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## E-Books: Cognitive and Visual Effects

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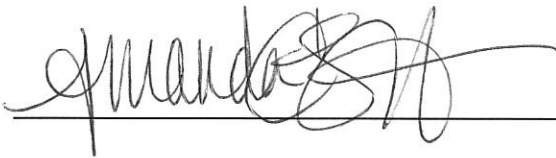
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Thesis title \_\_\_\_\_  
E-Books: Cognitive and Visual Effects  
\_\_\_\_\_

Intended date of commencement 5-11-19

Read, approved, and signed by:

Thesis adviser(s)  5-7-19  
Date

Reader(s)  5/5/19  
Date

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Date

E-Books: Cognitive and Visual Effects

A Thesis

Presented to the Department of Psychology

College of Liberal Arts and Sciences

And

The Honors Program

Of

Butler University

In Partial Fulfillment

Of the Requirements for Graduation Honors

Hannah DeGroot

11 May 2019

## **Abstract**

Sight is incredibly important to daily life. One critical use of this sense is reading, which allows people to communicate and learn new things if the reader is able to effectively comprehend what he or she has read. The proliferation of technology has resulted in much of our reading today being done through digital media. Information-presenting screens are found nearly everywhere, including within the education system. While E-books can offer some advantages, their purpose would not be served if they hindered understanding. Additionally, excessive use of technological devices can bring about symptoms of eyestrain. It was hypothesized that E-books are in fact neither helpful nor harmful in reading comprehension but may increase reading time.

In the present study, 40 students at Butler University read a short story either on paper or on a laptop screen. They then took a quiz over the plot events of the short story, either in a physical or digital format. Lastly, they completed a short survey regarding their use of E-books and how their technological interactions affect their vision. It was found that the only factor that affected quiz scores was the testing medium. It is important, then, to ensure that online exams are user-friendly.

## **The Function of Sight**

Humans use their eyes to take in information about the environment around them so that they can make appropriate responses. It is often taken for granted just how crucial the sense of sight is in order to function in day-to-day life. For example, if a person driving a car sees a stop sign on the road, his or her eyes see the sign, which sends a signal to the brain. The brain then responds to the stimulus by making a decision and causing the driver's foot to press down on the brake. The stimulus was sensed by the nervous system, which traveled to the "control center" and then elicited a response from the muscular system.

The previous example is one of countless instances in which clear vision is essential for functioning. If we see an object moving quickly toward our face, we instinctively close our eyes and often move our head away from the object if possible. These visual reflexes aid in our survival. Additionally, vision influences our social interactions (Haxby, Hoffman, & Gobbini, 2000). Although it is important in communication to listen to what another person is saying, facial expressions and other forms of body language often provide the most information. For example, someone speaking to a coworker could fairly easily sense that that person is angry if he or she displays crossed arms, a frown, and a furrowed brow.

As humans, we rely on the sense of vision more than those of hearing, scent, taste, and touch. This is simply a result of our bodies' structure and how well various parts function. Compared to other species of mammals, like dogs, our sense of smell is not

strong enough to guide us through our environment (Köster, 2002). On the other hand, our sense of hearing is often more useful, but it appears that our need to hear is less essential than our need to see. The disability weight for blindness (0.594), which is indicative of the severity of a disease, is higher than that for deafness (0.229) (World Health Organization, 2004). This information demonstrates that being blind is not necessarily “worse” than being deaf, but it has the potential to be more impactful on daily activities. Therefore, vision can be considered to be the most important sense in humans. Although all senses play a role in human functioning, the current study will delve into the various roles played by sight.

### **The Physiology of Vision**

Given that seeing is such a critical process, it makes sense that the structures and processes that make it happen are so complex. Our eyes take in visual information that is then processed by the brain in order to elicit a response. This occurs through an intricate process involving both the central and peripheral nervous systems (Marieb & Hoehn, 2010). Rays of light enter our eyes through the cornea, where they pass through the iris via the pupil. The rays, after being focused by the lens, then stimulate photoreceptor cells on the retina in the back of the eye. These cells include rods, which are able to function in levels of relatively low light and distinguish form and shape. The other type of photoreceptor, called cones, are sensitive to color in the presence of bright light. They are the most concentrated in a small pit known as the fovea centralis. In this area, light can travel to the cones more easily because it passes through fewer layers. Therefore, the fovea is the site within the eye with the greatest visual acuity.

