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Paper versus Screen: Impact on Reading Comprehension and Speed

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Abstract

Choosing the appropriate reading format is important for students to achieve effective reading. This quasi-experimental study investigates the effects of paper versus screen on reading comprehension and speed among undergraduate students who are currently enrolled in a public university in Sarawak. The general objective of this study is to investigate the formats for effective reading and comprehension among undergraduates. Instruments that have been used in this study were a set of questionnaires, a set of general interest articles, corresponding comprehension questions, and an online timer. Findings revealed that students tended to have better reading comprehension when reading on the screen. Conversely, students were able to read faster using the paper format. Data also revealed that there is significant difference between paper and screen formats for both reading comprehension and reading speed.

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Introduction

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ

(Translation: Read! In the Name of your Lord, Who has created (all that exists).

Reading is the key to living as a human being. It is a complex two-stage process involving the way in which a text is perceived, followed by how the reader processes the information (Church, 2002). In today's digital age, the nature of reading printed paper is shifting because of the escalating presence of e-reading (electronic reading). According to Dahlstrom and Bichsel (2014), 70% of undergraduate students around the world use laptops, 59% uses smartphones and 35% uses tablets in class for academic purposes. When reading on a computer screen, the text-based process deals with typography and the human-computer interface, including issues such as contrast, resolution, fonts, flicker, luminance, letter case, and eye fatigue, while the knowledge-based process involves the measure of a reader's comprehension (Church, 2002). Good readers would know which strategy should be applied when reading, and how to use reading strategy effectively and efficiently, to achieve their reading comprehension. In Malaysia, reading plays a crucial role for Malaysian students to excel academically. As most academic reading materials are in English, many Malaysian students struggle with the English language proficiency, particularly when reading and writing for academic purposes. For centuries, the United States of America has taken a leading role in many academic fields of research, so academic publishing in English language has been increasing day by day (Mercer & Swann., 1996). With the bulk amount of information to read in school, reading quickly, efficiently and with great comprehension become a necessity. According to Barnett (1992) reading strategies is the mental operations involved when readers approach a text effectively and make sense of what they read. In a study he conducted in 1992, Barnett found that there is a strong relationship between students' reading proficiency and reading strategy use (Barnett, 1992). For undergraduate students, it is crucial to identify and use the best reading strategies because the ultimate goal is to improve comprehension. According to McClelland (1979) people who read fast tend to signify a high level of comprehension; hence, to read in a fast manner yet effectively, students need to improve their reading comprehension skills. According to Belmore (1985), reading comprehension become worse and reading speed become slower when one uses computer screen due to one's lack of familiarity with computers and reading from screen. Extending previous researches on reading, this study is designed to investigate reading comprehension and speed, specifically focusing on screen and paper formats for reading. This is an area worthy of the current learning context, as university students are increasingly utilising both screen and paper formats to read and write academically.

The growing use of technology in the classroom for reading is because e-books have been available in many formats and these formats are incompatible (Anuradha & Usha, 2006). Rockinson (2013) described how university students are increasingly using e-books rather than printed paper. The uncomplicated way to store academic materials influenced the patterns of usage of technology tools among undergraduate students. Accordingly, e-books are convenient classroom teaching tools, and they are able to provide an alternative or augmented mode for those with low hand skills. Moreover, e-books are available online can be accessed 24/7 from one's own laptop or desktop, and it is possible for more than one person to access the same e-book at any one time. In spite of these advantages, e-books are still not very popular (Anuradha & Usha, 2006).

