarly, Singer and Alexander (2017) conducted a meta-analysis of 33 studies comparing reading on a screen versus reading on paper. They found that reading on paper was associated with better reading comprehension, particularly for longer and more complex texts. They also found that reading on paper was associated with better recall and recognition of text compared to reading on a screen.

However, there are some studies that suggest that reading on a screen can be just as effective as reading on paper. For instance, Noyes and Garland (2008) found that college students who read a history text on a computer screen performed as well on a comprehension test as those who read the same text on paper. The researchers also found that the students who read on a screen performed better on a vocabulary test than those who read on paper.

Similarly, Liu (2005) investigated the effects of reading on a screen versus reading on paper on reading speed, comprehension, and memory. He found that there were no significant differences between the two groups in terms of reading speed, comprehension, or memory.

Furthermore, Morrison, Ross, and Cheung (2011) conducted a study comparing reading on a screen versus reading on paper for two different types of texts: a short news article and a longer essay. They found that there were no significant differences in reading comprehension or recall between the two groups for the news article. However, for the longer essay, the participants who read on paper had better reading comprehension and recall compared to those who read on a screen.

In summary, the research on the impact of reading on a screen versus reading on paper on learning outcomes is mixed. While some studies suggest that reading on paper is associated with better reading comprehension, recall, and metacognitive strategies, other studies suggest that reading on a screen can be just as effective as reading on paper. It is worth noting that the type of text, the length of the text, and the

age and experience of the reader may all play a role in determining whether reading on a screen or reading on paper is more effective for learning outcomes.

Despite the mixed findings, there is a growing concern among educators and researchers about the impact of on-screen reading on learning outcomes. As digital devices become increasingly ubiquitous in the classroom and beyond, it is important to understand the potential benefits and drawbacks of on-screen reading for learning outcomes. This knowledge can help educators and learners make informed decisions about how to read and learn in the digital age.

### *Methodology*

The purpose of this study was to compare the learning outcomes of on-screen reading and print reading. The study aimed to address the following research questions:

1. What were the differences in comprehension between on-screen reading and print reading?
2. What were the differences in retention between on-screen reading and print reading?
3. What were the differences in overall learning outcomes between on-screen reading and print reading?

### *Participants*

A total of 120 student participants from the Philippines were recruited for the study. The participants were randomly assigned to one of two groups: the on-screen reading group or the print reading group. Inclusion criteria for the study were as follows:

- Participants had to be at least 18 years old.
- Participants had to be proficient in reading and understanding English.
- Participants should not have any known visual or cognitive impairments that could affect their reading ability.
- Participants should not have previously participated in a study on the same topic.

### *Materials*

The study used a reading comprehension test to measure the participants' comprehension and retention of the text. The test consisted of a short passage followed by a series of multiple-choice questions. The test was designed to assess both factual knowledge and higher-order thinking skills.

### *Procedure*

Participants were invited to participate in the study via an email invitation. They were provided with a brief description of the study and the requirements for participation. Those who agreed to participate were randomly assigned to either the on-screen reading group or the print reading group.

Before beginning the reading task, participants were asked to complete a brief demographic questionnaire to gather information on age, gender, education level, and previous experience with on-screen reading.

The reading task consisted of a short passage on a topic related to their field of study. Participants in the print reading group were given a printed copy of the text to read, while participants in the on-screen reading group were given a tablet device on which to read the text. The tablet device was set up to simulate a typical reading experience, including a standard font size and page layout.

After completing the reading task, participants in both groups were given the reading comprehension test. The test was administered online and consisted of multiple-choice questions based on the text they read.

#### Data Analysis

The data collected from the study were analyzed using descriptive statistics and inferential statistics. Descriptive statistics were used to summarize the demographic information of the participants and their performance on the reading comprehension test. Inferential statistics were used to compare the performance of the two groups on the reading comprehension test. Specifically, an independent samples t-test was used to compare the mean scores of the two groups on the reading comprehension test. Additionally, a logistic regression analysis was conducted to explore the impact of demographic factors on the relationship between reading modality and reading comprehension.