When excited by light, the rods and cones send output to two other types of neurons: bipolar cells and ganglion cells. This results in an action potential that travels down the optic nerve. The optic nerve from each eye crosses over to the opposite hemisphere of the brain at the optic chiasm. The impulse then stops in the lateral geniculate nucleus (LGN) before being sent on to the primary visual cortex in the occipital lobe of the brain. Lastly, the visual information goes to the temporal and parietal lobes to be processed further. For example, the limbic system can link certain sights with emotions and memories.

### **The Importance of Reading**

With the development of written language, humans became able to communicate with others even without their physical presence. Being able to see and comprehend words on a sign, page, or screen is critical in almost all aspects of life. In transportation, it is important for drivers to read signs so they can be in the correct lane in time for their desired exit on a freeway. Commuters on subway systems read maps of the rails to know at which stop to exit (Shustanov & Yakimov, 2017). In healthcare, it is critical that patients are able to correctly read their prescription bottles and know the precise time and dose of their medications to improve their health (Davis et al., 2006). If too little medicine is taken, the patient will not get any better and may develop drug resistance. If too much is taken, dangerous pharmaceutical reactions could occur. Therefore, the ability to read well is linked with autonomy and independence.

In education, reading can be considered the foundation of all learning. In kindergarten, children are gradually taught how to read. This process starts with the absolute basics, in which young pupils learn what the letters of the alphabet look like and

what sounds they make (Smith, 1992). After lots of practice with “sounding out” words phonetically, they develop the ability to read sentences and understand them. Through the next few years of primary school, they sharpen their skills in comprehension and being able to use context clues and draw conclusions from what they have read.

By the time they enter middle school, however, students are not learning to read but rather reading to learn (Perfetti, Landi, & Oakhill, 2005). This means that they use their skills in reading texts and comprehending those texts to understand new concepts relating to history, science, current events, and more. Students who can read well are then able to obtain new knowledge and skills more easily. Therefore, the understanding of more intellectual topics cannot occur without a strong foundation in phonetics, context clues, recollection, main ideas, and other essential reading skills.

With the continuous advancement of technology, much of our reading now seems to be done through a screen, whether it is a smartphone, tablet, laptop, or another type of device. This trend has spread to the education system, where E-books, downloaded either on tablets or personal laptops, are now beginning to take the place of physical textbooks. These E-books can be defined as any digital object that is an electronic representation of a book (Vassiliou & Rowley, 2008).

Electronic media are not only creeping into the way students are exposed to subject material but also the way they are tested over that material. Many standardized exams that were once completed on paper are now given on computers. These range from state-mandated testing in primary and secondary schools to graduate school admissions exams like the GRE, MCAT, and OAT. Interestingly, the SAT and ACT, the two most common undergraduate admissions exams in the United States, are still taken in the



traditional paper format. However, the distributors of both exams both plan to make the transition to online testing soon (Moore, 2018). This shift would create a greater consistency between admissions exams for undergraduate and graduate programs.

As the public has become more familiar with these kinds of software and devices, several advantages and disadvantages of the usage of E-books and similar electronic sources as opposed to paper media have become apparent. One of the main benefits of E-books, especially for cash-strapped university students, is that they tend have significantly lower prices compared to physical textbooks (Lai & Li, 2013). E-books also save a lot of space, which makes them more convenient for students to carry to class and store in their residence halls. These texts can be accessed on the students' laptops, which are already commonly used for taking notes, checking email, submitting electronic assignments, and writing papers. E-books can also help students learn through interactive features, variable fonts and text sizes, and audible reading (Embong, Noor, Hashim, Ali, & Shaari, 2012). These enhancements can be especially helpful for readers who struggle to remain engaged with paper books.

Even with their potential benefits, E-books continue to face a lot of competition from old-fashioned paper books. First, reading a text on a screen takes away the classic "feel" of reading a book, specifically being able to physically flip through pages. E-books, whether accessed on a computer or tablet, also use battery power and must be charged (Embong et al., 2012). If a student's device runs out of power during an important lesson or test, that student faces a disadvantage in his or her ability to learn. Also, a common issue with digital textbooks is that they tend to decrease reading speed

(Dillon, 1992). This means that students accessing texts digitally can cover less information in a given time than a peer reading on paper.