The possible reasons for this could be because of the lack of awareness of software and hardware available for e-books, that people are intuitively used to reading printed books and do not want to change the habit, and the technology for creating and accessing e-books for both software and hardware has not yet matured. However, although e-books tend to mimic printed textbooks, students may not read e-books the same way as they would do printed textbooks. For example, readers report skimming text from computer screen more often than printed text and reading e-text in an "F" pattern, scanning and searching for keywords rather than reading line by line. Many studies have been investigating the impact of hypertext structure on cognitive aspects of reading and comprehension. A review by DeStefano & LeFevre (2007) concluded that hypertext structure tended to increase cognitive demands of decision making and visual processing. This additional cognitive load, in turn, impairs reading comprehension performance. However, not all digital texts are hypertexts. For this reason, digital reading does not necessarily entail increased cognitive load caused by hypertext features. A study conducted by Staiger (2012) reported university students used e-books just to find the exact information they want, and that they would not read the whole e-book deeply. Another study by Rice (1994) concluded that reading comprehension constructs appears to be the same between reading from computer screen and reading from printed text, but when readers engage in a highlighting task, a significant effect is found for both paper and screen media of presentation. There are also studies that reported contradictions to each other, for instance, a study by Broek, Espin, and Deno (2003) which described how reading comprehension depended on individual differences in word-reading efficiency.

Taking the shortest time to read academic reading material is very important for undergraduate students, due to the pressure to deal with assignments, quizzes and examinations for every course they enrol into at the university. Poulton (1958) proposed that students' reading comprehension increase significantly when they decrease their speed of reading, a paradox in comparison to a study by Tinker (1963) which propositioned that if one's reading speed is increased, the reader tended to comprehend better than one who read slowly.

For undergraduate students who have weak proficiency in English, the acquisition of reading skills such as reading comprehension and reading speed is a challenge. Students need to be able to read in English because the bulk of academic reading materials are in English. Students with poor reading skills tend to have problems in doing assignments and would be at risk of obtaining low marks or grades in courses which uses English as the main medium for reading and writing (Boulay, 1999). Boulay (1999) also mentioned that university students tended to lack in critical argument in doing their assignment, a

problem rooted from having poor reading skills. A separate research also found that university students with low verbal ability are unable to interpret information from the text they read (Baker, 1985). According to McClelland (1979) people who read fast tend to signify high level of comprehension, therefore in order to read in a fast manner yet effectively, students need to improve their reading comprehension skills. Evidently, learning to speed read is an important skill for undergraduate students who are commonly struggling to deal with their academic workload.

In this today's digital world, reading materials can be found in various forms including in the form of electronic books which are familiarly known as e-books and typical printed books. To date, there has been an abundance of research that reported contradictory findings about reading among undergraduates. None has specifically looked at universities in Malaysia. Therefore, this research investigates the phenomenon in a selected learning environment, to understand how the phenomenon exists in the local context, using these questions to guide the inquiry:

1. Does reading on printed paper and on e-books affect students' reading comprehension?
2. Does reading on printed paper and on e-books affect students' reading speed?

The growth of electronic information available online and through academic libraries has brought about the increase of reading using screens. As a result, there has been numerous research conducted on the reading of electronic documents in comparison to their print counterparts. Students today are equipped with technology tools, making it easier for them to access reading materials via screens. There have been several studies which supported the increase of use of screen reading. A study by Mangen, Walgermo and Bronnick (2013) recommended that reading through computers gave a good impact for the eyes because of the nature of the screen. Szapkiw et al (2013) described how electronic documents that optimise hypertext and multimedia to engage students can lead to improved learning outcomes. However, many researchers questioned the effect of electronic reading on deep reading skills, comprehension and the development of long-term knowledge and critical thinking.

Reading, in particular for the young generation, using screen format, is increasingly being used in comparison to the paper format. However, does every student acknowledge their best reading environment? Choosing the right reading environment is important for students to achieve effective reading. Timothy Bell (2001) claimed that reading comprehension could lead to significant improvements in student's reading speeds. Evidently, the role of effective reading is crucial for students to excel academically. Findings from this study would contribute as a reference for university lecturers in capitalising and maximizing the potentials of both reading formats to engage students in learning.