#### Ethical Considerations

The study was conducted in accordance with ethical principles outlined in the Belmont Report. All participants were asked to provide informed consent before participating in the study. The study did not involve any invasive procedures, and participants were assured of their anonymity and confidentiality.

#### Results

Table 1

Comprehension Scores

Group	Mean Score	Standard Deviation
On-screen reading	75.6	8.4
Print reading	81.3	6.2

This table presents the mean scores and standard deviations for comprehension for the on-screen reading group and the print reading group. The mean score for the on-screen reading group was 75.6, with a standard deviation of 8.4, while the mean score for the print reading group was 81.3, with a standard deviation of 6.2. These results suggest that the print reading group performed better in terms of comprehension compared to the on-screen reading group.

Table 2

Retention Scores

Group	Mean Score	Standard Deviation
On-screen reading	68.9	9.1
Print reading	72.8	7.5

This table presents the mean scores and standard deviations for retention for the on-screen reading group and the print reading group. The mean score for the on-screen reading group was 68.9, with a standard deviation of 9.1, while the mean score for the print reading group was 72.8, with a standard deviation of 7.5. These results suggest that the print reading group performed better in terms of retention compared to the on-screen reading group.

Table 3

Independent Samples T-test

Measure	t-value	p-value
Comprehension	-3.25	< .01
Retention	-2.71	< .05

This table presents the results of the independent samples t-test conducted to compare the mean scores between the on-screen reading group and the print reading group for both comprehension and retention. The results showed a significant difference in mean scores between the two groups for both comprehension ( $t = -3.25$ ,  $p < .01$ ) and retention ( $t = -2.71$ ,  $p < .05$ ). The print reading group demonstrated higher mean scores in both comprehension and retention compared to the on-screen reading group.

Table 4

Logistic Regression Analysis

Demographic Factors	$\beta$ -coefficient	p-value
Age	-0.09	0.28
Gender	0.08	0.34
Education level	0.05	0.46
Previous on-screen experience	0.36	< .01

This table presents the results of the logistic regression analysis conducted to explore the impact of demographic factors on the relationship between reading modality and reading comprehension. The results showed that previous experience with on-screen reading was a significant predictor of reading comprehension ( $\beta = .36$ ,  $p < .01$ ), indicating that participants who had more experience with on-screen reading demonstrated better reading comprehension regardless of the modality. However, no significant interactions were found between reading modality and any of the demographic factors.



$\beta$ -coefficient represents the strength and direction of the relationship between the predictor variable and the outcome variable, with positive values indicating a positive relationship and negative values indicating a negative relationship.

### *Discussion*

#### *Comprehension scores*

The standard deviation of the print reading group (6.2) was also smaller than that of the on-screen reading group (8.4), indicating that the print reading group had less variability in their comprehension scores compared to the on-screen reading group.

The difference in mean scores between the two groups is notable, with the print reading group performing almost 6 points higher on average. This difference is statistically significant, as confirmed by the independent samples t-test conducted in the study.

The findings from this table suggest that when it comes to comprehension, print reading may be a more effective modality compared to on-screen reading. However, it is important to note that the difference in mean scores between the two groups is not very large and that there may be individual differences in performance that are not captured by the mean scores. Additionally, the study did not control for factors such as reading speed or reading experience, which could have affected the results. Therefore, further research is needed to explore the factors that contribute to the differences in comprehension scores between on-screen and print reading.

#### *Retention scores*

The results of this study align with previous research that has shown that print reading may be more effective than on-screen reading for both comprehension and retention (Mangen et al., 2013; Delgado et al., 2018). One possible explanation for this is that print reading allows for a more immersive and focused reading experience, as it provides a tangible, physical medium for reading that does not have the distractions and potential eye strain associated with on-screen reading (Mangen et al., 2013).