Fifty-six percent of students at one university in Hong Kong reported that they preferred printed textbooks over E-books. One of the major reasons that physical texts were preferred is that students think that they already spend a great amount of time using screens during their day. They feel that using more traditional textbooks gives them a break from technology and decreases the possibility of eyestrain from excessive screen glare due to frequent use of devices (Lai & Li, 2013). Technologically induced eyestrain, or “computer vision syndrome” is becoming an increasing issue in our modern world, especially among young people (Reddy et al., 2013). Its symptoms can include headaches, blurred vision, and dry, red eyes (Logaraj, Madhupriya, & Hedge, 2014). These symptoms would make the learning process even more difficult.

Fortunately, steps have been recently taken to develop methods to prevent eyestrain without reducing screen use time. Glasses have been invented that can filter out short-wavelength (blue) light, which can be particularly straining on the eyes (Pratt, 2007). Additionally, both iPhones and Androids now possess a new feature called “night shift” or “night mode.” This feature reduces blue light emissions from the screens, which reduces the risk of eyestrain and can improve users’ circadian rhythms (Oh et al., 2015).

It is also critical to consider that using electronic media as a primary mode of receiving information could potentially hinder people’s ability to understand and recall that information. A previous study (Dundar & Akcayir, 2012) examined the effect of E-books on reading speed and comprehension in elementary school children, specifically a class of twenty students in the fifth grade in Turkey. They compared both the words read

per minute and correct comprehension questions answered between a control group, which read a selected text on paper, and an experimental group, which read the same text on a tablet. No significant differences were found between the digital and paper texts regarding both speed and comprehension. The authors therefore concluded that, at least in children of that age, tablets, and presumably other devices, do not deter the reading and understanding process

However, there are many differences between juvenile and adult brains in cognitive functioning, so it is important to compare results in different age groups. Another study (Daniel & Woody, 2013) examined the effect of E-books on reading speed and comprehension in college students. Each student read a chapter from a textbook in one of five formats. Three of those formats were printed, and two were electronic. After reading was complete, the students were given a quiz over what they read. There was not a significant effect on quiz scores based on the format through which the story was read. However, students who were given an electronic version of the chapter took significantly longer to read it. The methods of this paper served as a significant model on which the current study was based.

### **Current Study**

The specific aim of this study was to examine whether there is an effect of using digital versus paper texts on reading comprehension in undergraduate students. In this study, it was examined how reading and testing on a digital screen compares to reading and testing on paper in undergraduate students, which was be done by giving students a story to read and a quiz to take over the story. It attempted to extend upon the knowledge gained about reading in digital formats in past work (Daniel & Woody, 2013; Dundar and

Akcayir, 2012) by adding a similar variation in test format and viewing its effect on reading comprehension, reading time, and testing time. Another goal of the study was to build upon the knowledge on why students choose to use either E-books or traditional books in their studies.

Based on the findings of Daniel & Woody (2013) and Dillon (1992), it is hypothesized that E-books increase the time it takes to read a text. This hypothesis therefore predicts that reading times for students who read a story on paper should be significantly lower than students who read the same story from an electronic source. Regarding the novel manipulation of testing format, a similar concept should apply that using paper tests will result in lower testing times. Additionally, in accord with previous studies, it is hypothesized that the ability for a reader to answer quiz questions correctly is unaffected by the format of the quiz.

However, it is predicted that switching modalities from reading to quizzing will result in lower scores and longer quiz times than consistency between reading and testing modality. For example, this means that if a student reads a story on paper and then is tested electronically, his or her quiz score should be lower and quiz time should be higher in comparison to someone who read and was tested all on paper. These same trends will hold true from any changes in reading or testing format.

## **Method**

### **Participants**

Participants consisted of 40 students who were enrolled for the 2018-2019 school year at Butler University in Indianapolis, Indiana and were selected on a volunteer basis. They were recruited through social media and received no compensation or course credit.