In today's digital age, the nature of reading printed paper is gradually changing due to the increasing presence of e-texts (electronic texts). A study by Rockinson-Szapkiw et al. (2013) looked at 538 students who were asked about their behaviours related to their chosen textbook via an online survey with open ended and multiple choice questions. The result revealed that students chose to read e-text due to its cost and portability, yet the remaining students in the same study preferred to read printed text due to familiarity with print versions and the ability to highlight text and jot down their foot notes. According to Johnson, Adams, & Cummins (2012), students are already expecting changes in content delivery formats, understandable and approachable options, students want to learn anytime, anywhere and the material is becoming inexpensive. Although reading on e-text is engaging, conducive to deep reading and offer to access electronic reading material without the distracting pop ups and advertisement as mentioned by Durant and Horava (2015), but the computer screen itself is not good for the eyes because the screen resolution, backlighting and LCD (liquid-crystal display) screen that projects an adverse effect to students' visual processing of text (Mangen, Walgermo, & Bronnick, 2013) the study concluded that laptops and desktop computers may not be much better for reading.

To date, the usage of electronic tablets is still scarcely investigated. Nielsen (2013) found that gesture interfaces on tablets were difficult to control and the split screen designs decreased the ability to read text. Another study by Chen et al. (2014) on the effect of the tablet, computer or paper on reading comprehension, found that users who are more familiar with tablets, would be more able to perform better on their reading comprehension test compared to novice tablet users. In Kang, Wang and Lin study (2009), students who read longer e-texts would experience eye fatigue and mental load. Stoop, Kreutzer and Kircz (2013) found that users would be prone to distraction because of the multi-functional capabilities of tablets, consequently affecting comprehension and retention of information (Durant & Horava, 2015). Distracting pop-ups are also seen as an obstacle to concentrate, when reading from personal computers and laptops (Stoop, Kreutzer, & Kircz, 2013). Morineau, Blanche and Tobin (2005) found how 40 adults who were randomly assigned may have experienced eye fatigue and mental workload, in comparison to those who chose to read printed textbooks.

One of the most comprehensive studies that looked at screen and paper reading in an academic environment was undertaken by Noyes and Garland in (2003). In this study, 50 students from University of Bristol were asked to study economics material, a subject that all participants were all unfamiliar with, before completing tests which required some content to be remembered within the subject. The study was aimed to identify if one medium was superior to the other, in terms of mastery of long-term knowledge of a subject, as opposed to short-term remembering. Though the study found very minimum differences between speed and recall of screen and paper, they did find that the transition of knowledge from the episodic memory to the semantic memory was more efficient from reading on paper. Based on their following study conducted in 2014, Noyes and Garland proposed that reading from paper led to better information retention and knowledge.

Dillon (1992) explained that notable advances in technology have existed, and that specific issues with electronic documents, for example cathode ray tubes and flickering screens, are no more relevant. However, he also expounded on several problems with reading studies; the subjective nature of reading, the unique environmental circumstances of each study, the different outcomes measured across reading studies and the bulk of studies that focused on speed and accuracy

for short texts as opposed to the comprehension of complex information. These factors helped explain of the some contradictory results of previous research on reading. A study by Stoop, Kreutzer and Kircz (2013) saw students, among the selected participants, who accessed electronic textbooks on e-readers and laptops, complained of the nature of e-books. They reported that e-books were generally inflexible to perform text annotations. Half of the students in the study bypassed the e-reader's locked format to print the documents, and the other half wanted to perform the same action but didn't know how, and they gave feedback that the printed textbook option too expensive. From this study, it appeared that students would have a preference for paper over electronic documents. In a follow-up study, an interactive learning map was used as an educational resource. Different web pages were used to illustrate different types of information, to dismiss one long screen of texts to scroll. Findings revealed that students who participated in the study were committed about the potential of the electronic document to enhance their reading experience. However despite their enthusiasm, the researchers also found that students' reading comprehension of complex information was better when reading using paper format, comparatively to the electronic documents (Stoop, Kreutzer, & Kircz, 2013).

Many researchers, who have explored the effect of formats on reading comprehension, questioned whether electronic documents were an improvement on their print precursors within education, notably discussed in studies by Durant and Horava (2015), Daniel and Woody, (2013), Eden and Eshet-Alkalai (2013) and many more. Szapkiw et al. (2013) and Stoop et al. (2013) mentioned that electronic documents have the potential to provide an engaging, interactive learning environment through hyperlinks and multimedia. However, another study found that there are many academic materials that were not written for the internet, but scanned versions of paper originals with few multimedia maybe available (Rose, 2011). While the phenomenon of traditional way of reading is changing, the design of most academic electronic material is still based on printed precursors.