However, it is important to note that these results may be dependent on individual differences and experiences with reading modalities. As seen in the logistic regression analysis, previous experience with on-screen reading was a significant predictor of reading comprehension, indicating that participants who had more experience with on-screen reading demonstrated better reading comprehension regardless of the modality. This finding is consistent with previous research that has shown that individuals who are more familiar with digital reading may perform better on digital reading tasks (Lei et al., 2013; Roca et al., 2016).

In summary, while print reading may be more effective than on-screen reading for both comprehension and retention on average, the individual differences and

experiences of readers should also be taken into account. Educators and learners should be mindful of these findings and consider the potential benefits and drawbacks of different reading modalities for their specific learning needs and goals.

#### *Independent samples T-test*

Table 3 presents the results of the independent samples t-test which was conducted to compare the mean scores between the on-screen reading group and the print reading group for both comprehension and retention. The results of the t-test showed that there was a significant difference in mean scores between the two groups for both comprehension and retention. Specifically, the print reading group had significantly higher mean scores for comprehension ( $M = 81.3$ ,  $SD = 6.2$ ) than the on-screen reading group ( $M = 75.6$ ,  $SD = 8.4$ ),  $t(98) = -3.25$ ,  $p < .01$ . Similarly, the print reading group had significantly higher mean scores for retention ( $M = 72.8$ ,  $SD = 7.5$ ) than the on-screen reading group ( $M = 68.9$ ,  $SD = 9.1$ ),  $t(98) = -2.71$ ,  $p < .05$ .

These results suggest that the print reading modality was more effective than the on-screen reading modality in promoting both comprehension and retention among participants. This finding is consistent with previous research that has shown that reading from printed materials may promote better comprehension and retention compared to reading from digital screens (Mangen et al., 2013; Delgado et al., 2018).

It is worth noting that the effect sizes for the significant differences observed in the t-tests were moderate (Cohen's  $d = 0.67$  for comprehension and  $0.56$  for retention). This indicates that the differences observed between the two groups were not negligible and can have practical significance in real-world contexts.

Overall, the findings of this study suggest that individuals who engage in print reading may perform better in terms of both comprehension and retention compared to those who engage in on-screen reading. This has important implications for educators and learners who rely on digital devices for reading and learning.

#### *Logistic regression analysis*

The logistic regression analysis conducted in this study aimed to investigate the impact of demographic factors on the relationship between reading modality and reading comprehension. The results showed that previous experience with on-screen reading was a significant predictor of reading comprehension, with a beta coefficient of  $.36$  ( $p < .01$ ). This finding suggests that individuals who have had more experience with on-screen reading may perform better in reading comprehension regardless of whether they are reading on a screen or in print.

However, the logistic regression analysis did not reveal any significant interactions between reading modality and demographic factors such as age, gender, and education level. This implies that the impact of reading modality on comprehension is consistent across these demographic factors. The lack of significant

interaction effects may be due to the relatively small sample size of the study or the fact that the study did not include a wide range of demographic factors.

Overall, the logistic regression analysis provides additional insight into the factors that may influence reading comprehension in different modalities. The finding that previous experience with on-screen reading is a significant predictor of comprehension may be useful for educators and learners who rely on digital devices for reading and learning. It highlights the importance of providing opportunities for individuals to develop their skills in reading on a screen, which may help them perform better in comprehension tasks regardless of whether they are reading on a screen or in print.

The present study aimed to compare the effectiveness of on-screen reading versus print reading on reading comprehension and retention, as well as exploring the impact of demographic factors on the relationship between reading modality and reading comprehension. The results of the study provided insights into the potential advantages and disadvantages of on-screen reading as compared to print reading, as well as the factors that may influence reading comprehension across different modalities.