Participants reported using devices for an average of four and a half hours per day, suggesting familiarity with using electronic devices.

## **Design**

For this study, story format and quiz format were manipulated. The formats could be either print or digital. Therefore, this created four independent experimental groups in a 2 (story format: paper vs. digital) x 2 (quiz format: paper vs. digital) between-participants design. Each participant received a randomized assignment for both story format and quiz format.

The primary dependent variable of this experiment, then, was the quiz score. The secondary dependent variables were how long it took each participants to read his or her version of the story and how long it took each participant to complete his or her version of the quiz. Collecting these data allowed for the measurement of the “user-friendliness” and time efficiency of using paper and/or digital media in academics.

## **Materials**

The short story that was selected for use in this experiment is titled “War of the Clowns” (see Appendix A). This text was chosen because, at under six hundred words, it is considered a work of “flash fiction.” Therefore, readers do not need a substantial amount of time to get through it. It also features distinct plot points that can be easily tested using a sequence of events quiz. This quiz (see Appendix B) contained ten listed events from the story in a random order, but the order was the same for both formats. All events were listed on different rows, and immediately to the left of the listed event, a blank space was given for the participant to indicate the numerical order of the event. Specifically, on the paper quiz, participants wrote the appropriate number on a blank next

to the question. The digital quiz, on the other hand, required participants to click the appropriate number. All numbers (one through ten) needed to be used once for the quiz to be considered complete.

All trials were completed in a quiet, enclosed classroom on the Butler University campus to avoid exposing readers to any audio or visual distractions. Participants sat at a large table near the front. All digital materials were distributed using an Apple MacBook Air with a 13” screen diagonal. The digital quiz was given using Google Forms. Paper texts and quizzes were displayed on standard letter-sized white paper (8.5” x 11”). All times recorded during the experiment were measured using a stopwatch. A pre-written script was used throughout the procedure to ensure consistency throughout interactions with participants.

A short survey (see Appendix C) was also used regarding how participants use technology for reading in their everyday lives. The survey was given to everyone on the laptop using Google Forms, the same program used for the digital quiz. The first questions on the survey asked if the students use E-books for their classes and which types of books they feel help them learn best. Additionally, the survey inquired how many hours per day, on average, the students spend using devices with screens and if they ever feel that their eyes need a break from those screens.

## **Procedure**

All participants were greeted and guided to a table in the room. Only one participant went through testing at a time. They were then told that they would be reading a short story and then answering questions about the order in which events occurred in that story. Participants were presented with their assigned version of “War of the

Clowns,” either on the laptop or on paper. They were informed that they were only able to read the story once and that they would no longer be able to refer to their copy of the story when they were finished. The time it took them to read the story was then measured.

After they were finished reading, the story was immediately recollected and replaced with the comprehension quiz, either digitally or on paper. Both quizzes contained ten items in the same order. Participants were instructed to label ten listed events from the story in the order in which they occurred, from one (first event) to ten (last event). They were told that it was not necessary to approach the questions in any particular order. Like with the reading portion, the time to complete the quiz was measured.

## **Results**

### **Reading Comprehension and Time**

To determine whether quiz score was influenced by story format or quiz format, a 2 x 2 independent groups ANOVA was performed on these data. There was no main effect of story format,  $F(1,36) = 0.026, p = 0.873$ , indicating that there was no difference in quiz score for those who read a paper story ( $M = 7.55, SD = 2.417$ ) and those who read a digital story ( $M = 7.65, SD = 1.814$ ). However, there was a main effect of quiz format,  $F(1,36) = 6.592, p = 0.014$ , indicating that those who took a paper quiz ( $M = 8.4, SD = 2.162$ ) scored significantly higher than those who took a digital quiz ( $M = 6.8, SD = 1.765$ ). The interaction effect was not significant,  $F(1,36) = 2.086, p = 0.156$ . Based on this, it appears that the most important factor contributing to participants' quiz scores was

quiz format. The difference between quiz scores based on quiz scores based on quiz format can be seen in Table 1.