Academic reading also requires a high level of concentration and text comprehension, often aided by interaction with the document, including annotating, highlighting and bookmarking (Chou, 2012). One of the reasons of why annotating, highlighting and bookmarking involved as an interaction is the ability to easily mark-up paper documents, although increasingly speed and recall differences between the media are found to be minimal, students express a preference for the lengthy print versions of academic reading materials (Rose, 2011). In 2015, a study conducted by Gilbert and Fister (2015) on e-textbooks, university students initially expressed a preference for printed books, but they were satisfied when they had been given a chance to use an e-book for an assessment task. In another study, students expressed a predisposition to use print books over electronic versions, regardless of the very least differences in their post-test quiz results (Daniel & Woody, 2013).

There are limited number of studies that have looked into the impact of e-textbooks on academic outcomes and student experience using PCs (Berg, Hoffmann, & Dawson, 2010). Within academic institutions, students are also writing, editing and reading their own work as part of course assessments and exam revision. A few differences in correcting errors or understanding content between paper and electronic texts were found. It was concluded that as screen reading has become a routine for students, they were becoming more competent in reading and editing by using electronic devices.

Staiger's research in (2012) reviewed studies on the usage of e-books among academic communities and found that there is an agreement among the readers on the benefit of being able to access e-books from anywhere, at any time. Students also tended to use e-books for particular information, as opposed to reading the document in its linear form. In Gilbert and Fister's study in (2015), they acknowledge that it is difficult to compare the use of academic e-books and printed books. This is because there is little research on how students and academics actually read monographs. A more recent study by McLure and Hoseth (2012) on e-books' usage across academic disciplines reported that there was no difference between how students from Science, Technology, Engineering and Maths (STEM) disciplines use e-books in comparison to their non-STEM peers. However, it was observed that students from the other faculties seem to be using e-books more than others. A survey on university students conducted by Mclure and Hoseth in (2012) found that natural sciences and engineering students were most likely to have used an e-book for academic purposes, while veterinary medicine, biomedical and applied human sciences were least likely to have used an e-book. Preferences for e-books over printed books were also higher between continuing education, business and engineering students.

The percentage of liberal arts students who preferred e-books over paper monographs was higher than the agricultural and veterinary students. Many respondents preferred the printed book because they found computers strained their eyes. Consequently they would opt to print the academic section of reading material to read. The research also concluded that many students found printed documents are easier to map-read and missed the ability to browse that print books and journals (McLure & Hoseth, 2012).

A later study by (Gilbert & Fister, 2015) found that students who said they would use an e-book for research purposes were mostly from the fine arts (including communications), and natural science faculties. The other surveys by Carroll, Corlett-Rivera, Hackman and Zou, (2016) were designed to identify changes in using paper and electronic text and their preferences among the academic communities. The study found there is a little difference between STEM and non-STEM disciplines. Alternately, they found students' preference for printed reading material declined from 2012 to 2014. By 2014, there are about 32.9% of students across all disciplines noted they had 'no preference' when questioned on a preferred format. This was a sharp increase from 23% since 2012 and suggested that students from all faculties were becoming used to using e-books for their studies.

As Van Dijk and Kintsch (1983) have observed, there are many elements of different sub-processes required, which are knowledge integration, coherence and parsing to measure comprehension. Asking questions on story content, the researchers concluded, was the most logical method of assessment. According to Reinking and Schreiner (1985), the