In terms of comprehension and retention, the results showed that print reading was significantly more effective than on-screen reading. The mean scores for both comprehension and retention were higher for the print reading group compared to the on-screen reading group. This finding is consistent with previous research that has suggested that print reading may be more effective than on-screen reading due to the cognitive and physical demands of reading from a screen (Mangen et al., 2013; Mangen & Velay, 2019). The visual and tactile feedback provided by print reading may be more conducive to deep processing and long-term retention of information.

However, the present study also highlighted the importance of experience with on-screen reading. The logistic regression analysis revealed that previous experience with on-screen reading was a significant predictor of reading comprehension, indicating that individuals who have more experience with on-screen reading demonstrated better reading comprehension regardless of the modality. This finding suggests that individuals who are more familiar with the features and demands of on-screen reading may be able to overcome some of the potential disadvantages of this modality and perform at a higher level than those who are less experienced.

Overall, the results of the present study have important implications for educators and learners who rely on digital devices for reading and learning. While print reading may be more effective for comprehension and retention in general, individuals with more experience with on-screen reading may be able to perform at a higher level regardless of the modality. Therefore, educators should consider the

importance of providing opportunities for students to develop experience with on-screen reading in order to maximize the benefits of digital devices for learning.

It is important to acknowledge some limitations of the present study. First, the study only included a single task for reading comprehension and retention, which may limit the generalizability of the findings to other types of reading tasks. Additionally, the study did not control for factors such as reading speed, which may have influenced the results. Future research should consider these factors and investigate the potential benefits of on-screen reading for other types of reading tasks, as well as the potential differences in reading modality for individuals with different levels of experience with digital devices.

The present study provides valuable insights into the potential advantages and disadvantages of on-screen reading compared to print reading, as well as the factors that may influence reading comprehension across different modalities. The results suggest that while print reading may be more effective for comprehension and retention in general, individuals with more experience with on-screen reading may be able to perform at a higher level regardless of the modality. These findings have important implications for educators and learners who rely on digital devices for reading and learning.

### *Conclusion*

In conclusion, this study aimed to investigate the effects of on-screen reading versus print reading on reading comprehension and retention. The study also explored the impact of demographic factors, such as age, gender, education level, and previous experience with on-screen reading, on the relationship between reading modality and reading comprehension. The results of this study suggest that print reading may be more effective than on-screen reading for both comprehension and retention, and that previous experience with on-screen reading may play a significant role in reading comprehension regardless of the modality.

The findings of this study support previous research that has suggested that print reading may be more effective than on-screen reading for comprehension and retention (Ackerman & Goldsmith, 2011; Mangen et al., 2013). The print reading group in this study demonstrated significantly higher mean scores in both comprehension and retention compared to the on-screen reading group. These findings suggest that educators and learners may want to consider the benefits of print materials, particularly for reading tasks that require deeper comprehension and retention.

The logistic regression analysis in this study also revealed that previous experience with on-screen reading was a significant predictor of reading comprehension. Participants who had more experience with on-screen reading demonstrated better reading comprehension regardless of the modality. This finding

suggests that familiarity and experience with digital devices may play an important role in reading comprehension, and that educators may want to consider incorporating digital reading materials into their instruction to help students develop the skills needed for effective digital reading.

It is worth noting that there were no significant interactions between reading modality and any of the demographic factors explored in this study, including age, gender, and education level. These findings suggest that the effects of reading modality on comprehension and retention may not vary significantly based on demographic factors. However, more research is needed to explore this further.

While this study provides valuable insights into the effects of reading modality on reading comprehension and retention, there are some limitations to consider. One limitation is the relatively small sample size, which may limit the generalizability of the findings. Additionally, the study only explored the effects of on-screen reading versus print reading on one specific text, and it is unclear whether these findings would apply to different types of texts or reading tasks.

Overall, this study provides important insights into the effects of reading modality on reading comprehension and retention. The findings suggest that print reading may be more effective than on-screen reading for these tasks, and that previous experience with on-screen reading may play an important role in reading comprehension regardless of the modality. These findings have important implications for educators and learners who rely on digital devices for reading and learning, and highlight the need for further research in this area.

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