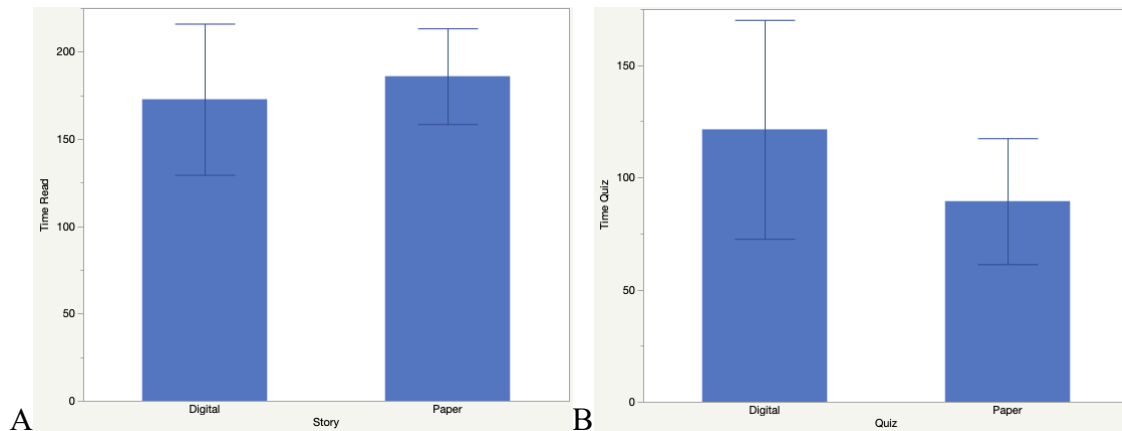
To investigate the effect of story format on reading time, an independent samples t-test was performed. The average time to read the story, measured in seconds, did not differ significantly between the two story formats,  $t(38) = 1.412, p = 0.083$ . When investigating the effect of quiz format on quiz time, an independent samples t-test was performed. Unlike reading time, it was found that the average time, measured in seconds, for the quiz to be taken electronically ( $M = 120.9, SD = 49.333$ ) was significantly longer than for the quiz to be taken on paper ( $M = 88.9, SD = 28.403, t(38) = 2.514, p = 0.008$ ). To see visual comparisons of reading and quiz times between formats, see Figure 1.

Lastly, to determine if/how the time taken to read the story or take the quiz affected quiz scores, a linear regression analysis was performed. For reading time, time to read the story significantly predicted quiz scores,  $b = -0.018, t(38) = -1.97, p = 0.056$ . Reading time also explained a significant proportion of variance in quiz scores,  $R^2 = 0.09, F(1,38) = 3.878, p = 0.056$ . This means that participants who read the text more quickly scored higher on the quiz. However, time to take the quiz was not a significant predictor of quiz scores,  $b = -0.006, t(38) = -0.74, p = 0.463$ . Regression graphs can be found in Figure 2.

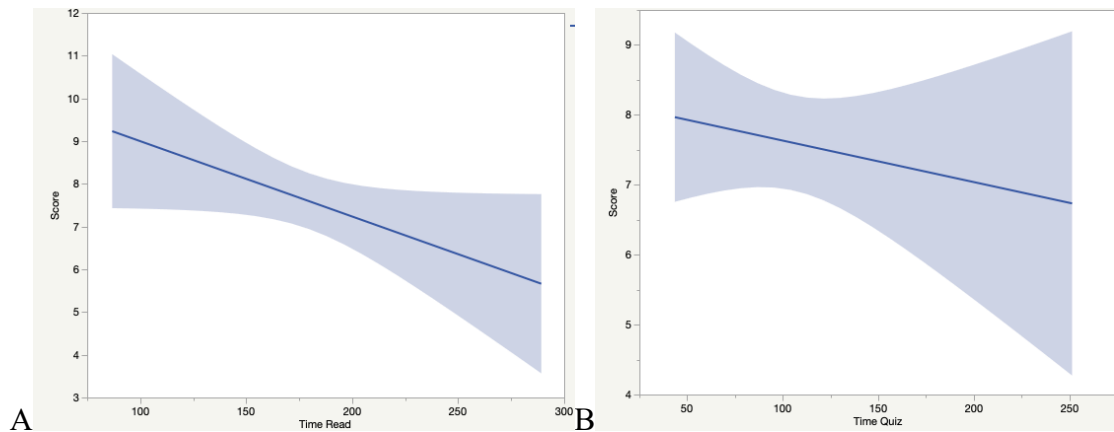
<b>Treatment Group</b>	<b>Mean Quiz Score</b>	<b>Standard Deviation</b>
Paper Story, Paper Quiz	8.8	1.99
Paper Story, Digital Quiz	6.3	2.00
Digital Story, Paper Quiz	8.0	2.14
Digital Story, Digital Quiz	7.3	1.19



**Table 1. Reading comprehension based on reading and testing media.** The maximum possible quiz score is 10.0 given that each quiz contained 10 items from the story to be ordered.