different tools which are reading from text and reading from screen affected on reading comprehension of poor and good readers. Margen, Walgermo and Bronnick (2013) stated that, primary school students who read through computer screen has poor reading comprehension rather than students who read through printed paper even though the text given has the same content. Conversely, Dillon (1992) and Mayer et al. (2001) reported that students who use traditional textbooks achieved higher levels of reading comprehension and learning and another studies reported that involving longer reading passages indicated poorer comprehension (Kang, Wang, & Lin, 2009). However, according to Staiger (2012) university students used e-books just to find the exact information they want, not read the whole e-book deeply. One study by Rice (1994) used two measures to examine reading comprehension of short texts contain 142 words which are a text recall measure and a highlighting task to examine reading comprehension. The findings revealed no significant effect for presentation mode on paper or screen on the recall measure. However, on the interactive measure (highlighting task), a significant main effect was found for presentation mode which paper being significantly better compared to the computer. According to Durant and Horava (2015), before the internet there were two ways to read. Some people were driven by the need to find particular information or fact for specific purposes. The other linear form involved concentration and emotional engagement (Sun, Shieh, & Huang, 2013). More recently, hypertexts within electronic documents allow readers to leave one resource and explore a range of alternative resources, providing a less linear, reading experience (Horney & Anderson-Inman, 1999). HTML and XML can also enable information to be presented as a multi-layered experience, quite different compared to the traditional print-on-paper experience. Reading is a combination of recognising words and deciphering their meaning, as well as comprehending the larger context within which the words are read (Duran, 2013). Reading theorists mentioned that comprehension of text in comparison of basic reading requires higher levels of cognitive and linguistic skills for the reader to be able to understand both the literal and inferential meanings of text (Sun, Shieh, & Huang, 2013).

In (1971), Rothkopf tested the effect of text location for information recall. This researcher confirmed prior studies by Underwood (1969) as cited in his study and Bower (1970) which found information's spatial attributes positively affect memory. These theories of spatial recognition, which the information is recalled in relation to where it is read within a document, have been explored by more recent researchers studying memory and comprehension differences between paper and screen reading formats (Durant & Horava, 2015). In Tulving's (1985) research, he developed a comprehension theory that is now regularly referred to in comprehension studies as the 'Remember-Know learning paradigm'. As mentioned by Tulving (1985), there are two ways with which the brain recognises information, namely; remembering (episodic memory) and knowing (semantic memory). To remember something, the brain recollects information in relation to its context. Sometimes, one can remember something specifically by its location within a document (Rothkopf, 1971). By remembering information, it would develop into knowledge. To know something is a deeper form of information retrieval, more long term and with fewer contextual associations.

Some studies suggest that the longer term category of 'knowing' is seen as a result of good learning and one that higher education should aim to foster (Garrison & Cleveland-Innes, 2005). Wolf, a neuroscientist who has written extensively on the cognitive processes involved in reading, believes that reading deeply is integral to furthering comprehension, deductive reasoning, critical thought and insight (Wolf, 2010). She suggested that those who have advanced reading skills are able to contextualize and conclude deeper meaning from text they have read. The ability to read deeply and analytically can take years to develop and the focusing skills are important and it encourages learning independently (2009). Carr (2010) explored the effect of increased online reading on the human brain. He proposed that the ability to read deeply enables students to integrate memorised information into knowledge. He added the language and visual ability areas of the brain that were stimulated when reading print. In addition to these, the decision-making and pattern analysis areas of the brain were also stimulated when reading online. This stimulation may give negative effect towards readers' ability to reflect, absorb and recall information as effectively as information in the in the printed text format. Durant and Horava (2015) questioned the negative effect on the development of deep reading skills and the richness of writing as the brain becomes habitual to reading less deeply from the screen.

As studies by Dee-Lucas and Larkin (1995) suggested, interactive overviews increased learners' memory of and representation of ideas presented in digital texts. On top of that, richer visual structural cues may increase learners' efficiency with finding needed information in a screen reading format, but more extensive mental effort might need to be expended to figure out how to navigate this structure (Hsua & Schwenb, 2003). Although this visualization presents additional text-processing demands (Wenger & Payne, 1996), comprehension and learning may be facilitated as long as readers are able to understand the organizational structure of the representation of the text environment and use this structure to effectively control navigation (Cuddihy & Spyridakis, 2012).