**Figure 1. Task completion times based on media.** The average time (in seconds) for participants to read the short story (A) or complete the quiz (B) was compared between two experimental groups based on the medium through which the task was performed (on paper or on the computer). Error bars represent standard deviation.



**Figure 2. Relationship between task completion times and performance.** Average reading (A) and testing (B) times, in seconds, were plotted against the corresponding quiz scores for each participant to determine what type of relationship existed between the two variables.

## **Technology and Vision Survey**

The first half of the survey focused on the use, or lack thereof, of E-books. According to the responses, over half of students sampled (52.5%) use a combination of both printed and digital textbooks for their classes. Fewer (42.5%) use only printed books, and the minority (5%) utilize only digital texts for learning. The main reason selected for using E-books was that they are less expensive than traditional textbooks. The second most popular reason was that they conserve paper, followed by the fact that E-books take up less space than printed books.

The latter questions of the survey related to how the use of technology affected the vision of the individuals. All participants reported using devices for more than two hours per day. The average response was around four and a half hours. The vast majority (92.5%) reported that they sometimes feel that their eyes “need a break” from screens. Although all were aware of the existence of their cell phones’ “night mode” feature, only 65% reported using it.

In summary, it was found that using technology to evaluate students’ learning can be problematic. This applies to not only how fast assessments are completed but also how accurately they are completed. However, reading on screens did not get in the way of readers’ ability to understand what he or she has read, specifically relating to the sequence of plot events, as long as the testing method was consistent.

## **Discussion**

### **Reading Comprehension**

The ultimate goal of this study was to investigate whether the use of technology in education has a negative effect either on processing or understanding texts. Even though

story format did not affect quiz scores, which corroborated with what was hypothesized, taking the quiz on a computer had a negative effect on the number of questions answered correctly. It seems, then, that students tend to perform better on exams that are distributed on paper. The hypothesis that switching modalities would result in lower test scores was also proven to be false based on the experimental data.

The presence of lower quiz scores on digital quizzes has important implications for the ways in which college students are tested over course material. If test-takers are unable to apply their knowledge to their full potential on computerized tests, the test can be considered inaccurate. This is important because the goal of most standardized tests is to evaluate performance or competency of an individual or an educational institution as a whole.

It is important, however, to consider the fact that for standardized tests, all examinees are being tested in the same way, so the playing field can be considered even for exams that are considered competitive, like the MCAT or OAT. In other words, these tests are meant to determine which applicants are most competent in their field, so the effectiveness of the test is not necessarily relevant as long as it is consistent for all participants. Test-takers in these cases are not being evaluated on the absolute value of questions they got correct but rather how many more or fewer correct questions they had compared with their peers.

Therefore, it can be implied that E-books are just as effective for learning as paper books. Students who access their textbooks on a laptop, tablet, or other device are not at a disadvantage compared to their peers who buy traditional texts. This could be seen as good news for individuals who not only want to save money on their course materials but

also help the environment by reducing their use of paper, as long as tests are still given on paper.

### **Reading and Test Time**

Although it was hypothesized that the use of electronic texts increases reading time, the experiment demonstrated a disadvantage only regarding testing time.

Participants who took the quiz on the computer took longer to complete the questions.

Regardless of how familiar a reader is with the material on which he or she is being tested, not being able to complete questions quickly can be detrimental on timed exams.

If a test-taker possessed all the necessary knowledge to succeed on an exam but was not able to complete all of the questions in time due to not being comfortable with the format, then that individual's score would not really reflect his or her abilities.