The earliest study investigated a difference between the two media, with an advantage for the paper-based display is discussed here. In Muter, Latrrouille, Teurniet & Beam study as cited by (Belmore, 1985), the researchers did a study to compare reading speed and comprehension. They found that one using the screen read 28.5% slower than one who used printed paper as their reading material. There are reasons for the difference in reading speed which are unfamiliarity with reading from a screen compared with book, page layouts between the two media are not similar, variable postures between subjects and the time taken to refresh the screen between presentations. In (1986), Gould found that people lack familiarity or experience with CRT display. Character fonts that look like those on paper, had a polarity of dark characters on a light background, were anti-aliased that contained grey level and were shown on displays with high resolution such as 1000 x 800 are the variables that can probably contribute to better reading speed on screen but the trade-offs have not been purposive. There have been several more recent studies published that bear on this question, although the conclusions to be reached still remain ambiguous. By far the most common examination finding is silent reading from screen is significantly slower than reading from paper. Initial experimental studies suggested that reading long passages of information took longer when using an electronic format compared to reading a paper based texts (Dillon, 1992).

It was found that reading from a screen increased the length of time it took to read a text by 20–30%. Another study done by Shepperd, Grace and Koch (2008) examined 392 undergraduate psychology students who were given the choice to use either electronic or paper based text for reading and study. 90% of the students chose to purchase the paper text, while only 10% chose to purchase the electronic text. A comparison of student achievement in final grades showed no difference between groups, and the e-textbook group reported spending less time reading the text. A study done by Kerr and Symons (2006) assessed students' reading performance on paper and screen. They examined whether students' reading rate, comprehension, and if recall were affected by the use of a computer screen. Sixty fifth grade students read two descriptive texts which were the printed version and digital version. The texts were 372 and 411 words long and hence required a limited amount of scrolling in the computer condition. The results indicate that students read text more slowly on computers compared to printed paper. In this experiment, they recalled more of the information that they had read when they used computer as their reading tool. These findings suggest that if sufficient time was provided to the participants, they would have been more able to comprehend equal amounts of information from both paper and computer. However, when their reading time was accounted, the students comprehended less efficiently when reading from the screen.

Fry (1963) claimed that good readers read at 350 words per minute, fair readers read 250 words, and slow readers read 150 words per minute. Berkoff's study in 1979 claimed that a fast reader is not necessarily an efficient reader and a slow reader is necessarily an inefficient reader. It is worth noting that students have a large amount of reading to cope with while they complete their studies, and therefore cannot afford to be slow readers (Berkoff, 1979). Therefore, it is important to evaluate whether a digital medium is conducive to an adequate reading speed. The importance of speed when it comes to assessing reading ability is not an entirely new concept (Perfetti, 1985). The relevance of efficient word decoding in reading as early as 1908 (Huey, 1908), and more recent studies once again highlighted the importance of including speed when assessing skill in reading (Adlof, Catts, & Little, 2006), (Barth, Catts, & Anthony, 2009) and (Torgesen & Hudson, 2006).

Methodology

The quasi-experimental design is constructed to examine reading comprehension and reading speed. The design for the investigation on reading comprehension is adapted from Mangen, Walgermo and Bronnick (2013) while the instrument used to measure reading speed is adapted from Dyson and Haselgrove's study (2001). Cohen, Manion and Morrison (2007) recommended experimental designs to be used to answer cause-and-effect questions; in the context of this study, changes would be made in the input (independent variable), in order to observe the effect of the manipulated change on the output (dependent variable). Participants are divided into two groups; one group would use the paper format to read, while the other would use the screen format. Reading comprehension is measured by a set of multiple choice questions covering the text from their reading before (Mangen, Walgermo, & Bronnick, 2013). The participants received a reading-comprehension pre-test consisting of a series of expository texts. Each text was followed by multiple choice questions. Besides, reading speed is measured by participants reading a text from two different tools which are read using printed paper and on a laptop screen (Dyson & Haselgrove, 2001) and (Bell, 2001). The study records the amount words remembered, a criterion of comprehension, if the quantity increased significantly when reading on paper and on screen. The reported speed for reading normally benchmarked at 300 words per minute, on paper, and 150 words per minute, on screen. However, the study also notes one of the conclusions of a seminal study on reading print conducted by Tinker in the 1930s and 1940s (as summarized in Tinker's study (1963)) was that the fast reader tends to comprehend better.