Also, students who took a longer time to read their version of the story tended to score lower on the quiz, no matter the format, compared to those who read the story more quickly. This could mean that students who find the material they are reading easier to understand will be able to cover the information faster and be able to recall that information with greater ease, reflecting on the spectrum of natural learning abilities within the population. It can be assumed that the fact that readers were only able to read the story one time through during the experiment was an extraneous variable.

### **Limitations**

This study was limited by its fairly small number of participants, especially for one that utilized random assignment. Since each participant was given a combination of only one story format and one quiz format, the collection of data that were gathered was relatively small. Alternatively, if the number of participants had been kept the same, it

could have been more beneficial to carry out a repeated measures experiment. Having each participant read stories and take quizzes in multiple formats may have provided more accurate insights into the effects of digital reading on comprehension. This type of study would also have opened up the opportunity to look into how different individuals interact with E-books in unique ways.

The experiment was performed with each participant for approximately ten to fifteen minutes. This was not a realistic amount of time to perform an in-depth analysis on the use of E-books for studying on a long-term scale. It could be beneficial to improve upon research in the field of evaluating E-book usefulness to compare the academic performance of students who alternate between longer periods of using E-books or printed books exclusively.

Collecting more information from each participant could have added to the overall implications of this study's findings. For example, it may have been beneficial to ask participants to report their GPA so that their quiz scores could be compared to their normal academic performance to better determine if the use of electronic stories or quizzes had an impact on their comprehension. Also, adding more in-depth questions to the survey could have provided more answers regarding student attitudes around E-books, like why they choose to continue to primarily use printed textbooks when E-books are readily available.

If the use of E-books is just as effective in the classroom as their printed counterparts, it remains unknown why printed textbooks remain the more popular choice throughout universities, especially at Butler, where E-books are greatly outnumbered by standard textbooks. This phenomenon could simply be the result of personal preference

and established habits. Reading from an actual book allows the reader to physically turn pages and sometimes make annotations with pens and highlighters, which can be helpful for students who learn best by using their hands (Hillesund, 2010). Also, E-books are still a relatively new development. Many university students today were not given the opportunity to familiarize themselves with electronic resources for learning during their time in primary and secondary school. When they come to college, it makes sense that they would continue to use the tools that they always have.

Given that evidence was found that E-books do not have a negative effect on recall of material, the main issue remaining with electronic reading is the potential for complications to the eyes. This is especially true because most students continue to use devices for multiple hours in the day outside of class for studying, communication, and entertainment. In the case of the experiment participants, an average of four and a half hours is a noteworthy amount of time. It is important, then, that technology developers continue to make the light emissions from their products more eye-friendly, especially by reducing blue light emissions.

### **Conclusion**

Many of society's daily tasks have been altered over the past several years because of advancements in technology. When it comes to reading, the public can now access vast amounts of information almost everywhere with the help of phones, laptops, and tablets. Given that the data from the experiment show no difference in comprehension between electronic and paper format, it appears that technology does not make tasks easier or more difficult, just different.

It is likely that digital texts will continue to replace printed materials, including medical records, receipts, tickets, and more. Therefore, it is important that the population is still able to take in and process what they are reading in the same way that they did before. Based on the results of this study, it can be concluded that the brain is fully capable of making the transition to a digital world. As long as long-term eye damage can be prevented, reading E-books will be a useful way for people around the world to learn new things for years to come.

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## Appendix A

### THE MASSACHUSETTS REVIEW

#### War of the Clowns

One time two clowns set themselves to arguing. The people would stop, amused, to watch them.

— What's that? they asked.

— Why, it's only two clowns arguing.

Who could take them seriously? Ridiculous, the two comedians reparteed. The arguments were common nonsense, the theme was a ninnery. And an entire day passed.

The following morning, the two remained, obnoxious and outdoing each other. It seemed as though, between them, even yucca soured. In the street, meanwhile, those present were exhilarated with the masquerade. The buffoons began worsening their insults with fine-edged and fine-tuned barbs. Believing it to be a show, the passersby left coins along the roadside.

On the third day, however, the clowns arrived at acts of force. Their blows became a disarray, their counterkicks zinged more across air than across bodies. The children rollicked, imitating each jester's blows. And they laughed at the two fools, their bodies tripping upon their own selves. And the boys wanted to repay the delightful goodness of the clowns.