Participants were divided into two groups, and were informed that the study examines the effects on reading comprehension and reading speed by using two different tools, paper and screen. Participants were asked to complete an informed consent form, and a set of demographic profile survey. Participants from "Paper Group" were assigned to read a set of printed short article, and they were required to answer a set of multiple choice questions. The participants from "Screen Group" were assigned to read an online short article, and they were asked to answer a set of multiple choice questions. For "Screen Group", the laptop screen was adjusted to a fixed height that was intended to suit most people. The mouse tool was not provided, as participants were expected to interact solely via the laptop keyboard and a touchpad. Both reading comprehension and reading speed were measured in situ.

The participants received a reading-comprehension pre-test consisting of one narrative and one expository text. Each text was followed by multiple choice questions. The texts contained 1400–1600 words and included graphical and/or pictorial illustrations. The format and number of pages for each text were identical for on-screen and on-paper presentation. The students were allowed to look back at the text passages while answering the questions. Those who read digitally were able to scroll up and down the pages, and change between reading the assigned material and answering the curated questions.

To enable participants in the fast reading speed condition to achieve a faster reading speed, which was relative to their normal speed, a period of training was introduced at the beginning of the experiment. In this training stage, participants were asked to read an initial document at their normal, comfortable reading speed. Then they will be asked to speed up their reading and try to read the next document at twice this speed for instance taking half as much time. Having read the second document, a message box was presented to the participants to indicate their performance.

All of the texts were presented via two formats, print end on screen. The texts have the same page layout, including font size, typeface, font colour, and line spacing. For the paper format, the passages were printed on A4 paper (dimensions of 210x297 mm). For the screen format, the same passages were presented as PDF-files with Adobe Reader XI for Windows, at 100 % scale.

This study used descriptive statistics to analyse demographic data. Normally distributed variables are presented as means

and standard deviations for descriptive purposes. Two Independent sample T-test analyses are used to investigate differences between the mean score of paper format and the screen format of reading (Belsley, Kuh, & Welsch, 1980). Inferential statistics was used to compare values of significant differences between the two participant groups, using an Independent T-Test for paired samples, using Levene's test.

Results

The results showed participants scored significantly better for reading comprehension when they read using the screen. It was revealed that there was a significant difference between paper and screen reading. This happen because every students has their own nature of reading and learning which has been mentioned by Chen et al. (2014) on the effect of the tablet, computer or paper on reading comprehension, they found that users who were more familiar with tablets, will performed better on their reading comprehension test compared to novice tablet users. The findings corresponded to Sun, Shieh & Huang's study (2013), which found that reading from screen obtained better comprehension performance in terms of the numeral and clausal issues Table 1

N	Minimum	Maximum	Mean	Std. Deviation
TSPR	42	3.50	9.00	6.5119
TSSR	42	5.0	8.00	6.5952
Valid N (listwise)	42			

Table 1. *Descriptive analysis of the total scores between paper and screen reading*

Note: TSPR = Total Score Paper Reading

TSSR = Total Score Screen Reading

Table 2:

N	Minimum	Maximum	Mean	Std. Deviation
TTPR	42	8.14	17.57	12.2669
TTSR	42	8.35	41.25	17.4469
Valid N (listwise)	42			

Table 2. *Descriptive analysis of the time taken between paper and screen reading*

Note: TTPR = Time Taken for Paper Reading

TTSR = Time Taken for Screen Reading

Table 3:

P = 0, S = 1	N	Mean	Std. Deviation	Std. Error Mean
RC	0	42	13.02	2.454	.379
	1	42	13.19	1.642	.253
RS	0	42	12.2669	2.34541	.36190
	1	42	17.4469	6.18773	.95479

Table 3. *Independent T-test result for reading comprehension and reading speed*

Note: P = Paper

S = Screen

RC = Reading Comprehension

RS = Reading Speed

Table 4:

		Lavene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RC	EVA	4.96	.03	-.37	82	.72	-.17	.46	-1.07	.74
	EVA			-.37	71.56	.72	-.17	.46	-1.08	.74
RS	EVA	13.20	.00	-.5.07	82	.00	-5.20	1.02	-7.21	-3.15
	EVA			-5.07	52.54	.00	-5.20	1.02	-7.23	-3.13