— Dad, give me some coins to leave on the sidewalk.

On the fourth day, the jabs and blows grew worse. Beneath their makeup, the faces of the clowns began to bleed. Some kids became scared. Was that true blood?

— It's not serious, don't fret, their parents soothed them.

In failures of trajectory, some were struck by directionless wallops. But it was light fare, only serving to add to the laughs. More and more people joined the gallery.

— What's going on?

Nothing. A friendly unsettling of accounts. It's not worth separating them. They'll tire out, it's nothing more than a bit of clowning around.

On the fifth day, however, one of the clowns armed himself with a stick. Advancing on his adversary, he discharged a blow that tore off his wig. The other, furious, equipped himself with a symmetrical beating bat and responded with the same dismeasure. The wooden rods whistled through the air in somersaults and deliriums. One of the spectators, unexpectedly, was struck. The man fell, deadspread.

A certain confusion arose, the souls divided. Little by little, two battlefields began to form. Various groups traded drubbings. Still more were felled.

It entered a second week and the surrounding neighborhoods heard it said that a dizzied pandemonium had set in around the two clowns. And the thing embroiled the entire plaza. And the neighbors found it funny. Some went to the plaza to verify the reports. They returned with contradicting and inflamed versions of their own. The neighborhood continued to divide itself, in opposing opinions. Conflicts began in some neighborhoods.

On the twentieth day, shots began to be heard. No one knew exactly where they came from. Could have been from any point in the city. Full of terror, the inhabitants armed themselves. The tiniest movement seemed suspect. The shots spread. Dead bodies began to accumulate in the streets. Terror reigned over the whole city. Soon, massacres began.

At the beginning of the month, all the city's inhabitants had died. All except the two clowns. That morning, the clowns sat, each one in his corner, and ridded themselves of their ridiculous dress. They looked at each other, worn out. Later, they rose to their feet and embraced, laughing at the flags dispersed. Arm in arm, they gathered the coins from the roadsides. Together they crossed the city destroyed, careful not to tread on the cadavers. And they went in search of another city.

## Appendix B

### War of the Clowns

Please place the following events from the story in the order in which they occurred, from 1 (first event) to 10 (last event).

- \_\_\_\_\_ A pair of clowns set themselves to arguing.
- \_\_\_\_\_ War broke out in the city.
- \_\_\_\_\_ One clown hit the other with a stick.
- \_\_\_\_\_ Everyone in the city was dead.
- \_\_\_\_\_ The clowns left the city.
- \_\_\_\_\_ People gave the clowns money.
- \_\_\_\_\_ The clowns took off their costumes.
- \_\_\_\_\_ A spectator was struck and killed.
- \_\_\_\_\_ The clowns punched each other.
- \_\_\_\_\_ People watched the clowns for entertainment.

## Appendix C

### Technology and Vision Survey

- Which response best describes the way you use textbooks for your classes?
  - I use only printed textbooks.
  - I use only digital textbooks.
  - I use a combination of both printed and digital textbooks.
  
- Why do you use digital textbooks/E-books?\*\*\*
  - They are less expensive than printed books.
  - They take up less space than printed books.
  - They conserve paper.
  - Other
  - I do not use digital textbooks/E-books.
  
- Which response best describes the way that you read?
  - When I read, I take my time to ensure that I understand the story I usually only read through things one time.
  - I skim through readings quickly and then go back and review important concepts or things that I did not understand.
  - I use a combination of these methods.
  - I use a different reading method.
  
- Which type of textbooks do you feel helps you learn the best?
  - Printed textbooks
  - Digital textbooks
  - I do not think either form is more beneficial than the other.

- Unsure
- How many hours per day, on average, do you spend using devices? (Cell phone, tablet, laptop, etc.)
  - 0-1
  - 2-3
  - 4-5
  - 6-7
  - 8 or more
- Do you sometimes feel like your eyes “need a break” from screens?
  - Yes
  - No
  - Unsure
- Do you utilize a “night mode” on your cell phone to reduce eyestrain?
  - Yes
  - No
  - I do not know about this feature.

\*\* For this question, participants could select more than one response.