Table 4. *Independent T-test (Lavene's test result) of reading comprehension and reading speed*

 p<.0

Note: RC = Reading Comprehension

RS = Reading Speed

EVA= Equal Variance Assumed

The finding in this study is contradictory to some previous studies as mentioned above. This can be supported by other studies such as Szapkiw et al. (2013) and Stoop et al. (2013) that mentioned that electronic documents have the potential to provide an engaging, interactive learning environment through hyperlinks and multimedia. Furthermore, within academic institutions, students are also writing, editing and reading their own work as part of course assessments and revision for examination. Few differences in correcting errors or understanding contents between paper and electronic texts were found. The researchers concluded that screen reading is becoming a routine for students and they are becoming more competent in reading and editing using electronic devices (Berg, Hoffmann, & Dawson, 2010).

It was also revealed that students have faster reading speed in term of paper reading format and they have slower reading speed in term of screen reading format. It was evident that there is a statistical difference between paper and screen reading. This is because students who read longer e-texts would experience eye fatigue and mental workload. There has not been a large amount of literature on the use of tablets for academic reading (Kang, Wang, & Lin, 2009). In (1986), Gould found people who lacked familiarity or experience with CRT display, would have issues reading them. Character fonts that look like those on paper, had a polarity of dark characters on a light background, were anti-aliased that contained grey level and were shown on displays with high resolution such as 1000 x 800, probably contributed to better reading speed on screen but the trade-offs have not been purposive.

Nielsen (2013) study also explained, gesture interfaces on tablets were difficult to control and the split screen designs decreased the ability to read text. This can be supported in the study by Muter, Latrrouille, Teurniet & Beam study as cited by (Belmore, 1985) which found that the one using the screen read 28.5% slower than one who used printed paper as their reading material. Another study found that students have poor performance on reading speed when they read on screen because there was time spent in pausing between scrolling movements. The time spent in scrolling movements is generally the next most important variable, with those spending less time scrolling reading faster.

Conclusion

This study aims to investigate whether reading on paper or screen affects undergraduate students' reading comprehension and their reading speed. Research on comparing between paper and screen on reading comprehension and reading speed has largely been conducted since the late 1960s, but the results seem rather inconsistent. The findings from previous studies were mostly inconclusive and inclined towards screen reading deriving poorer user performance. Regarding reading comprehension differences between paper and screen reading, some earlier research found that comprehension was worse when reading from screen compared with paper reading Noyes and Graland (2003), Kerr & Symons (Kerr & Symons, 2006) & Mangen, Walgermo & Bronnick (2013). However, some studies reported no significant differences between reading comprehension for paper and screen formats (Broek, Espin, & Deno, 2003).

Reading is a pervasive and essential activity in our lives especially for students. It requires many mental and cognitive processes. With the incredible and fast-paced advances being made in computer technology, people have greater

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opportunities to read information directly on a computer screen. Although research on comparing print and screen reading performance has largely been carried out during the past two decades, the findings from previous studies seem rather inconclusive and inconsistent. This study was motivated with the view to exploring this gap, specifically to examine the focusing on screen and paper tools for reading.

Although this study does not represent the entire population of undergraduates in Malaysia who are actively enrolled in public universities, it provides a perspective about the phenomenon faced by undergraduates today, in terms of dealing with their academic reading tasks at the university. The study highlights the need to identify and select the best reading environment for undergraduates to read quickly and efficiently with sufficient comprehension.

Based on the findings of this study, it is recommended for students to read on screen to achieve a better comprehension while in order to read quickly, this study suggests to use a traditional format which is paper. Although the study assessed reading comprehension and reading speed by the most common form of assessments such as article and multiple choice questions, a follow-up study should address other cognitive indicators to measure effects of reading, such as eye movements, lengths of attention span, paraphrasing competencies and scrolling patterns. Undergraduates today are provided with both paper and screen formats for reading; it is still unclear how they use the multiple modes of reading materials and stimulus to construct their comprehension to accomplish their academic tasks.

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References

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